RECORD OF DECISION

OPERATION OF GLEN CANYON DAM

Final Environmental Impact Statement

October 1996

Approved

______________________________ Date OCT 08 1996

Commissioner, U.S. Bureau of Reclamation

______________________________ Date OCT 09 1996

Secretary of the Interior

RECORD OF DECISION

OPERATION OF GLEN CANYON DAM
FINAL ENVIRONMENTAL IMPACT STATEMENT

I. INTRODUCTION

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

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

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

> "...in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use."

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

II. DECISION

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

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

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

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

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

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

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

III. DESCRIPTION OF ALTERNATIVES

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

UNRESTRICTED FLUCTUATING FLOWS

> **No Action**: Maintain the historic pattern of fluctuating releases up to 31,500 cubic feet per second and provide a baseline for impact comparison.
>
> **Maximum Power plant Capacity:** Permit use of full power plant capacity up to 33,200 cubic feet per second.

RESTRICTED FLUCTUATING FLOWS

> **High:** Slightly reduce daily fluctuations from historic levels.
>
> **Moderate:** Moderately reduce day fluctuations from historic levels; includes habitat maintenance flows.
>
> **Modified Low (Preferred Alternative):** Substantially reduce daily fluctuations from historic levels; includes habitat maintenance flows.
>
> **Interim Low:** Substantially reduce daily fluctuations from historic levels; same as interim operations except for addition of common elements.

STEADY FLOWS

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

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

Year-Round: Provide steady flows throughout the year.

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

IV. SIGNIFICANT ISSUES AND ALTERNATIVES

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

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

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

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

V. COMMENTS RECEIVED ON THE FINAL EIS

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

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

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

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

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

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

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

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

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

As part of the EIS, the effects of each alternative on long-term sand storage in Marble Canyon (river miles 0 to 61) were analyzed. The Marble Canyon reach was chosen for analysis because it is more sensitive to impacts from darn operations than downstream reaches. For each fluctuating flow alternative, the analysis used 20 years of hourly flow modeled by Spreck Rosekrans of the Environmental Defense Fund and 85 different hydrologic scenarios (each representing 50 years of monthly flow data). This analysis was documented in the draft EIS on page 182, and Appendix D, pages 4-5. The analyses relating to the probability of net gain in riverbed sand for each alternative is documented in the draft EIS on pages 54-55, 184, 187, and 194.

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

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

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

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

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

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

COMMENT: Endorse the Fish & Wildlife Service's Biological Opinion and implement experimental steady flows to benefit native fishes, subject to the results of a risk/benefit analysis now in progress.

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

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

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

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

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

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

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

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

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

VI. ENVIRONMENTAL COMMITMENTS AND MONITORING

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

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

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

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

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

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

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

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

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

VII. BASIS FOR DECISION

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

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

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

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

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

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

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

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

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

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

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

ATTACHMENT 1.

Specific peer reviewed sediment studies:

Beus, S. and C. Avery. 1993. The influence of variable discharge regimes on Colorado River sand bars below Glen Canyon Dam. Glen Canyon Environmental Studies, Report PHY0101, Chapters 1 through 7. Northern Arizona University, Flagstaff, AZ

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

Budhu, M and R. Gobin. 1-994. Monitoring of sand bar instability during the interim flows: a seepage erosion approach. Glen Canyon Environmental Studies, Report PHY 0400. University of Arizona, Tucson, AZ

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

Cluer, B. 1993. Annual Report. Sediment mobility within eddies and the relationship to rapid erosion events. Glen Canyon Environmental Studies, Report PHY 01l. National Park Service, Ft. Collins, CO

Cluer, B. and L. Dexter. 1994. An evaluation of the effects of the interim flows from Glen Canyon Dam on the daily change of beach area in Grand Canyon, AZ. Glen Canyon Environmental Studies, Report PHY 0109. Northern Arizona University, Flagstaff, AZ

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

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

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

Smith, J. and S. Wiele. 1994. Draft report. A one-dimensional unsteady model of discharge waves in the Colorado River through the Grand Canyon. Glen Canyon Environmental Studies, Report PHY 0805. U.S. Geological Survey, Boulder, CO

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

ATTACHMENT 2.

Samples of comment letters and cards, and a copy of EPA's comment letter.

F - J

Colorado River Studies Office
Bureau of Reclamation
Attn:UC1512
PO Box 11568
Salt Lake City, UT 84147

Dear Sirs,

I am deeply concerned with the Final Glen Canyon EIS document and would like my concerns attached to the Record of Decision you are sending to Secretary Babbitt.

1 Maintain interim flows. I ask for credible proof, based on the testing of a specific scientific hypothesis, that alterations in operating procedures at Glen Canyon Dam follow the spirit and intent of the Grand Canyon Protection Act.

2 Do not change two parameters at once. Changing two flow criteria does not make prudent scientific sense; it will not result in reliable data. There is not enough information at hand to predict the outcome of these proposals.

3 Habitat/Beach Building Floods. Periodic "spike flows" are critical to restore some of the river's historic dynamics; without them any flow regime will result in continued loss of beach and backwater habitat. This "spike" should be assessed and implemented for the spring of 1996.

4 Fish & Wildlife Service's Biological Opinion. I call for experimental steady flows to benefit native fishes, subject to the results of a risk/benefit analysis now in progress.

5 Adaptive Management Program. I urge immediate funding and implementation of the AMP. It is imperative that reasoned judgment monitor over, and respond to, possible adverse effects resulting from changes in dam operations.

6 1 urge Interior Secretary Babbitt to issue a Record of Decision by December 31, 1995 and, to this end, I ask for an efficient and timely audit by the General Accounting Office as mandated by the Grand Canyon Protection Act.

7 Keep me posted as to the progress and changes to the EIS

Sincerely,

Jon Porter, M.D.
501 7th Street
Manhattan Beach CA 90266

CITY OF ENTERPRISE

P.O. Box 340
ENTERPRISE, UTAH 84725
(801) 878-2221
FAX (801) 878-2223

F01445

FEIS

APRIL 12, 1995

MR. RICK GOLD
COLORADO RIVER STUDIES OFFICE
BUREAU OF RECLAMATION
ATTN: UC1512
BOX 11568
SALT LAKE CITY, UT 84147

DEAR MR. GOLD:

THE FINAL IMPACT STATEMENT (FEIS), WHICH WAS RELEASED ON MARCH 22, 1995, REFLECTS YEARS OF RESEARCH, STUDY AND DISCUSSION AMONG DIVERSE GROUPS. POWER USERS HAVE BORNE SOME $100 MILLION IN STUDY COSTS TO ASCERTAIN THE EFFECT OF POWER OPERATIONS ON THE ENVIRONMENT IN THE GRAND CANYON. WE PLEDGED AT THE OUTSET TO ACCEPT THE FINAL RECOMMENDATION, PROVIDED THAT IT COULD BE SUPPORTED BY CREDIBLE, THOROUGH SCIENCE.

NOW THAT THE FEIS IS OUT, SOME GROUPS ARE CHALLENGING THE RECOMMENDATION. IT IS UNDERSTANDABLE THAT NO PARTICULAR GROUP IS FULLY SATISFIED WITH THE RESULT, INCLUDING POWER USERS. THE FEIS IS TRULY A COMPROMISE, A RECOGNITION THAT THE BENEFITS OF THIS PUBLIC RESOURCE MUST BE SHARED AMONG MANY--AND SOMETIME COMPETING--INTERESTS. FOR US, IT MEANS THE LOSS OF VALUABLE PEAKING CAPACITY FROM GLEN CANYON, WHICH WE MUST REPLACE AT HIGHER COST.

SCIENCE SUPPORTS THE RECOMMENDED WATER RELEASE PATTERNS CONTAINED IN THE FEIS. ACCORDING TO INFORMATION RELEASED BY THE BUREAU, "the GCES senior scientist and the advisory group....determined there would be no significant impact to downstream resources if the maximum flow was raised to 25,000 cfs and the upramp to 4,000 cfs per hour."

I COMMEND THE BUREAU OF RECLAMATION AND THE PARTICIPANTS OF THE COOPERATING AGENCIES FOR THEIR DEDICATION TO SOUND SCIENTIFIC METHODS AND CAREFUL CONSIDERATION OF THE FINDINGS. THE GCEIS IS A MODEL FOR RESOLVING COMPLEX ENVIRONMENTAL ISSUES AMONG DIVERGENT INTERESTS. I URGE YOU TO PROTECT THE INTEGRITY OF THE PROCESS AND RESIST EFFORTS TO OVERTURN THE FEIS. ALLOW THE SCIENTISTS' ASSESSMENT TO STAND, KNOWING THAT THE ADAPTIVE MANAGEMENT PROCESS WILL GIVE THE BUREAU AN OPPORTUNITY TO EVALUATE THE EFFECTS OF OPERATIONAL CHANGES OVER TIME AND MAKE MODIFICATIONS ACCORDING TO SCIENTIFIC FINDINGS.

SINCERELY,

GAYLE L. ROHDE, CITY RECORDER

Dear Sirs,

I am deeply concerned with the Final Glen Canyon EIS document and would like my concerns attached to the Record of Decision you are sending to Secretary Babbitt.

- *Maintain Draft EIS flows*. I ask for credible proof, based on the testing of a specific scientific hypothesis, that alterations in operating procedures at Glen Canyon Dam follow the spirit and intent of the Grand Canyon Protection Act
- Do not *change two parameters at once.* Changing two flow criteria does not make prudent scientific sense; it will not result in reliable data. There is not enough information at hand to predict the outcome of these proposals.
- I support *Habitat/Beach Building* Floods. Periodic "spike flows" are critical to restore some of the river's historic dynamics; without them any flow regime will result in continued loss of beach and backwater habitat. This "spike" should be assessed and implemented for the spring of 1996.
- Fish *& Wildlife Service's Biological Opinion.* I call for experimental steady flows to benefit native fishes, subject to the results of a risk/benefit analysis now in progress.
- *Adaptive Management Program.* I urge immediate funding and implementation of the AMP. It is imperative that reasoned judgement monitor over, and respond to, possible adverse effects resulting from changes in dam operations.
- I urge Interior Secretary Babbitt to issue a Record of Decision by December 31, 1995 and, to this end, I ask *for an efficient and timely audit by the General Accounting Office* as mandated by the Grand Canyon Protection Act.
- Keep me posted as to the progress and changes to the EIS.

Sincerely,

Signature *Mark J. Diedrick*

Name MARK J. DIEDRICK

Address 220 Grove Ave.

City, State, Zip Prescott AZ 86301

PM
23 MAR
1995

Old Glory
USA G
For U.S. addresses

Colorado River Studies Office
Bureau of Reclamation
P.O. Box 11568
Salt Lake City, UT 84147

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION DC
75 Hawthorne Street
San Francisco, CA 94105-2901

June 20, 1995

Charles Calhoun
Regional Director
Upper Colorado River Region
Bureau of Reclamation • •
P.O. Box 11568
Salt Lake City, UT 84147

Dear Mr. Calhoun:

The U.S. Environmental Protection Agency (EPA) has reviewed the Final Environmental Impact Statement (Final BIS) for Operation of Glen Canyon Dam/ Arizona. Our comments are provided to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementation Regulations at 40 CFR 1500-1508, and EPA's authorities under Clean Air Act §309.

EPA continues to support the preferred alternative, and we are pleased that the Final BIS addresses the issues we raised in our April 11, 1994, comment letter on the Draft EIS. We had. expressed concerns regarding ehe impacts of raising the spillway gates and recommended that flood frequency reduction measures be evaluated in greater detail before an option was selected. We are pleased that a more detailed analysis of the flood frequency reduction measures will be conducted, in compliance with NEPA, before a decision is made on this issue, Furthermore, since the Draft EIS was released to the public last year, much progress has been made among all of the interested parties regarding future research and adaptive management.

We applaud the efforts made by all of the agencies, tribes, organizations, and individuals involved in the research, scoping, and preparation Qf this BIS. Their dedication to sound science and cooperative relations have been critical to developing a preferred alternative (including adaptive management) , which we believe will protect and enhance environmental and cultural resources downstream from Glen Canyon—Dam.

Sincerely,

Deanna M. Wieman

Deanna M. Wieman, Director
Office of External Affairs

000218
cc: mailing list

Printed on Recycled Paper

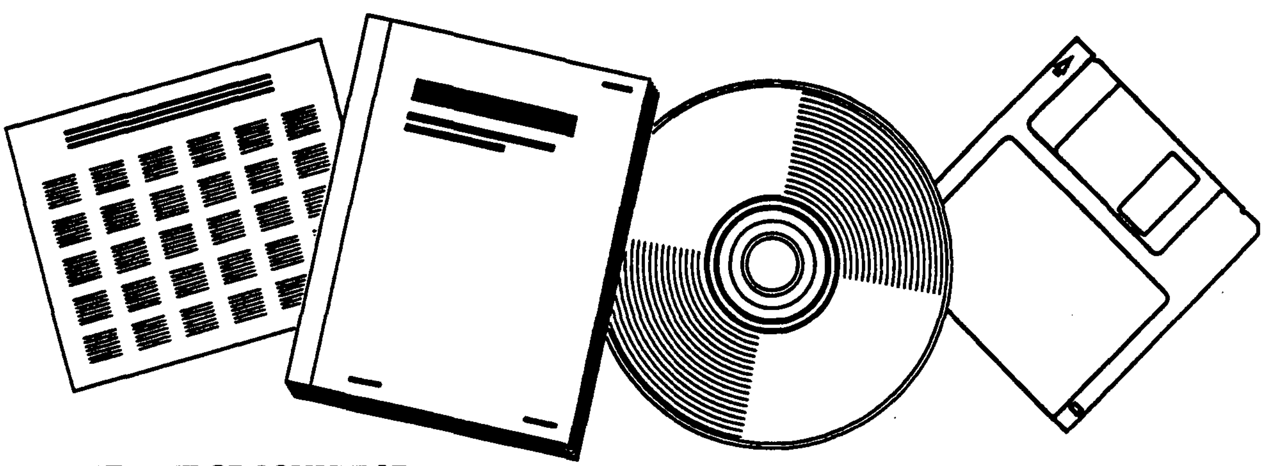
ATTACHMENT 3.

GCES Non-Use Values Final Study Summary Report.

PB98-105406

GLEN CANYON DAM
COLORADO RIVER STORAGE PROJECT, ARIZONA
NONUSE VALUES STUDY

OCT 97



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

GLEN CANYON DAM
Colorado River Storage Project, Arizona

NONUSE VALUES STUDY FINAL REPORT

October 1997

U.S. Department of the Interior
Bureau of Reclamation

REPORT DOCUMENTATION PAGE

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PB98-105406

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6. AUTHOR(S)

Michael P. Welsh, Richard C. Bishop, Marty L. Phillips, and Robert M. Baumgartner

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, WI 53711-1058
(608) 232-2800

8. PERFORMING ORGANIZATION REPORT NUMBER

NA

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Bureau of Reclamation
Upper Colorado Regional Office
125 South State Street
Salt Lake City, UT 84138-1102

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

EC-97-10

11. SUPPLEMENTARY NOTES

The summary report (alone) is EC-97-09. Related reports include EC-97-11 and EC-97-12. The study data set is available as NTIS number PB-96-501887.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Available from the National Technical Information Service,
Operations Division, 5285 Port Royal Road. Springfield, Virginia 22161
(703) 487-4650

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Nonuse or passive use economic value is the value of a natural resource held by individuals who may not physically use the resource. The goal of the Glen Canyon Environmental Studies (GCES) Nonuse Study was to estimate the total economic value for changes in the operation of Glen Canyon Dam. This four year effort included extensive qualitative research, a number of focus groups, a survey design phase, two reviews by the Office of Management and Budget, a pilot-test phase, and a final survey of 8,000 households in the United States. This document details the approach, methodology, analysis, and results of that study.

14. SUBJECT TERMS

Glen Canyon Dam, Grand Canyon, Nonuse Value, Total Economic Value, Passive Use Value, Contingent Valuation.

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REPORT EC-97-10

GLEN CANYON DAM, COLORADO RIVER STORAGE PROJECT, ARIZONA
NONUSE VALUES STUDY FINAL REPORT

by

Hagler Bailly Consulting Inc.
University Research Park
455 Science Drive
Madison, WI 53711-1058

October 1997

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GCES NON-USE VALUE STUDY

Final Report

Prepared for:

Glen Canyon Environmental Studies
Non-Use Value Committee

Prepared by:

Hagler Bailly Consulting
University Research Park
455 Science Drive
Madison, WI 53711-1058

Authors:

Michael P. Welsh
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September 8, 1995

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Appendix H Additional Analyses

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CHAPTER 1
OVERVIEW AND SUMMARY

The operation of Glen Canyon Dam has been the focus of an ongoing controversy. Operations that increase the value of electric power produced at the dam tend to result in substantial daily fluctuations in river levels below the dam. These fluctuations have been found to decrease the size and number of beaches and change the habitat of terrestrial and aquatic species including endangered fish species. In addition, daily fluctuations tend to reduce the quality of recreation on the river downstream from Glen Canyon Dam.

Changes made in operations to benefit the downstream environment and the quality of recreation will reduce the value of power produced at the dam, resulting in a conflict between the type, level, and availability of environmental amenities and recreational opportunities along the Colorado River versus dam operations. This conflict can be partially evaluated by measuring the relative economic value placed on electric power, recreation, and preservation of river-related resources downstream from Glen Canyon Dam. In 1983, the Bureau of Reclamation established the Glen Canyon Environmental Studies (GCES) to explore these relationships between dam operations and downstream resources. As part of the GCES, the Bureau of Reclamation authorized and funded a series of economic studies to measure these three values in a theoretically consistent way. Previous studies resulted in estimates of the economic value of downstream recreation (Bishop et al., 1987) and the value of power produced at the dam (GCES Power Resources Committee, 1995). The Glen Canyon Non-Use Value Study is the third component of the GCES Economic Studies.

This report describes the GCES Non-Use Value Study, a study of values associated with preserving the river-related resources on the Colorado River downstream from Glen Canyon Dam. The value associated with environmental preservation is often referred to as "non-use value."[1] While the concept may be unfamiliar to non-economists, it has been a part of economic theory for over 30 years. Beginning with an article written by John Krutilla (1967), economists have come to recognize that economic values for public resources may not be limited to direct use values. For a variety of reasons, people may value environmental

[1] The term non-use value will be used in this report to denote a value placed on a resource in the absence of any direct or indirect use of the resource. This type of value is sometimes referred to as passive use value. The term total value denotes the value placed on a resource regardless of the motivation for the value. While the study presented in this report technically measured total values, because very few respondents have use values for resources affected by dam operations, the measured total values are likely to consist primarily of non-use values.

resources even though they do not benefit from directly consuming produced goods or recreational opportunities. They may, for example, be sympathetic toward animals, altruistic toward others in the current generation or future generations, or be concerned about maintaining the resource for future personal use. It is now widely agreed among economists (see, for example, Freeman, 1993) that the value of a public resource may include non-use values in addition to the more traditionally measured use values. It follows that a full accounting of the values associated with changes in dam operations will include the non-use values, if they are present, as well as direct use values.

In this study, non-use values were measured using a contingent valuation mail survey. This chapter provides an overview of the study and a summary of the survey results. A more detailed presentation of the study, implementation, and results is provided in the chapters that follow. Chapter 2 provides a detailed discussion of the conceptual basis of the study. This is followed by a discussion of the study process, including the research plan, the qualitative research conducted in the early stages of the study, and the pilot test implemented to test the field-readiness of the survey instruments. Chapter 4 provides information on the design and implementation of the final survey. Results are presented and discussed in Chapter 5. A discussion of the validity of these results is provided in Chapter 6.

1.1 BACKGROUND ON THE RELATIONSHIP BETWEEN POWER PRODUCTION AND DOWNSTREAM RESOURCES

Glen Canyon Dam is an energy-constrained hydroelectric facility. This means that in a typical year, the annual release from the dam is not sufficient to sustain peak generation for the entire year. The economic benefits of energy-constrained hydroelectric facilities are maximized by concentrating water releases during periods of highest electrical demand. Historically, Glen Canyon Dam has been operated in this way. The consequence of this type of operation has been substantial daily fluctuations in the river flows below Glen Canyon Dam. These daily fluctuations tended to result in a net loss of sediment in the Colorado River below Glen Canyon Dam, resulting in a decrease in the size and number of beaches, as well as changes in habitat for terrestrial and aquatic animals, including endangered species of fish. Daily fluctuations in water levels were also documented as having decreased the quality of rafting and fishing on the Colorado River below Glen Canyon Dam (Bishop et al., 1987).

These linkages form the basis for the conflicts that have resulted over issues of dam operation. A change in dam operations that decreases the range of daily fluctuations is likely to reduce impacts to the downstream resources and to increase the quality of recreation. On the other hand, such a change will also reduce the value of the power produced at Glen Canyon Dam. From an economic perspective, this problem can be addressed by measuring the relative values placed on power, recreation, and the protection of resources affected by the operations of Glen Canyon Dam. To this end, GCES has carried out a series of economic studies designed to measure each of these values. This report summarizes the GCES effort to measure the non-use values associated with alternative dam operations.

1.2 RESEARCH PLAN, QUALITATIVE RESEARCH, PILOT TEST

Each step in the evolution of this study was guided by the GCES Non-Use Value Committee. The committee consisted of representatives of federal agencies, American Indian tribes, and power consumer groups. A peer review panel consisting of four nationally prominent resource economists reviewed research plans and results at each key stage in the research. In addition, the Office of Management and Budget (OMB), which is required to approve all federally sponsored surveys, provided insightful suggestions during the approval process.

The initial step in the GCES Non-Use Value Study was the completion of a report assessing the feasibility of estimating total values associated with the preservation of environmental resources in and along the Colorado River below Glen Canyon Dam. This effort was initiated in 1990 and completed in 1991. The report concluded that a total value study, including the measurement of non-use values, should be a component of the GCES economic studies (Bishop and Welsh, 1992). The report further concluded that although the prospects appeared favorable, such a study should proceed in phases and be subjected to a peer review process at the conclusion of each phase. Subsequent phases would be recommended only with the approval of committee members and peer reviewers.

The Non-Use Value Study was initiated with a qualitative research effort involving focus groups and in-depth personal interviews. The qualitative research phase had several objectives. These included:

- Exploring whether potential survey respondents could focus on affected resources as distinct from the Grand Canyon in its entirety;
- Exploring whether potential survey respondents care about the status of the affected resources;
- Exploring whether individuals geographically distant from Glen Canyon Dam care about the status of the affected resources;
- Exploring alternative methods for describing the environmental effects of dam operations; and
- Evaluating the performance of prototype survey instruments.

Results from the qualitative research reinforced the conclusion of the feasibility report. The results suggested that many citizens across the United States were concerned about the status of the resources affected by the operation of Glen Canyon Dam. Issues of particular concern included beaches and vegetation, archeological sites, American Indian traditional use areas, native fish, trout, and price impacts to consumers of power produced at Glen Canyon Dam. Furthermore, the qualitative research also suggested that the study could be implemented using a mail survey instrument for primary data collection. In the summer of 1993, the results of the qualitative research phase and prototype mail survey instruments were reviewed by the both the GCES Non-Use Value Committee and an external peer review panel. The decision was made to proceed with a pilot test.

The fall of 1993 was devoted to finalizing the design of survey instruments to be used in the pilot test and securing clearance from OMB to proceed with implementation of a pilot test. Implementation of the pilot test began in January 1994. Purposes of the pilot test included evaluating the performance of mail survey instruments, examining methodological concerns related to the validity of the contingent valuation method, and testing survey implementation procedures. The results of the pilot test suggested that the survey instrument and implementation procedures would result in valid estimates of non-use values associated with resources affected by the operation of Glen Canyon Dam. After review by the committee and external peer review panel, a decision was made to proceed with a final study.

The final study design was the end product of an extensive research process that has been overseen at every step by the GCES Non-Use Value Committee. Review by the committee provided valuable insights from a broad range of perspectives. In addition, members of the committee worked closely with members of the GCDEIS team to ensure that the survey instruments contained accurate descriptions of the expected consequences of each dam operation alternative. We believe the input from the committee, peer reviewers, and OMB has greatly enhanced the quality and overall validity of the GCES Non-Use Value Study.

1.3 FINAL SURVEY DESIGN AND IMPLEMENTATION

The GCES Non-Use Value Study was designed to evaluate three of the alternatives assessed in the Glen Canyon Dam Environmental Impact Statement (GCDEIS). In the survey, the no-action alternative was defined as the baseline (or current) dam operation condition. This baseline condition consisted of maintaining the maximum daily fluctuation in flows, ranging from 3,000 cubic feet per second (cfs) to 31,500 cfs between Easter and Labor Day and from 1,000 cfs to 31,500 cfs between Labor Day and Easter. Given the similarities in resource impacts between several of the remaining eight alternatives and the depth of detail required to describe them, the GCES Non-Use Value Committee recommended that only three main alternatives be considered for the final study:

1. Moderate fluctuating flow alternative - featuring a moderate reduction in the magnitude of the daily fluctuations;
2. Low fluctuating flow alternative - featuring reductions in the magnitude of the daily fluctuations; and
3. Seasonally adjusted steady flow alternative - providing steady flows on a seasonally adjusted or monthly basis.

These three alternatives covered most of the range of alternative dam operations being examined and were considered to include the set of alternatives most likely to contain the eventual preferred alternative.[2] Therefore, the experimental design was planned around these three alternatives.

The experimental design included two samples, seven versions of a mail questionnaire, and a follow-up telephone interview with nonrespondents. Because water releases from Glen Canyon Dam affect resources located in the Grand Canyon National Park, the sampling frame included all residents of the United States. Two separate random samples were identified within this frame: a national sample and a marketing area sample. The national sample consisted of residents of the United States. The marketing area sample was a subset of the national sample whose energy needs were serviced by Salt Lake City Area Integrated Projects (SLCA/IP). This design ensured that estimates of non-use values reflected both the values held by United States residents as well as the values held by individuals who would be directly affected by increases in utility bills. Samples were purchased from Survey Sampling, Inc., an independent firm that specializes in maintaining national marketing databases.

There were two primary differences between surveys administered to the marketing area sample and those administered to the national sample. First, the surveys differed in the payment vehicle used to solicit non-use values in the contingent valuation question. For the national sample, the payment vehicle consisted of an annual payment in increased taxes. For residents of the marketing area, increases in utility bills were used as a payment vehicle. Surveys administered to each sample also differed in the description of resources included in the dam operation alternative. In the national sample, the survey contained a description of the environmental and power cost impacts of the dam operation alternative. In contrast, the marketing area survey described only the environmental impacts of the dam operation alternative.

Separate survey versions were designed in order to address the three water release alternatives chosen, resulting in a total of six survey versions (three for the national sample and three for the marketing area sample). One additional survey version was developed for

2 For more detailed information on alternative dam operations, refer to the GCDEIS (U.S. Bureau of Reclamation, 1995).

the national sample to examine in more detail the effects on the study of including the impacts that water flow alternatives would have on power costs. Table 1-1 identifies the differences between questionnaire versions.

Table 1-1
Identification of Glen Canyon Studies Non-Use Mail Questionnaire Versions

Questionnaire Version	Water Release Alternative
National Sample	
Version 1	Moderate Fluctuating Flow
Version 2	Low Fluctuating Flow
Version 3	Seasonally Adjusted Steady Flow
Version 4	Seasonally Adjusted Steady Flow with Moderate Fluctuating Flow Impact Costs to Power
Marketing Area Sample	
Version 5	Moderate Fluctuating Flow
Version 6	Low Fluctuating Flow
Version 7	Seasonally Adjusted Steady Flow

Four of the seven questionnaire versions were administered to the national sample, and three were administered to the marketing area sample. Each version was administered to 850 sample points (Table 1-2). The sample for the follow-up telephone survey consisted of the portion of national and marketing area samples for which no final mail disposition had been reached. Interviews were attempted with 1,708 individuals: 1,102 from the national sample and 606 from the marketing area sample.

Table 1-2
Sample Sizes for the Glen Canyon Studies Mail Surveys and Follow-up Telephone Interviews

Questionnaire Version	Sample Size	
	Mail Survey	**Telephone Survey**
National Sample		
Moderate Fluctuating Flow (Version 1)	850	286
Low Fluctuating Flow (Version 2)	850	267
Seasonally Adjusted Steady Flow (Version 3)	850	272
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	850	277
Total	3,400	1,102
Marketing Area Sample		
Moderate Fluctuating Flow (Version 5)	850	207
Low Fluctuating Flow (Version 6)	850	205
Seasonally Adjusted Steady Flow (Version 7)	850	204
Total	2,550	606
Overall Total	5,950	1,708

Mail questionnaires were administered using the Dillman (1978) method, which consisted of the following procedures:

1. An advance, introductory letter on U.S. Bureau of Reclamation letterhead, signed by the GCES manager. The letter explained the study and advised that a questionnaire would be sent within the week.

2. A survey mailing package containing a copy of the questionnaire, background information materials, a cover letter on U.S. Bureau of Reclamation letterhead, a stamped return envelope, and a $3 cash incentive.

3. A thank you/reminder postcard sent to all respondents, thanking those who had already responded to the survey and encouraging those who had not responded to please do so.

4. A second survey package containing a second copy of the questionnaire and background materials, a different cover letter, and a stamped return envelope.

5. A third survey package delivered via certified mail. This package also contained a copy of the questionnaire and background materials, a different cover letter, and a stamped return envelope.

Mail survey implementation began in October 1994 and was concluded in early January 1995. All mail survey versions were administered concurrently.

Follow-up telephone interviewing began on January 19, 1995, four weeks after the final survey mailing. Telephone interviews were attempted for all nonrespondents for whom telephone numbers could be obtained. All telephone interviews were conducted by experienced interviewers using Computer Assisted Telephone Interviewing (CATI) software at an in-house telephone laboratory in Madison, Wisconsin.

Response rates for completed mail surveys were calculated as a percentage of deliverable questionnaires. The study achieved a response rate of 66 percent for the national sample, and 75 percent for the marketing area sample (Table 1-3).

Table 1-3
Glen Canyon Studies Non-Use Mail Survey Response Rates

	Sample Size	Out of Scope[a]	Completed Surveys	Response Rate[b]
National Sample				
Moderate Fluctuating Flow (Version 1)	850	188	426	64%
Low Fluctuating Flow (Version 2)	850	202	431	66%
Seasonally Adjusted Steady Flow (Version 3)	850	1,196	439	67%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	850	190	432	65%
Total	3,400	776	1,728	66%
Marketing Area Sample				
Moderate Fluctuating Flow (Version 5)	850	219	467	74%
Low Fluctuating Flow (Version 6)	850	226	467	75%
Seasonally Adjusted Steady Flow (Version 7)	850	200	489	75%
Total	2,550	645	1,423	75%

[a] Includes cases where the addressee was deceased or the survey mailing was returned as undeliverable.
[b] Calculated as a percentage of deliverable questionnaires (sample size minus out-of-scope cases).

Response rates to the telephone survey of nonrespondents are shown in Table 1-4. Telephone interviews were completed with 35 percent of nonrespondents from the national sample, and with 46 percent of nonrespondents to the marketing area sample.

Table 1-4
Glen Canyon Studies Non-Use Telephone Survey Response Rates

	Sample Size	Out of Sample[a]	Withdrawn from Sample[b]	Completed Interviews	Response Rate[c]
National Sample					
Moderate Fluctuating Flow (Version 1)	286	90	9	66	35%
Low Fluctuating Flow (Version 2)	267	92	6	53	31%
Seasonally Adjusted Steady Flow (Version 3)	272	79	9	69	37%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	277	80	14	63	34%
Total	1,102	341	38	251	35%
Marketing Area Sample					
Moderate Fluctuating Flow (Version 5)	207	57	7	62	43%
Low Fluctuating Flow (Version 6)	205	63	7	58	43%
Seasonally Adjusted Steady Flow (Version 7)	194	42	6	74	51%
Total	606	62	20	194	46%

a Includes disconnected, no listing available, wrong phone numbers, and cases where the identified respondent was unavailable for the study duration, unable to participate due to physical or mental impairment, deceased, or had moved.

b Includes cases pulled from the sample before a final disposition was reached because a mail questionnaire was received during implementation of the telephone survey.

c Calculated as a percentage of available (reachable) respondents.

1.4 RESULTS

Non-use values were measured using the contingent valuation method. In a contingent valuation survey, respondents are asked questions about how much they would be willing to pay to either maintain or acquire a preferred level of an environmental good. In this survey, respondents were first asked if they would vote in favor of a proposal to change dam operations if it cost them nothing. Those in favor of the proposal were then asked how they would vote if passage of the proposal cost them a specified amount of money. Responses to this second question were used to make inferences about the value, or willingness-to-pay, placed by respondents on the proposal being evaluated.

Proposals evaluated by members of the national sample included descriptions of the impacts the proposal would have on the number and size of beaches, archaeological sites and American Indian traditional uses, native fish, trout, electric bills for consumers of power produced at Glen Canyon Dam, and farm incomes. In the national sample, willingness-to-pay was measured by asking respondents whether they would vote for a proposal to change dam operations if passage meant they would have to pay increased taxes. Proposals evaluated by members of the marketing area sample included descriptions of the proposal's impacts on the number and size of beaches, archaeological sites and American Indian traditional uses, native fish, and trout. In the marketing area sample, willingness-to-pay was measured by asking respondents how they would vote on a proposal to change dam operations if passage increased their monthly electric utility bill.[3]

Estimates of average willingness-to-pay in the national sample for each of the three alternatives evaluated are shown in Table 1-5. These numbers reveal substantial non-use values for each of the three alternatives. The low fluctuating flow alternative and the seasonally adjusted steady flow alternative would result in non-use values that are approximately 50 percent greater than the non-use values associated with the moderate fluctuating flow alternative.

[3] Copies of survey instruments are found in Appendix E.

Table 1-5
Summary of Estimated Willingness-to-Pay -- National Sample

Water Release Alternative	Average Annual Value Per Household[a]	Aggregate Annual Value[b] (Millions of Dollars)
Moderate fluctuating flow (Version 1)	$13.56	$2,286.4
Low fluctuating flow (Version 2)	$20.15	$3,375.2
Seasonally adjusted steady flow (Version 3)	$20.55	$3,442.2

[a] Best estimates based on "Definitely Yes" models, adjusted to reflect values of nonrespondents and to reflect the belief that the respondent would actually have to pay if the proposal passed. For details see Chapter 5.

[b] Levelized annual values extrapolated to the national population. See Chapter 5 for additional details on the procedures used to calculate these numbers.

Estimates of average willingness-to-pay in the marketing area sample for each of the three alternatives evaluated are shown in Table 1-6. Survey respondents in the marketing area are individuals who will likely bear the costs of any changes in dam operations, and this may give their responses added importance in decisions regarding the future operations of Glen Canyon Dam. Residents of the marketing area also expressed significant non-use values for each of the three alternatives evaluated. Non-use values were approximately equal for the moderate and fluctuating flow proposal and were about one-third higher for the seasonally adjusted steady flow alternative.

Table 1-6
Summary of Estimated Willingness-to-Pay -- Marketing Area Sample

Water Release Alternative	Average Annual Value Per Household[a]	Aggregate Annual Value[b] (Millions of Dollars)
Moderate fluctuating flow (Version 5)	$22.06	$62.2
Low fluctuating flow (Version 6)	$21.45	$60.5
Seasonally adjusted steady flow (Version 7)	$28.87	$81.4

[a] Best estimates based on "Definitely Yes" models, adjusted to reflect values of nonrespondents and to reflect the belief that the respondent would actually have to pay if the proposal passed. For details see Chapter 5.

[b] Levelized annual values extrapolated to the population of households residing in areas served by utilities with firm power contracts for power produced at Glen Canyon Dam. See Chapter 5 for additional details on the procedures used to calculate these numbers.

The non-use values contained in this report are just one of many factors that might be considered in making decisions regarding future operations of Glen Canyon Dam. The extent to which these values might be considered will depend, at least in part, on the perceived validity of the values. Given the substantial controversy among economists regarding the validity of the non-use values measured using contingent valuation method, we conclude this chapter with some observations about the validity of the study results.

As discussed in Chapter 6, the validity of a contingent valuation study can be assessed in terms of content validity (how well the study was designed and implemented), and construct validity (the consistency of the results with economic theory).

A contingent valuation study with a high level of content validity would have many characteristics. For example, a content valid study would be based on a clear theoretical definition of the value to be measured. Based on well-documented evidence of the respondent-relevant effects of the intervention, a sound study effectively communicates the potential effects of the intervention to respondents. The scenario describing the intervention must include whatever information respondents might need regarding potential substitutes for the environmental resources in question and reminds them of their context for valuation. The scenario also includes a fully specified and incentive-compatible context for valuation. A sound study will do all of this in ways that potential respondents can accept and, if possible, believe. Beyond the scenario, a content-valid survey instrument also includes well-designed questions to support construct validity testing and achieve other goals. The mode chosen for administering the survey must be appropriate for the complexity of the scenario and the ultimate goals of the study. Prior to administration, the instrument must be subjected to sufficient qualitative investigation, pretesting, and, if needed, pilot testing to eliminate as many problems as possible. Econometric analysis of the results must be adequately performed and the final results effectively reported. We believe that the GCES Non-Use Value Study meets these standards well.

A contingent valuation study with high construct validity is one that would pass both rudimentary and advanced theoretical validity tests. The valuation equations estimated in this study showed a high degree of consistency between study results and prior expectations. Furthermore, subject to a few caveats discussed in Chapter 6 regarding the marketing area surveys, we were able to achieve considerable success in passing scope tests.

Our conclusion, then, is that the GCES Non-Use Value Study has demonstrated sufficiently high levels of content and construct validity to be used in choosing the criteria for operating Glen Canyon Dam in the future. Integrating the results of this study with recreation valuation studies should help to judge the economic implications of alternative criteria for operation of Glen Canyon Dam.

CHAPTER 2
CONCEPTUAL CONTEXT

Glen Canyon Dam has been producing electric power for over 30 years. For most of this time, typical power operations resulted in large daily fluctuations in the level of the Colorado River downstream from the dam. Concern about the environmental consequences of these daily fluctuations resulted in the initiation of the Glen Canyon Environmental Studies (GCES) in 1982. The initial phase of GCES demonstrated a link between the operation of the dam and downstream environmental conditions. This link, and continued concern about the effects of dam operations on the Grand Canyon River environment, led then Secretary of the Interior Lujan, in 1989, to order the preparation of an environmental impact statement for the operations of Glen Canyon Dam. At that time, the GCES were directed to further document effects of dam operations on the downstream environment for use in the preparation of the Glen Canyon Dam Environmental Impact Statement (GCDEIS).

From the early days, the GCES recognized that in addition to affecting the natural environment, the operations of Glen Canyon Dam also affect the human environment. The initial phase of the GCES targeted the effects of dam operations on downstream recreation, including whitewater rafting and fishing. In a review of the initial GCES research, the National Academy of Sciences identified two additional aspects of the human environment for future study. These areas included the impact of changes in dam operations on the value of power produced at that dam and the existence, or non-use, values that would be placed on resources affected by dam operations. Each of these topics has been the subject of additional research in subsequent phases of GCES.

2.1 THE RELATION BETWEEN POWER PRODUCTION AND DOWNSTREAM RESOURCES

Glen Canyon Dam is an energy-constrained hydroelectric facility. This means that in a typical year, the annual release from the dam is not sufficient to sustain peak generation for the entire year. The economic benefits of energy-constrained hydroelectric facilities are maximized by concentrating water releases during periods of highest electrical demand. Historically, Glen Canyon Dam has been operated in this way. The consequence of this type of operation has been substantial daily fluctuations in the river flows below Glen Canyon Dam. These daily fluctuations tended to result in a net loss of sediment in the Colorado River below Glen Canyon Dam. This resulted in a decrease in the size and number of beaches, and changes in habitat for both terrestrial and aquatic animals, including endangered species of fish. Daily fluctuations in water levels were also shown to decrease the quality of rafting and fishing on the Colorado River below Glen Canyon Dam (Bishop et al., 1987).

These linkages form the basis for conflicts over dam operation. A change in dam operations that decreases the amount of daily fluctuations is likely to reduce impacts on the downstream resources and increase the quality of recreation. On the other hand, such a change will also reduce the value of the power produced at Glen Canyon Dam. From an economic perspective, this problem can be addressed by measuring the relative values placed on power, recreation, and the protection of resources affected by the operations of Glen Canyon Dam. To achieve this, GCES has carried out a series of economic studies designed to measure each of these values.

The value associated with environmental preservation is often referred to as "non-use value." While the concept may be unfamiliar to non-economists, it has been a part of economic theory for over 30 years. Beginning with an article written by John Krutilla (1967), economists have come to recognize that economic values for public resources may not be limited to direct use values. For a variety of reasons, people may value environmental resources even though they do not benefit from directly consuming produced goods or recreational opportunities. They may, for example, be sympathetic toward animals, altruistic toward others in the current generation or future generations, or be concerned about maintaining the resource for future personal use. Economists now widely agree that the value of a public resource may include non-use values in addition to the more traditionally measured use values (see, for example, Freeman, 1993). It follows that a full accounting of the values associated with changes in dam operations will include the non-use values, if they are present, as well as direct use values.

It should be noted that the value of a resource, regardless of the motivation for the value, is commonly referred to as a "total value." The values measured in this report are total values in that respondents are asked about their willingness-to-pay for a change in dam operations. Theoretically, the values expressed by survey respondents could arise from any one (or all) of the following motivations: a direct use of the resource (for example, rafting the Colorado River or hiking along the river below Glen Canyon Dam), a desire to preserve the option for future direct uses, and a desire to preserve the resources even in the absence of current or future use. This latter type of value is typically referred to as non-use value. Practically speaking, we suspect that non-use value is likely to be the primary motivation for total value of the resources affected by the operation of Glen Canyon Dam. For this reason, although the survey technically measures a total value, it is referred to in this report as a non-use value.

CHAPTER 3
NON-USE VALUE STUDY PROCESS

The Glen Canyon Non-Use Value Study is the third component of the GCES Economic Studies. Previous studies have resulted in estimates of the economic value of downstream recreation (Bishop et al., 1987) and the value of power produced at the dam (GCES Power Resources Committee, 1995). The GCES Non-Use Value Study is the product of a series of research steps carried out over the last five years.

At each step, the study was guided by the GCES Non-Use Value Committee. The committee consisted of representatives of federal agencies, American Indian tribes, and power consumer groups. A peer review panel consisting of four nationally prominent resource economists reviewed research plans and results at each key stage in the research. In addition, the Office of Management and Budget (OMB), which is required to approve all federally sponsored surveys, provided insightful suggestions during the approval process.

3.1 THE RESEARCH PLAN

The initial step in the GCES Non-Use Value Study was the completion of a report assessing the feasibility of estimating total values associated with the preservation of environmental resources in and along the Colorado River below Glen Canyon Dam. This effort was initiated in 1990 and completed in 1991. The report concluded that a total-value study, including the measurement of non-use values, should be a component of the GCES economic studies (Bishop and Welsh, 1992). The report further concluded that although the prospects appeared favorable, such a study should proceed in phases and be subjected to a peer review process at the conclusion of each phase. Subsequent phases would be recommended only with the approval of committee members and peer reviewers.

3.2 QUALITATIVE RESEARCH

The Non-Use Value Study was initiated with a qualitative research effort involving focus groups and in-depth personal interviews. The qualitative research phase had several objectives. These included:

- Exploring whether potential survey respondents could focus on affected resources as distinct from the Grand Canyon in its entirety;
- Exploring whether potential survey respondents care about the status of the affected resources;
- Exploring whether individuals geographically distant from Glen Canyon Dam care about the status of the affected resources;
- Exploring alternative methods for describing the environmental effects of dam operations; and
- Evaluating the performance of prototype survey instruments.

The qualitative research reinforced the conclusion of the original research plan. Specifically, the results suggested that many citizens across the United States were concerned about the status of the affected resources. Issues of particular concern included beaches and vegetation, archeological sites, American Indian traditional use areas, native fish, trout, and price impacts to consumers of power produced at Glen Canyon Dam. Furthermore, the qualitative research also suggested that the study could be implemented using a mail survey instrument as the primary data collection tool.[1] In the summer of 1993, the results of the qualitative research phase and prototype mail survey instruments were reviewed by both the GCES Non-Use Value Committee and an external peer review panel, and a decision was made to proceed with a pilot test.

3.3 PILOT TEST

The summer and fall of 1993 were spent on finalizing the design of survey instruments and obtaining clearance from OMB to proceed with the implementation of a pilot test. In addition to obtaining information required to assess implementation issues for a possible final study, the pilot test was designed to test several methodological issues. A primary methodological issue was whether the pilot test instruments could provide willingness-to-pay estimates that were sensitive to details of the water release alternatives being evaluated. A second methodological issue was whether the pilot test instruments could provide estimates of willingness-to-pay that were not sensitive to minor changes in wording. Implementation of the pilot test began in January of 1994. Like the final study described in the next chapter, the pilot test involved a series of survey instruments, each administered to a separate sample.

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1 More detailed discussion of the qualitative research plan can be found in Appendix B.

The pilot test consisted of nine survey versions, each administered to an initial sample of 250 in the pilot test.[2]

Three of these survey versions, each addressing different water flow alternatives, were administered to samples of U. S. residents (national samples). Respondents were asked to evaluate the moderate fluctuating flow alternative, the low fluctuating flow alternative, and the seasonally adjusted steady flow alternative. Two surveys were administered to a sample of individuals residing in areas served by utilities receiving power produced at Glen Canyon Dam (the marketing area). The marketing area versions asked respondents to evaluate the moderate fluctuating flow alternative and the seasonally adjusted steady flow alternative. Comparisons of mean willingness-to-pay derived from these five versions revealed that among the national samples, mean willingness-to-pay was significantly lower for the moderate fluctuating flow alternative than for the seasonally adjusted steady flow alternative. In the marketing area, willingness-to-pay was highest for the seasonally adjusted steady flow alternative. However in the marketing area samples, this difference was not statistically significant.

The remaining four versions of the survey were administered to national samples and all represented variations on the seasonally adjusted steady flow alternative. These variations allowed the exploration of additional methodological issues. For example, the scenario in one of the additional versions was modified so that the respondents were asked to evaluate only a small subset of the resources actually affected by a change in dam operations. This version resulted in a significantly lower estimate of mean willingness-to-pay. Another version was developed by making small changes in the wording of the survey. This version produced estimates of mean willingness-to-pay that were statistically indistinguishable from estimates derived from the original seasonally adjusted steady flow version. Another survey version differed in the format of the contingent valuation question format used. Eight of the nine survey versions used in the pilot test used a multiple-bounded contingent valuation question format. This particular format is relatively new. At the time of the pilot test its performance, relative to more traditional question formats, had not been evaluated. Therefore, one survey version was modified so that it used a standard single-bounded dichotomous choice contingent valuation question. The estimates of mean willingness-to-pay produced by this version were consistent with estimates of willingness-to-pay developed using data collected using the multiple-bounded questioning format.

These results indicated favorable prospects for implementing a final study. Pilot test results indicated a positive willingness-to-pay for all three of the alternative dam operations evaluated. Furthermore, estimated willingness-to-pay was higher for operations providing

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2 A more detailed discussion of the pilot test, including implementation and results, can be found in Appendix C.

higher levels of environmental benefits. In the national sample, willingness-to-pay was significantly higher for the seasonally adjusted steady flow alternative than for the moderate fluctuating flow alternative. Estimates of willingness-to-pay dropped significantly when the range of the environmental benefits was reduced, and were stable with respect to minor changes in the wording of the survey materials. In light of these results, members of the GCES Non-Use Value Committee and the external peer review panel recommended implementation of the final study discussed in the next two chapters.

CHAPTER 4
DESIGN AND IMPLEMENTATION OF THE NON-USE VALUE STUDY

The final study design was the end product of an extensive research process overseen at every step by the GCES Non-Use Value Committee. Review by the committee provided valuable insights from a broad range of perspectives. In addition, members of the committee worked closely with members of the GCDEIS team to ensure that the survey instruments contained accurate descriptions of the expected consequences of each dam operation alternative. The input from the committee, peer reviewers, and OMB greatly enhanced the quality and overall validity of the GCES Non-Use Value Study.

The GCDEIS evaluated nine different dam operations alternatives in detail, including a no-action alternative. For the non-use survey, the no-action alternative was defined as the baseline (or current) dam operation condition. This baseline condition consisted of flows ranging from 3,000 cubic feet per second (cfs) to 31,500 cfs between Easter and Labor Day and from 1,000 cfs to 31,500 cfs between Labor Day and Easter. Given the similarities in resource impacts for several of the alternatives and the depth of detail required to describe them, the GCES Non-Use Value Committee recommended that only three main alternatives be evaluated in the final study. These three alternatives included:

1. Moderate fluctuating flow alternative - featuring a moderate reduction in the magnitude of the daily fluctuations;
2. Low fluctuating flow alternative - featuring large reductions in the magnitude of the daily fluctuations; and
3. Seasonally adjusted steady flow alternative - providing steady flows on a seasonally adjusted or monthly basis.

These three alternatives covered most of the range of alternative dam operations being studied and were considered to include the set of alternatives most likely to contain the eventual preferred alternative. For more detailed information on alternative dam operations, refer to the GCDEIS (U.S. Bureau of Reclamation, 1995).

4.1 EXPERIMENTAL DESIGN

The experimental design included seven versions of a mail questionnaire, two samples, and a follow-up telephone interview with nonrespondents. Because any alternative water release from Glen Canyon Dam would affect resources found in the Grand Canyon National Park, the sampling frame included all residents of the United States. Two separate random samples were identified within this frame: a national sample and a marketing area sample. The national sample consisted of residents of the United States. The marketing area sample was a subset of the national sample consisting of households receiving power from the Salt Lake City Area Integrated Projects (SLCA/IP). There were two primary differences between surveys administered to the marketing area sample and those administered to the national sample. First, the surveys differed in the payment vehicle used to solicit non-use values in the contingent valuation question between the national sample and the marketing area sample. For the national sample, the payment vehicle consisted of an annual payment in increased taxes. For residents of the marketing area, increases in utility bills were used as a payment vehicle. Surveys administered to each sample also differed in the description of resources affected by the dam operation alternative. In the national sample, each survey contained a description of the environmental and power cost impacts associated with a particular dam operation alternative. In contrast, the marketing area surveys described only the environmental impacts of the dam operation alternative.

Separate survey versions were designed in order to evaluate the three dam operation alternatives chosen for detailed study. This resulted in a total of six survey versions (three for the national sample and three for the marketing area sample).

One additional survey version was developed for the national sample. The purpose of this version was to examine in more detail the effects on the study of including the impacts of alternatives on power costs in the national sample versions.

Thus a total of seven versions of the Glen Canyon Studies non-use value mail questionnaire were developed to be administered to two samples. Table 4-1 identifies the differences between questionnaire versions.

Table 4-1
Identification of Glen Canyon Studies Non-Use Mail Questionnaire Versions

Questionnaire Version	Water Release Alternative
National Sample	
Version 1	Moderate Fluctuating Flow
Version 2	Low Fluctuating Flow
Version 3	Seasonally Adjusted Steady Flow
Version 4	Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts to Power
Marketing Area Sample	
Version 5	Moderate Fluctuating Flow
Version 6	Low Fluctuating Flow
Version 7	Seasonally Adjusted Steady Flow

4.2 SAMPLING

The sampling frame included all residents of the United States. Two separate random samples were identified within this frame: a national sample and a marketing area sample. This design was chosen to reflect the values held by United States residents as well as values held by the individuals who would be affected by changing power prices.

Both the national sample and the marketing area sample were purchased from Survey Sampling, Inc. (SSI), an independent firm that specializes in maintaining national marketing databases. A sample of 5,950 individuals was selected: 3,400 for the national sample and 2,550 for the marketing area sample (Table 4-2).

Prior to selecting a sample of households, SSI screens all samples to exclude nonresidential addresses. The national sample was drawn from a list of total households where the number of households was proportional to the number of households in each state, not from listed households only, and supplemented with motor vehicle records and postal additions in states which release such records. (Postal additions refer to address changes that are available on postal tapes.) The marketing sample was drawn to be proportional to the total number of households in a predetermined sample of ZIP code areas. As with the national sample, the marketing area sample was drawn from SSI's data base, supplemented with motor vehicle records and postal additions where available.

All sample points were submitted to a "deduping" process in which all sample points were compared to the sample used for the pilot test to ensure that there would be no overlap of cases. This process is done by comparing the telephone numbers of each case. Since a portion of the sample purchased did not have telephone numbers (sample points from motor vehicle records or postal additions), there is a very small possibility that there could be some overlap between the two samples. However, given the size of SSI's data base and the total number of households that exist, the likelihood of overlap between the pilot sample and the final sample is remote.

Four of the seven questionnaire versions were administered to the national sample, and three were administered to the marketing area sample. Each version was administered to 850 sample points.

An attempt was made to contact all nonrespondents to the mail survey via telephone. Thus, the sample for the follow-up telephone survey consisted of the portion of national and marketing area samples for which no final mail disposition had been reached. Interviews were attempted with 1,708 individuals: 1,102 from the national sample and 606 from the marketing area sample (Table 4-2).

Table 4-2
Sample Sizes for the Glen Canyon Studies Mail Surveys and Follow-up Telephone Interviews

	Sample Size	
Questionnaire Version	**Mail Survey**	**Telephone Survey**
National Sample		
Moderate Fluctuating Flow (Version 1)	850	286
Low Fluctuating Flow (Version 2)	850	267
Seasonally Adjusted Steady Flow (Version 3)	850	272
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	850	277
Total	3,400	1,102
Marketing Area Sample		
Moderate Fluctuating Flow (Version 5)	850	207
Low Fluctuating Flow (Version 6)	850	205
Seasonally Adjusted Steady Flow (Version 7)	850	194
Total	2,550	606
Overall Total	5,950	1,708

4.3 SURVEY IMPLEMENTATION PROCEDURES

Mail questionnaires were administered using the Dillman (1978) method, which included the following procedures:

1. An advance, introductory letter on U.S. Bureau of Reclamation letterhead, signed by the GCES manager was sent via U.S. first class mail. The letter explained the study and advised that a questionnaire would be sent within the week.

2. A survey package containing a copy of the questionnaire, background information materials, a cover letter on U.S. Bureau of Reclamation letterhead, a stamped return envelope, and a $3 cash incentive was mailed via U.S. first class mail.

3. A thank you/reminder postcard was sent to all respondents, thanking those who had already responded to the survey and encouraging those who had not responded to please do so. This mailing was sent first class through the U.S. postal service.

4. A second survey package containing a second copy of the questionnaire and background materials, a different cover letter, and a stamped return envelope, was sent using U.S. first class mail.

5. A third survey package was delivered via certified mail. This package also contained a copy of the questionnaire and background materials, a different cover letter, and a stamped return envelope.

The mail survey implementation began in October 1994 and was concluded in early January 1995. All mail survey versions were administered concurrently.

Follow-up telephone interviewing began on January 19, 1995, four weeks after the final survey mailing. Telephone interviews were attempted for all nonrespondents for whom telephone numbers could be obtained. All telephone interviews were conducted by experienced interviewers using Computer Assisted Telephone Interviewing (CATI) software at an in-house telephone laboratory.

A complete description of mail and telephone survey materials can be found in Appendix E.

4.4 DATA PROCESSING

The disposition of all mail questionnaires was entered into a tracking database. The categories consisted of a completed questionnaire, an undeliverable questionnaire, a deceased individual, or a refusal. Completed questionnaires went through three stages of data processing: editing, data entry, and cleaning. Completed questionnaires were coded and prepared for data entry by data editors. Open-ended responses were coded, missing data were checked, and all fields were checked to ensure that invalid codes were not included. Missing data were studied to determine if the correct skip patterns had been followed. After editing, data entry personnel entered the completed questionnaires into an SPSS database. All data were subjected to 100 percent verification. All verified data were subject to a cleaning process. Data cleaning was carried out using a series of computer programs that identify out-of-range data points for each variable and cross-check related questions. A survey research supervisor also inspected missing data for each of the survey variables.

All responses to the telephone survey were directly entered into computer files as the interview was carried out. Upon completion of the telephone survey, the CATI system was used to clean the data. A data editor reviewed each completed interview, provided response codes to open-ended questions, and conducted consistency checks. Upon completion of the cleaning and coding process, the data were exported from the CATI system and imported to an SPSS data file.

4.5 RESPONSE RATES

Response rates for completed mail surveys are calculated as a percentage of deliverable questionnaires. The study achieved a response rate of 66 percent for the national sample, and 75 percent for the marketing area sample (Table 4-3).

Response rates to the telephone survey of nonrespondents are shown in Table 4-4. Telephone interviews were completed with 35 percent of nonrespondents from the national sample, and with 46 percent of nonrespondents to the marketing area sample.

Finally, Table 4-5 shows an overall response rate for the entire study. A combined response rate for the mail and telephone surveys shows that data was collected from 74 percent of the national sample and 83 percent of the marketing area sample who could be contacted.

Table 4-3
Glen Canyon Studies Non-Use Mail Survey Response Rates

	Sample Size	Out of Scope[a]	Completed Surveys	Response Rate[b]
National Sample				
Moderate Fluctuating Flow (Version 1)	850	188	426	64%
Low Fluctuating Flow (Version 2)	850	202	431	66%
Seasonally Adjusted Steady Flow (Version 3)	850	196	439	67%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	850	190	432	65%
Total	3,400	776	1,728	66%
Marketing Area Sample				
Moderate Fluctuating Flow (Version 5)	850	219	467	74%
Low Fluctuating Flow (Version 6)	850	226	467	75%
Seasonally Adjusted Steady Flow (Version 7)	850	200	489	75%
Total	2,550	645	1,423	75%

[a] Includes cases where the addressee was deceased or the survey materials were returned as undeliverable.
[b] Calculated as a percentage of deliverable questionnaires (sample size minus out-of-scope cases).

Table 4-4
Glen Canyon Studies Non-Use Telephone Survey Response Rates

	Sample Size	Out of Sample[a]	Withdrawn from Sample[b]	Completed Interviews	Response Rate[c]
National Sample					
Moderate Fluctuating Flow (Version 1)	286	90	9	66	35%
Low Fluctuating Flow (Version 2)	267	92	6	53	31%
Seasonally Adjusted Steady Flow (Version 3)	272	79	9	69	38%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	277	80	14	63	34%
Total	1,102	341	38	251	35%
Marketing Area Sample					
Moderate Fluctuating Flow (Version 5)	207	57	7	62	43%
Low Fluctuating Flow (Version 6)	205	63	7	58	43%
Seasonally Adjusted Steady Flow (Version 7)	194	42	6	74	51%
Total	606	162	20	194	46%

a Includes disconnected, no listing available, wrong phone numbers, and cases where the identified respondent was unavailable for the study duration, unable to participate due to physical or mental impairment, deceased, or had moved.

b Includes cases pulled from the telephone survey sample before a final disposition was reached because a mail questionnaire was received during implementation of the telephone survey.

c Calculated as a percentage of available (reachable) respondents.

Table 4-5
Glen Canyon Studies Non-Use Survey Response Rates for the Mail and Telephone Surveys Combined

	Sample Size	Out of Scope[a]	Completed Surveys	Response Rate[b]
National Sample				
Moderate fluctuating flow	850	197	480	74%
Low fluctuating flow	850	211	472	74%
Seasonally adjusted steady flow	850	198	491	75%
Seasonally adjusted steady flow with moderate fluctuating flow impact costs to power	850	196	485	74%
Total	3,400	802	1,928	74%
Marketing Area Sample				
Moderate fluctuating flow	850	224	521	83%
Low fluctuating flow	850	233	508	82%
Seasonally adjusted steady flow	850	207	543	84%
Total	2,550	664	1,572	83%

a Includes cases identified as out of scope in either the mail or the telephone survey.
b Calculated as a percentage of deliverable questionnaires (sample size minus out of scope).

CHAPTER 5
RESULTS

In the analyses that follow, percentages are calculated to represent all cases for which data exist for the variable being reported. The number of valid cases, shown in parentheses in most tables, excludes cases with user-missing codes (where respondents did not answer a given question).

5.1 BACKGROUND CHARACTERISTICS OF RESPONDENTS

Selected socioeconomic characteristics were collected in both the mail and telephone surveys and then compared across the two surveys. Characteristics included the respondent's age, sex, and education, as well as household size and 1993 household income. Results are reported in Table 5-1 and discussed below.

Some differences were observed between mail survey respondents in the national sample and mail survey respondents in the marketing area sample. Mail survey respondents in the national sample averaged 49 years of age, whereas respondents from the marketing area sample were slightly older, averaging 52 years of age. In both samples, just over half of the respondents to the mail survey were male (54 percent in the national sample versus 57 percent in the marketing area sample). Average education of mail survey respondents also differed between samples, with respondents from the national sample reporting a slightly higher educational level than respondents from the marketing area. Household size in the national sample averaged 2.69 people per household. In contrast, household size for marketing area respondents was significantly higher, averaging 2.85 people per household. Respondents in the national and marketing area samples also differed in average household income. National-sample respondents reported an average household income of approximately $43,400, whereas respondents from the marketing area had an average household income of approximately $39,000.[1]

Fewer differences existed between the two samples in the telephone survey. In fact, the only socioeconomic characteristic that differed was the percent of respondents who were male.

1 Note that age and income figures reported for the national sample are higher than those reported for the U.S. population by the Census Bureau. This result is an artifact of sampling that cannot be avoided. As a consequence, even with high quality samples such as those purchased for this study, some groups will be under represented. For a more in-depth comparison of sample demographics with U.S. Census data, see Appendix D .

Telephone survey results for the national sample show that 44 percent of respondents were male in comparison to 53 percent in the marketing area sample. Although the average age of respondents was lower in the national sample than in the marketing area sample (46 years versus 49 years, respectively), this difference was not significant.

Comparing the national sample mail survey respondents to telephone survey respondents shows that on average telephone survey respondents were younger, more likely to be female, and more likely to have a lower education level. In contrast, national respondents did not differ significantly with respect to average household size (2.69 people in the mail survey versus 2.74 people in the telephone survey) or average household income ($43,460 versus $41,797). Marketing area sample respondents also differed between the mail and telephone surveys with respect to average age and education. Telephone survey marketing area respondents were slightly younger and had less education in comparison to mail survey respondents. However, the percent of male respondents did not differ significantly between the survey types, nor did household size or income.

Table 5-1
Socioeconomic Characteristics of Mail and Telephone Survey Respondents

	Mail Survey		Telephone Survey	
	National Sample	Marketing Area Sample	National Sample	Marketing Area Sample
Average Age (years)[a,c,d]	49	52	46	49
	(1,630)	(1,353)	(243)	(189)
Percent Male[b,c]	54%	57%	44%	53%
	(1,647)	(1,361)	(247)	(193)
Average Education[a,c,d]				
Less than 8 years	2%	3%	6%	4%
Some high school	5	4	9	5
High school graduate	20	19	27	28
Some college or technical school	27	32	26	31
College or technical school graduate	27	25	20	19
Post graduate work	19	17	12	13
	100%	100%	100%	100%
	(1,642)	(1,353)	(243)	(191)
Average Household Size[a]	2.69 people	2.85 people	2.74 people	2.94 people
	(1,535)	(1,258)	(245)	(193)
Average 1993 Household Income[a]	$43,460	$39,180	$41,797	$36,918
	(1,540)	(1,292)	(217)	(176)

a Significant differences exist between the national sample and the marketing area sample in the mail survey.
b Significant differences exist between the national sample and the marketing area sample in the telephone interview.
c Significant differences exist between the mail survey and the telephone interviews in the national sample.
d Significant differences exist between the mail survey and the telephone interview in the marketing area sample.
( ) Numbers in parentheses indicate the number of valid cases.

Both the mail and the telephone surveys included several questions that addressed respondents' familiarity with Glen Canyon Dam and Grand Canyon National Park. First, respondents were asked if they had ever visited Glen Canyon Dam and whether they had heard of the dam prior to receiving the questionnaire (Table 5-2). In both surveys, marketing area respondents were more likely than national respondents to have either visited the dam or heard of it. Only 11 percent of mail survey respondents from the national sample reported they had visited Glen Canyon Dam, and less than 30 percent said they had heard of it prior to receiving the survey. In contrast, 45 percent of mail survey respondents from the marketing area sample said they had visited the dam, and 72 percent had heard of the dam.

Results from the telephone interviews also show that a higher percentage of respondents from the marketing area sample had heard of, or visited, the Glen Canyon Dam compared to the national telephone sample. Only seven percent of the telephone survey respondents from the national sample reported they had visited Glen Canyon Dam compared to 23 percent of respondents from the marketing area sample. When asked if they had heard of the dam before receiving the survey, 25 percent of national sample respondents said yes in contrast to 54 percent of marketing area respondents.

Table 5-2
Visitation of Glen Canyon Dam

	Mail Survey		Telephone Survey	
	National Sample	**Marketing Area Sample**	**National Sample**	**Marketing Area Sample**
Visited Glen Canyon Dam[a,b,c,d]	11% (1,661)	45% (1,351)	7% (246)	23% (192)
Heard of Glen Canyon Dam before receiving the survey[a,b,d]	29% (1,652)	72% (1,351)	25% (246)	54% (192)

a Significant differences exist between the national sample and the marketing area sample in the mail survey.
b Significant differences exist between the national sample and the marketing area sample in the telephone interview.
c Significant differences exist between the mail survey and the telephone interviews in the national sample.
d Significant differences exist between the mail survey and the telephone interview in the marketing area sample.
( ) Numbers in parentheses indicate the number of valid cases.

Regardless of sample, higher percentages of mail survey respondents reported having visited the dam in comparison with the telephone survey respondents. This result could indicate that for mail survey nonrespondents (telephone survey respondents), the survey topic was less salient than for mail survey respondents. This salience could be one factor that influenced survey response rates.

A similar set of questions was asked about Grand Canyon National Park. For the mail survey, comparison of the national and marketing area samples shows that respondents in the national sample were less likely to have visited Grand Canyon National Park than respondents from the marketing area sample (Table 5-3). Only 34 percent of respondents in the national sample reported they had visited the park compared to 66 percent of respondents from the marketing area. This is not surprising given that the marketing area respondents are geographically closer to the park than the majority of the national respondents. Among the mail survey respondents who had visited the park, the percentage who saw the Colorado River or went down to the river did not differ significantly between national and marketing area samples: 92 percent of mail survey respondents in both samples said they saw the Colorado River while at the park. Substantially fewer respondents in either sample reported going down to the river.

When asked about their expected likelihood of visiting Grand Canyon National Park in the future, approximately one-third of the national mail survey sample said it was not at all likely or was somewhat unlikely. The remainder were divided between being somewhat likely (35 percent) or very likely (34 percent) to visit it. In comparison, respondents from the marketing area were significantly more likely to say they will visit the park in the future: 80 percent of respondents from this sample said they were either somewhat or very likely to visit Grand Canyon National Park in the future.

Table 5-3
Visitation of Grand Canyon National Park

	Mail Survey		Telephone Survey	
	National Sample	Marketing Area Sample	National Sample	Marketing Area Sample
Visited Grand Canyon National Park[a,b,c,d]	34%	66%	18%	41%
	(1,638)	(1,354)	(246)	(192)
Saw the Colorado River while in Grand Canyon National Park[b,c]	92%	92%	80%	92%
	(553)	(884)	(45)	(78)
Went down to the Colorado River while in Grand Canyon National Park[d]	19%	22%	14%	12%
	(510)	(819)	(36)	(72)
Expected likelihood of visiting Grand Canyon National Park in the future[a,b,c,d]				
Not at all likely	16%	9%	34%	29%
Somewhat unlikely	15	11	14	10
Somewhat likely	35	34	36	33
Very likely	34	46	16	28
	(1,635)	(1,353)	(244)	(189)

a Significant differences exist between the national sample and the marketing area sample in the mail survey.
b Significant differences exist between the national sample and the marketing area sample in the telephone interview.
c Significant differences exist between the mail survey and the telephone interviews in the national sample.
d Significant differences exist between the mail survey and the telephone interview in the marketing area sample.
( ) Numbers in parentheses indicate the number of valid cases.

Results to the telephone survey show a similar pattern: A higher percentage of marketing area respondents report having visited the park than national sample respondents. However, the percentages for most of these questions were substantially lower than for the mail survey. Of the telephone survey respondents who had visited the park, 80 percent from the national sample and 92 percent from the marketing area sample said they saw the Colorado River while at the park. Less than 15 percent of either sample reported going down to the river.

The self-reported likelihood of visiting Grand Canyon National Park in the future followed a pattern similar to the mail survey. National telephone respondents are less likely to visit the park than those from the marketing area. National respondents were almost evenly split between being not likely to visit the park in the near future (34 percent "not at all likely" and 14 percent "somewhat unlikely) and likely to visit (36 percent "somewhat likely" and 16 percent "very likely"). A similar split existed in the marketing area sample: 39 percent said they are not at all or somewhat unlikely to visit the park in the future, and 61 percent said they were somewhat or very likely to visit it. Overall, these results suggest that respondents who reside nearer to Grand Canyon National Park are more likely to have visited it in the past and are more likely to visit it in the future.

Attitudinal and belief differences between the two types of surveys and the two types of samples were also examined. It was hypothesized that the attitudes that people hold affect their willingness-to pay.

The mail survey instruments included a total of 46 attitude and belief items. These items measured attitudes toward the environment, trade-offs between economic issues and the environment, national parks, Native Americans, and hydroelectric power. Respondents were asked whether they agreed or disagreed with each attitude statement using a scale of 1 to 5, where 1 meant strongly agree and 5 meant strongly disagree. The distribution of responses to these items is shown in the appendices. Time constraints in the telephone survey prevented the inclusion of all 46 attitudinal and belief items from the mail survey. However, 19 of the attitude items were included in the telephone survey. Factor analysis is used to identify a number of factors that represent relationships between groups of related variables, such as the attitude items included here Factor analysis was used to aggregate these 19 items from both surveys into 5 factors Factor loadings provide a measure of how heavily each attitude item contributes to the overall factor score (Table 5-4). Attitude items with factor loadings greater than 0.60 are considered to be the most influential items contributing to the factor score, and these attitude items are referred to for deriving explanatory labels for the factors. The five factors that were identified include: impacts of human intervention on nature, economic security, limits to growth, human ingenuity will ensure balance, and human dominance over nature

Table 5-4
Factor loadings for attitude statements used in factor analysis

	Factor 1 Impacts of human intervention on nature	Factor 2 Economic security	Factor 3 Limits to growth	Factor 4 Human ingenuity will insure balance	Factor 5 Human dominance over nature
When humans interfere with nature, it often produces disastrous consequences	.70725	-.01213	.08691	-.17461	-.13564
The balance of nature is very delicate and easily upset.	.67526	-.13834	.16032	-.00832	-.08305
If things continue on their present course, we will soon experience a major ecological catastrophe.	.66676	-.12286	.18103	.01435	-.16856
Humans are severely abusing the environment.	.66303	-.11003	.15319	-.03096	-.07308
Plants and animals have just as much right as humans to exist.	.59958	-.20075	.03649	.13781	-.33425
Despite our special abilities, humans are still subject to the laws of nature.	.54960	-.17622	-.06756	-.28471	.43616

(Continued)

Table 5-4
Factor loadings for attitude statements used in factor analysis *(Continued)*

	Factor 1 Impacts of human intervention on nature	Factor 2 Economic security	Factor 3 Limits to growth	Factor 4 Human ingenuity will insure balance	Factor 5 Human dominance over nature
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market	-.18189	.70266	-.00587	.05908	.03529
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	-.25300	.68206	-.08831	.17278	.13007
Economic security and well-being should be considered first, then we can worry about environmental problems.	-.06704	.67120	-.09893	.13315	.06640
Some pollution is inevitable if we are going to continue to improve our standard of living.	.03025	.63347	-.02762	-.01126	.07527
The so-called ecological crises facing humankind has been greatly exaggerated.	-.37544	.45750	-.24539	.12213	.27374
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	-.26556	.42551	-.32269	.34084	.16267

(Continued)

Table 5-4
Factor loadings for attitude statements used in factor analysis (*Continued*)

	Factor 1 Impacts of human intervention on nature	Factor 2 Economic security	Factor 3 Limits to growth	Factor 4 Human ingenuity will insure balance	Factor 5 Human dominance over nature
The earth is like a spaceship with very limited room and resources.	.31727	-.07844	.80195	.01377	.02462
We are approaching the limit of the number of the people the earth can support.	.32131	-.01760	.77736	.04217	-.04968
The earth has plenty of natural resources, if we just learn how to develop them.	.17046	.25478	-.61498	.34287	.14653
Humans will eventually learn enough about how nature works to be able to control it.	-.01900	.05749	.03451	.81147	.03782
Human ingenuity will ensure that we do not make the earth unlivable.	-.06821	.19476	-.12949	.66908	.16488
Humans were meant to rule the rest of nature.	-.29391	.18148	-.10946	.16806	.68549
Humans have the right to modify the natural environment to suit their needs.	-.28098	.24396	.00557	.22323	.67654

The average responses to attitude and belief items that were most influential (items that loaded heavily) in the factor analysis are shown in Table 5-5. Responses to the mail survey show that the opinions of the respondents in the national sample differ significantly from those in the marketing area sample for many of the statements shown. However, these differences are not from completely opposite ends of the scale. For example, the results do not show that one sample "strongly agreed" with a statement while another "strongly disagreed." Instead, it appears that both samples have similar attitudes but of differing intensity. Likewise, the differences observed between samples for the telephone survey are not extreme. That is, the average scores do not reveal polar differences in opinions between the two samples.

Table 5-5
Mean Response to Attitude Questions Included in Factors*

	Mail Survey		Telephone Survey	
	National Sample	Marketing Area Sample	National Sample	Marketing Area Sample
Factor 1: Impacts of human intervention on nature				
When humans interfere with nature, it often produces disastrous consequences.[a]	2.08 (1,654)	2.21 (1,346)	2.13 (239)	2.24 (187)
The balance of nature is very delicate and easily upset.[a]	1.89 (1,648)	2.00 (1,352)	1.87 (237)	1.86 (189)
If things continue on their present course, we will soon experience a major ecological catastrophe.[a,c,d]	2.58 (1,649)	2.70 (1,350)	2.35 (235)	2.42 (186)
Plants and animals have as much right as humans to exist.[a,c]	1.07 (1,652)	2.19 (1,348)	1.78 (243)	2.00 (189)
Humans are severely abusing the environment.[a]	2.10 (1,656)	2.19 (1,349)	2.02 (242)	2.14 (188)
Factor 2: Economic security				
Economic security and well-being should be considered first; then we can worry about environmental problems.[a,c]	3.62 (1,656)	3.48 (1,372)	3.44 (241)	3.41 (187)
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market.[a,c]	3.46 (1,658)	3.30 (1,360)	3.11 (230)	3.18 (188)
Some pollution is inevitable if we are going to improve our standard of living.[c]	2.79 (1,657)	2.80 (1,367)	2.56 (237)	2.67 (186)
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.[a,c,d]	3.79 (1,653)	3.64 (1,363)	3.55 (232)	3.44 (186)

(Continued)

Table 5-5
Mean Response to Attitude Questions Included in Factors* *(Continued)*

	Mail Survey		Telephone Survey	
	National Sample	Marketing Area Sample	National Sample	Marketing Area Sample
Factor 3: Limits to growth				
We are approaching the limit of the number of people the earth can support.	2.73 (1,650)	2.78 (1,350)	2.66 (232)	2.61 (185)
The earth is like a spaceship with very limited room and resources.[d]	2.60 (1,646)	2.64 (1,345)	2.61 (237)	2.37 (185)
Factor 4: Human ingenuity will ensure balance				
Humans will eventually learn enough about how nature works to be able to control it.[d]	3.49 (1,655)	3.58 (1,352)	3.31 (244)	3.21 (188)
Human ingenuity will ensure that we do not make the earth unlivable.[b,d]	3.03 (1,649)	3.09 (1,338)	2.92 (235)	2.63 (186)
Factor 5: Human dominance over nature				
Humans have the right to modify the natural environment to suit their needs.	3.61 (1,652)	3.51 (1,352)	3.43 (237)	3.34 (188)
Humans were meant to rule the rest of nature.	3.91 (1,650)	3.77 (1,348)	3.78 (242)	3.76 (186)

* Ratings represent the average response based on a 5-point scale where 1 meant strongly agree and 5 meant strongly disagree.
[a] Significant differences exist between the national sample and the marketing area sample in the mail survey.
[b] Significant differences exist between the national sample and the marketing area sample in the telephone interview.
[c] Significant differences exist between the mail survey and the telephone interviews in the national sample.
[d] Significant differences exist between the mail survey and the telephone interview in the marketing area sample.
( ) Numbers in parentheses indicate the number of valid cases.

Factor scores were calculated for each respondent. Factor analysis uses a standardized regression-like procedure to predict factor scores for each observation. For this study, factor scores were created using an orthogonal rotation to eliminate multicollinearity between factor scores. Scores range from +1 to -1. Mean scores for orthogonally rotated factors are shown in Table 5-6. The predicted sign of the coefficient for each factor in subsequent discrete choice models on willingness to pay is also shown. Factors 2, 4, and 5 were expected to show a positive effect on willingness-to-pay, while Factors 1 and 3 were expected to show a negative effect. Another way to view these results is to consider that for Factors 1 and 3, lower factor scores indicate attitudes that favor the environment over economic development. For Factors 2, 4, and 5, higher values indicate attitudes that favor economic development over the environment. In many cases, the mean factor scores reported in Table 5-6 suggests that nonrespondents to the mail survey expressed attitudes that are less favorable toward the environment than did the respondents to the mail survey.

Table 5-6
Mean Factor Scores Calculated for Combined Mail and Telephone Survey Data

	Mail Survey		Telephone Survey	
Factor (predicted sign)	**National Sample**	**Marketing Area Sample**	**National Sample**	**Marketing Area Sample**
Factor 1 (-)[a,b]	-.0193 (1,545)	.0914 (1,257)	-.3106 (208)	-.1621 (173)
Factor 2 (+)[a,b]	.1111 (1,545)	.0155 (1,257)	-.5873 (208)	-.5306 (173)
Factor 3 (-)	-.0035 (1,545)	-.0013 (1,257)	.0630 (208)	-.0413 (173)
Factor 4 (+)[a,b]	-.0264 (1,545)	.0978 (1,257)	-.1712 (208)	-.3644 (173)
Factor 5 (+)[a]	.0482 (1,545)	-.0830 (1,257)	.1484 (208)	.0153 (173)

[a] Significant differences exist between the national sample and the marketing area sample in the mail survey.
[b] Significant differences exist between the mail survey and the telephone interviews in the national sample.
( ) Numbers in parentheses indicate the number of valid cases.

5.2 RESPONDENTS' UNDERSTANDING OF THE BACKGROUND INFORMATION

The complexity of the contingent valuation scenarios required a substantial amount of information be conveyed to the survey respondent. Prior to completing the survey booklet, respondents were asked to review a background information packet. The background information packet described the study area, the resources in the study, the current status of these resources, concerns about these resources and a discussion of how these concerns could be addressed by changing the operations of Glen Canyon Dam. Because of the amount of information contained in the background material there was some concern that survey respondents would not read or be able to comprehend these materials.

To address this issue, the survey booklet began with a series of true or false questions. The series included a total of 16 statements that referred to facts presented in the background materials. Respondents were asked to indicate whether the statements were correct (true) or not (false). The statements and the percentages of correct responses to them are shown in Table 5-7. Although the statements are grouped by topic in Table 5-7, in the surveys they appeared in a random order.

Results of the "quiz" lend confidence to the conclusion that, overall, respondents not only read the background materials, but understood them as well. With only one exception, 90 percent or more of all respondents correctly answered the quiz questions pertaining to beaches along the river. Responses to quiz questions about fish showed similar results: 85 percent or more of all respondents were able to correctly indicate whether these questions were true or false. Three of the statements addressed issues concerning the effects of fluctuating flows on Native American or cultural sites along the river. Like the other categories, almost all respondents were able to correctly answer these questions.

Finally, three additional statements were included in the quiz to address (1) present in-stream flow conditions, (2) the definition of the study area, and (3) the effects of reducing fluctuations on the production of hydroelectricity. The majority of respondents were again able to correctly indicate whether the statements addressing these issues were true or false. Nearly all respondents (93 percent in the national sample and 95 percent in the marketing area sample) correctly indicated that water levels are <u>not</u> constant throughout the day under current dam operations. Most respondents correctly said that the study area consists only of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead (88 percent in the national sample and 89 percent in the marketing area sample). Finally, the quiz question describing the effects of reducing fluctuations on production of hydro electricity was also answered correctly by a majority of respondents in both samples, although the percentage of correct responses was somewhat lower than for the other questions (68 percent and 71 percent for the national and marketing area samples, respectively).

Overall, it is clear from the quiz results that most respondents read the background materials prior to beginning the survey and understood the issues described. Almost all respondents answered the quiz questions correctly: only one question was answered correctly by less than 85 percent of respondents.

To provide a more comprehensive picture of respondents' grasp of the issues, a quiz score was calculated for each respondent. Scores were calculated by summing the number of correct responses to the quiz questions, dividing by the total number of questions (statements), and multiplying by 100. Item nonresponse was considered to represent an incorrect response. There were 35 cases where respondents did not answer any of the quiz questions: these cases were not included in this analysis. Average quiz scores are shown in Table 5-8 for each sample and by survey version. Results show the average quiz scores are stable across both samples and survey versions. National sample respondents received an average score of 89, while those in the marketing area achieved an average score of 90. Looking at average scores by survey version shows similar results, with national sample respondents ranging from 89 to 90 compared to 90 for marketing area respondents regardless of survey version. This lack of fluctuation across survey versions was not unexpected, because the quiz questions only addressed <u>current</u> conditions of the resources and all survey versions contained identical descriptions of the current conditions.

Table 5-7
Percent of Correct Responses to True or False Questions

	Percent of Respondents	
	National Sample	**Marketing Area Sample**
Beaches		
There are now many more beaches along the Colorado River than there were 20 years ago.	92% (1,673)	92% (1,362)
The decrease in the number and size of beaches is most severe along wide sections of the river.	86% (1,649)	86% (1,336)
None of the beaches along the river have vegetation.	96%[b] (1,660)	98% (1,357)
Nearly all visitors to the Grand Canyon National Park use the beaches along the river.	90%[a] (1,654)	92% (1,365)
The shoreline in the study area consists only of beaches.	96% (1,605)	96% (1,321)
Vegetation on beaches provides habitat for birds and other wildlife.	98%[b] (1,634)	99% (1,336)
Fish		
Native fish populations in the Colorado River have declined.	96% (1,670)	95% (1,364)
Trout are not native to the study area.	85% (1,662)	86% (1,356)
All native fish species have disappeared from the Grand Canyon.	96% (1,664)	97% (1,358)
Two of the native fish species are in danger of extinction.	89% (1,630)	91% (1,325)

(Continued)

Table 5-7
Percent of Correct Responses to True or False Questions *(Continued)*

	Percent of Respondents	
	National Sample	**Marketing Area Sample**
Native American Sites		
There are American Indian traditional-use areas and sacred sites located along the Colorado River below Glen Canyon Dam.	98%[b] (1,652)	99% (1,365)
Archeological sites are not being affected by erosion.	95% (1,662)	96% (1,359)
American Indian traditional-use areas are affected by erosion.	95% (1,634)	96% (1,324)
Other Issues		
Water levels are constant throughout the day.	93%[b] (1,631)	95% (1,327)
The Study Area consists only of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.	88% (1,612)	89% (1,317)
Reducing daily fluctuations in the amount of water released from the dam will reduce the total amount of hydroelectricity produced.	68%[a] (1,619)	71% (1,318)

a Significant at $\alpha = 0.10$.
b Significant at $\alpha = 0.05$.
( ) Numbers in parentheses is the number of valid cases.

Table 5-8
Quiz Scores

	National Sample	Marketing Area Sample
Overall average score	89% (1,679)	90% (1,374)
Average Score by Survey Version		
Moderate fluctuating flow (Versions 1, 5)	89% (416)	90% (455)
Low fluctuating flow (Versions 2, 6)	89% (416)	90% (441)
Seasonally adjusted steady flow (Versions 3, 7)	90% (423)	90% (478)
Seasonally adjusted steady flow with moderate fluctuating flow price impacts (Version 4)	90% (424)	NA

( ) Numbers in parentheses indicate the number of valid cases.
NA = Not applicable

5.3 SUPPORT OF DAM OPERATION ALTERNATIVES

After completing the quiz, survey respondents were presented with a proposal to change dam operations. The proposal described how dam operations would be changed and the consequences, or impacts, of these changes for downstream resources. Descriptions of the environmental impacts were designed to be consistent with the ones used in the GCDEIS. In the national sample, the consequences of the proposed change also included a description of expected impacts to users of power produced at Glen Canyon Dam.

Immediately following the description of the alternative, or proposal, respondents were asked (Question 2) how they would vote on a proposal to change the operations of Glen Canyon Dam if passage of the proposal cost them nothing ($0).

The first column in Table 5-9 shows the distribution of responses to alternative proposals at no cost. In the national sample, the proportion of respondents who would support the no-cost proposal was lowest for the moderate fluctuating flow proposal (Version 1) and highest for the low fluctuating flow proposal (Version 2). Support for the seasonally adjusted steady flow proposal (Version 3) was lower than for the low fluctuating flow proposal (Version 2). Although Version 3 is more favorable than Version 2 for trout and native fish, it has much higher price impacts to consumers of power produced at Glen Canyon Dam. Focus groups conducted during the survey design process indicated that potential survey respondents would be concerned about price impacts to power users (indeed, this result was an important factor in the decision to include power impacts as part of the description of impacts). The lower level of support for the Version 3 proposal might reflect a judgment by survey respondents that the higher price impacts of Version 3 more than offset any additional environmental gains.

This interpretation is further strengthened by the level of support shown for Version 4. Version 4 contained a description of the environmental impacts of the seasonally adjusted steady flow alternative but with the lower price consequences of the moderate and low fluctuating flow alternatives. The proposal in Version 2 and the proposal in Version 4 differ only in environmental consequences. Support for Versions 2 and 4 are virtually identical, indicating that respondents found these two proposals equally acceptable.

Table 5-9
Support of Water Release Alternatives

Survey Version	Yes, Would Support the Proposal at No Cost	No, Would Not Support the Proposal at No Cost	Would Choose not to Vote	Number of Cases
National Sample				
Moderate Fluctuating Flow (Version 1)	71%[a]	17%	12%	402
Low Fluctuating Flow (Version 2)	83[b]	9	8	408
Seasonally Adjusted Steady Flow (Version 3)	77[c]	12	11	414
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	81[b,c]	9	10	411
Marketing Area Sample				
Moderate Fluctuating Flow (Version 5)	76%[a]	17%	7%	434
Low Fluctuating Flow (Version 6)	85[b]	8	7	437
Seasonally Adjusted Steady Flow (Version 7)	85[b]	9	6	467

a,b,c The percentages of "yes" responses were compared within the national and marketing area samples; they were not compared between the two samples. Within the sample, percentages that share the same superscript are not significantly different ($Z < 1.64$).

A similar support pattern can be observed in the marketing area sample. Support for the proposal at no cost was lowest for the moderate fluctuating flow (Version 5) and significantly higher for the low fluctuating and seasonally adjusted steady flows (Versions 6 and 7, respectively).

These results indicate that mail survey respondents were sensitive to the details contained in the proposals, and that these details determined whether they would support the proposal at no cost.

5.4 CONSIDERATION OF BUDGET CONSTRAINTS AND CHANGES IN VOTES

All respondents voting in favor of a proposal at zero cost were asked how they would vote if passage of the proposal increased their taxes (national sample) or utility bills (marketing area sample) by a specified amount (Question 3). Figure 5-1 presents the wording for Question 3 in the national sample versions of the survey.

Figure 5-1
Willingness-to-Pay Question Format (National Sample)

The higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal. Taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. Would you vote for this proposal if passage of the proposal would cost your household $ ____ in increased **taxes every year** for the foreseeable future? *(CIRCLE ONE NUMBER)*

1	**Definitely No**	-	**I would definitely vote against the proposal.**
2	**Probably No**	-	**I would probably vote against the proposal.**
3	**Not Sure**	-	**I am not sure if I would vote for the proposal.**
4	**Probably Yes**	-	**I would probably vote for the proposal.**
5	**Definitely Yes**	-	**I would definitely vote for the proposal.**

Responses to Question 3 by dollar amount are shown in Table 5-10 for both the national and the marketing area samples. As expected, across all proposals, responses to the cost of the proposal follow a general trend. The percentage of respondents voting "Definitely No" increased as the cost of the proposal increased. Likewise, the percentage of respondents voting "Definitely Yes" decreased as the cost of the proposal increased. For both the national and marketing area samples, the percentages of respondents choosing the "Not Sure" category fluctuated somewhat, tending to be highest in the middle dollar amounts ($60 to $150) for the national sample and highest in the higher dollar amounts ($120 to $200) for the marketing area sample.

Members of the marketing area sample appeared to have more definite opinions about whether they would support the proposal than the national sample. This was shown by the lower percentages of the marketing area sample choosing the "Not Sure" category and the correspondingly higher percentages choosing "Definitely Yes" or "Definitely No."

Table 5-10
Results of Initial Vote on Alternative Proposals by Dollar Values for Respondents Who Supported a Change in Dam Operations[a]

	Annual Dollar Amount								
	\$5	**\$15**	**\$30**	**\$60**	**\$90**	**\$120**	**\$150**	**\$200**	**Total**
National Sample									
Definitely no	5%	4%	7%	12%	11%	19%	19%	19%	12%
Probably no	2	10	13	18	22	25	24	21	17
Not sure	12	10	16	20	22	16	21	17	17
Probably yes	44	47	41	35	33	26	28	31	35
Definitely yes	37	29	23	15	12	14	8	12	19
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(154)	(164)	(165)	(157)	(145)	(175)	(157)	(149)	(1,266)
Marketing Area Sample									
Definitely no	4%	7%	9%	13%	20%	18%	22%	23%	14%
Probably no	4	8	11	13	22	18	27	27	16
Not sure	4	9	13	10	14	17	18	23	13
Probably yes	40	42	43	43	28	35	29	18	35
Definitely yes	48	34	24	21	16	12	4	9	22
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(145)	(142)	(127)	(133)	(129)	(133)	(133)	(142)	(1,084)

1 Reported results represent cases where respondents supported a change in dam operations. Percentages are rounded to sum to 100 percent.
( ) Numbers in parentheses indicate the valid number of cases.

After voting on the proposal at a specific cost, respondents were asked to indicate the items they would give up to pay for the proposal if it passed. The items most commonly cited by members of both the national and marketing area samples included food and drink (for example, take-out food, eating out, and "junk" food), entertainment (such as video rental, cable T.V., subscriptions, and movies), recreation and hobbies, and clothing (Table 5-11). Approximately 13 percent of the national sample and 12 percent of the marketing area sample indicated that passage of the proposal would have no perceptible effect on their expenditure patterns. No other categories were listed by more than 10 percent of either sample.

Table 5-11
Items That Would be Given Up to Pay for the Proposal if the Proposal Passed[a,b]

	National Sample	Marketing Area Sample
Food and drink	30%	31%
Entertainment	28	26
The stated amount would have no effect	13	12
Recreation and hobbies	13	13
Clothing	12	12
Needless items	12	7
	(1,107)	(939)

a Reported results represent cases where respondents supported a change in dam operations.
b Percentages may sum to more than 100 percent because respondents could list more than one response.
( ) Numbers in parentheses indicate the valid number of cases.

After considering the impact to their budget if the proposal passed, respondents were asked if they would like to change their vote on the proposal. Very few respondents chose to change their vote (Table 5-12). Only six percent of the national sample respondents and five percent of marketing area respondents elected to change their votes.

Table 5-12
Percentage of Respondents Who Supported a Change in Dam Operations but Elected to Change Their Initial Votes on Alternative Proposals[a]

	Annual Dollar Amount								
Sample	**$5**	**$15**	**$30**	**$60**	**$90**	**$120**	**$150**	**$200**	**Total**
National	3%	1%	6%	7%	4%	9%	8%	8%	6%
	(153)	(161)	(164)	(157)	(142)	(172)	(156)	(147)	(1,252)
Marketing Area	2%	4%	7%	4%	5%	8%	6%	6%	5%
	(141)	(139)	(124)	(132)	(127)	(129)	(133)	(140)	(1,065)

a Reported results represent cases where respondents supported a change in dam operations and responded to the initial vote question (Question 3).
( ) Numbers in parentheses indicate the valid number of cases on which the percentage is based.

Vote changes were observed in both directions. After considering the impacts to their budgets, some respondents were more likely to vote in favor of the proposal while others were less likely to vote in favor of the proposal (Tables 5-13, 5-14, and 5-15). However, in both samples, the majority of respondents electing to change their vote changed it to be more favorable to passage of the proposal (74 percent in the national sample and 69 percent in the marketing area). (Given the small number of valid cases available for analysis, we emphasize that these results should only be used for suggestive purposes.)

Table 5-13
Initial and Changed Votes for Respondents Electing to Change Their Initial Votes on Alternative Proposals by Dollar Values for the National and Marketing Area Samples[a]

	Annual Dollar Amount								
	$5	**$15**	**$30**	**$60**	**$90**	**$120**	**$150**	**$200**	**Total**
National Sample									
INITIAL VOTE[b]									
Definitely no	25%	0%	0%	27%	0%	20%	8%	33%	17%
Probably no	0	50	22	46	33	66	17	25	35
Not sure	50	0	45	18	50	7	50	42	33
Probably yes	25	50	22	9	17	7	25	0	14
Definitely yes	0	0	11	0	0	0	0	0	1
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(4)	(2)	(9)	(11)	(6)	(15)	(12)	(12)	(71)
CHANGED VOTE[c]									
Definitely no	0%	0%	14%	18%	0%	8%	9%	10%	9%
Probably no	25	50	29	18	0	15	8	0	14
Not sure	50	50	0	28	33	31	17	40	28
Probably yes	25	0	43	27	67	38	58	50	43
Definitely yes	0	0	14	9	0	8	8	0	6
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(4)	(2)	(7)	(11)	(6)	(13)	(12)	(10)	(65)
Marketing Area Sample									
INITIAL VOTE[b]									
Definitely no	0%	20%	22%	50%	16%	40%	0%	22%	23%
Probably no	0	0	22	33	17	40	12	45	25
Not sure	0	60	56	0	67	10	50	33	36
Probably yes	100	0	0	17	0	10	38	0	14
Definitely yes	0	20	0	0	0	0	0	0	2
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(3)	(5)	(9)	(6)	(6)	(10)	(8)	(9)	(56)

(Continued)

Table 5-13
Initial and Changed Votes for Respondents Electing to Change Their Initial Votes on Alternative Proposals by Dollar Values for the National and Marketing Area Samples[a] *(Continued)*

	Annual Dollar Amount								
	$5	**$15**	**$30**	**$60**	**$90**	**$120**	**$150**	**$200**	**Total**
CHANGED VOTE[c]									
Definitely no	0%	0%	22%	40%	0%	11%	13%	12%	13%
Probably no	0	25	34	40	34	34	12	25	27
Not sure	0	0	11	0	33	33	12	25	20
Probably yes	0	75	33	0	33	22	38	38	31
Definitely yes	100	0	0	20	0	0	25	0	12
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(3)	(4)	(9)	(5)	(6)	(9)	(8)	(9)	(52)

[a] Percentages are rounded to sum to 100 percent.
[b] Reported results represent cases where respondents supported a change in dam operations and responded to the initial vote question (Question 3), but elected to change their vote.
[c] Reported results represent cases where respondents supported a change in dam operations, responded to the initial vote (Question 3), and indicated what their changed vote would be.
( ) Numbers in parentheses indicate the valid number of cases.

Table 5-14
Direction of Vote Changes for Respondents Electing to Change Their Initial Votes on Alternative Proposals by Dollar Values for the National Sample[a]

Initial Vote ---> Final Vote	Annual Dollar Amount $5	$15	$30	$60	$90	$120	$150	$200	Total
Definitely no ---> Probably no	0%	0%	0%	0%	0%	15%	0%	0%	3%
Definitely no ---> Not sure	25	0	0	9	0	7	0	20	8
Definitely no ---> Probably yes	0	0	0	19	0	0	9	10	6
Probably no ---> Definitely no	0	0	0	18	0	8	8	0	6
Probably no ---> Not sure	0	50	0	18	16	23	0	20	14
Probably no ---> Probably yes	0	0	15	9	17	31	8	0	12
Not sure ---> Definitely no	0	0	14	0	0	0	0	10	3
Not sure ---> Probably no	25	0	14	18	0	0	8	0	8
Not sure ---> Probably yes	25	0	29	0	50	8	42	40	25
Probably yes ---> Probably no	0	50	14	0	0	0	0	0	3
Probably yes ---> Not sure	25	0	0	0	17	0	17	0	6
Probably yes ---> Definitely yes	0	0	14	9	0	8	8	0	6
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(4)	(2)	(7)	(11)	(6)	(13)	(12)	(10)	(65)

[a] Reported results represent cases where respondents supported a change in dam operations, responded to the initial vote (Question 3), and indicated what their changed vote would be. Percentages are rounded to sum to 100 percent.

( ) Numbers in parentheses indicate the valid number of cases.

Table 5-15
Direction of Vote Changes for Respondents Electing to Change Their Initial Votes on Alternative Proposals by Dollar Values for the Marketing Area Sample[a]

Initial Vote ---> Final Vote	Annual Dollar Amount $5	$15	$30	$60	$90	$120	$150	$200	Total
Definitely no ---> Probably no	0%	0%	11%	40%	0%	23%	0%	13%	11%
Definitely no ---> Not sure	0	0	11	0	17	11	0	12	8
Definitely no ---> Probably yes	0	25	0	0	0	0	0	0	2
Probably no ---> Definitely no	0	0	22	40	0	11	0	12	12
Probably no ---> Not sure	0	0	0	0	17	11	13	13	8
Probably no ---> Probably yes	0	0	0	0	0	22	0	12	6
Not sure ---> Definitely no	0	0	0	0	0	0	12	0	2
Not sure ---> Probably no	0	25	22	0	33	11	0	13	13
Not sure ---> Probably yes	0	50	34	0	33	0	38	25	23
Probably yes ---> Probably no	0	0	0	0	0	0	12	0	2
Probably yes ---> Not sure	0	0	0	0	0	11	0	0	2
Probably yes ---> Definitely yes	100	0	0	20	0	0	25	0	11
	100%	100%	100%	100%	100%	100%	100%	100%	100%
	(3)	(4)	(9)	(5)	(6)	(9)	(8)	(8)	(52)

a Reported results represent cases where respondents support a change in dam operations, responded to the initial vote (Question 3), and indicated what their changed vote would be. Percentages are rounded to sum to 100 percent.

( ) Numbers in parentheses indicate the valid number of cases.

Regardless of the sample, the majority of respondents choosing to change their votes had originally voted "Definitely No," "Probably No," or "Not Sure" (Table 5-14). No votes were changed from "Definitely No," "Probably No," or "Not Sure" to a "Definitely Yes." Only respondents who had already voted "Probably Yes" changed their vote to "Definitely Yes." For both samples, no respondent changed a "Definitely Yes" vote to another. (In each sample, only one respondent chose to change from a "Definitely Yes" vote to something else. However, neither of these answered the subsequent question asking how their vote would change.) Finally, a majority of respondents who originally voted "Not Sure" changed their votes to "Probably Yes."

In summary, very few respondents chose to change their votes after consideration of their budget constraints. Those changing their votes were slightly more likely to vote in favor of the proposal. However, since the number of vote changes was small, subsequent analysis in this report was based on the initial vote to the contingent valuation question.

5.5 RESPONDENT SELF-REPORTS ON DATA QUALITY

Some would argue that quality of responses to contingent valuation questions are improved to the extent that respondents understand the valuation scenario and take the valuation task seriously. Several questions in the survey were designed to collect data on the potential quality of the data collected in the survey.

Quality of contingent valuation responses might be higher if respondents find the payment vehicle to be credible. Payment vehicles differed between the national and marketing area samples. For the national sample, taxes were used as the payment vehicle. In the marketing area sample, utility bills were used as the payment vehicle. Following the contingent valuation question in the survey, respondents who voted to support the proposal at $0 cost were asked whether they had believed their taxes (or utility bills) would increase if the proposal passed (Figure 5-2).

Figure 5-2
Payment Vehicle Questions

National Sample Survey:

7. Do you believe your taxes will increase if this proposal passes? *(CIRCLE ONE NUMBER)*

   1 No
   2 Yes

Marketing Area Sample Survey:

7. Do your believe your utility bill will increase if this proposal passes? *(CIRCLE ONE NUMBER)*

   1 No
   2 Yes

In both samples, the majority of respondents indicated they believed their taxes (or utility bills) would have increased if the proposal had passed (Table 5-16). Fully 72 percent of the national sample and 83 percent of the marketing area sample said they believed their bills (tax or utility) would have increased if the proposal had passed. In the national sample, across survey versions, the average percentage of respondents who believed their taxes would have increased ranged from 70 to 75 percent. Respondents from the marketing area apparently found the payment vehicle to be more believable than did respondents from the national sample: 81 to 85 percent believed their utility bills would have increased.

Table 5-16
Believability of the Payment Vehicle[a]

	Percent of Respondents	
	National Sample	**Marketing Area Sample**
All respondents	72% (1255)	83% (1076)
Survey Versions		
Moderate fluctuating flow (Versions 1,5)	75% (280)	81% (328)
Low fluctuating flow (Versions 2,6)	70% (229)	83% (299)
Seasonally adjusted fluctuating flow (Versions 3,7)	70% (221)	85% (331)
Seasonally adjusted fluctuating flow with moderate fluctuating flow price impacts (Version 4)	72% (240)	NA

a This question was asked only of respondents who supported a change in dam operations at zero cost.
( ) Numbers in parentheses indicate the valid number of cases.
NA = not applicable

A second method of examining the validity of the payment vehicle is to determine whether the selected vehicle is binding on the respondents. There has been some concern that individuals might express a large willingness-to-pay when it is measured using a payment vehicle that is not binding on the respondent. For example, in the marketing area, a respondent might be willing to vote in favor of a change in dam operations regardless of the impact to utility bills if they are not responsible for paying the utility bills.

To determine whether the payment vehicles were binding, respondents in the national sample were asked whether they had taxes withheld from their 1993 earnings and whether they had filed a 1993 federal income tax form. Marketing area survey versions contained questions asking if respondents owned or rented their homes and whether they were responsible for paying the utility bills.

Eighty-three percent of all national sample respondents reported paying taxes in 1993, and 93 percent reported filing a Federal income tax form (Table 5-17). This result suggests that for the national sample, taxes represented a binding payment vehicle since nearly all these respondents either paid taxes or filed a federal income tax form. Looking only at those national sample respondents who supported the proposal at zero cost shows slightly higher percentages: 87 percent reported they paid taxes and 95 percent reported they filed federal income tax forms in 1993. Responses from members of the marketing area sample shows similar patterns. Almost all respondents either owned or rented their homes and paid utility bills (85 percent and 98 percent, respectively). These results did not differ for marketing area respondents who voted to support the proposal only at $0 cost.

Table 5-17
Binding Effects of the Payment Vehicle

	Percent of Respondents	
	National Sample	**Marketing Area Sample**
All respondents		
Taxes were withheld from 1993 earnings	83% (1,619)	NA
Filed a 1993 federal income tax form	93% (1,620)	NA
Own or rent residence	NA	85% (1,354)
Responsible for paying utility bills	NA	98% (1,357)
Respondents who support a change in dam operations at zero cost		
Taxes were withheld from 1993 earnings	87% (1,236)	NA
Filed a 1993 federal income tax form	95% (1,238)	NA
Own or rent residence	NA	85% (1,073)
Responsible for paying utility bills	NA	98% (1,075)

( ) Numbers in parentheses indicate the number of valid cases.
NA = not applicable

All respondents were asked whether they felt public officials <u>should</u> consider study results in deciding how Glen Canyon Dam should be operated, and whether they felt public officials <u>will</u> consider the results in such decisions. Clearly, the majority of respondents feel study results should be considered when deciding how Glen Canyon Dam should be operated in the future (Table 5-18). In contrast, substantially fewer people feel the results actually will be used. These results hold even when examining only the responses of the individuals who supported a change in dam operations.

Table 5-18
Respondent Opinions on the Use of Study Results in Future Decisions About the Operation of Glen Canyon Dam

	Percent of Respondents	
	National Sample	**Marketing Area Sample**
All respondents		
Public officials <u>should consider</u> study results in deciding how Glen Canyon Dam should be operated in the future.	95% (1,646)	95% (1,337)
Believe public officials <u>will consider</u> study results in deciding how Glen Canyon Dam will be operated in the future.	61% (1,633)	58% (1,331)
Respondents who support a change in dam operations		
Public officials <u>should consider</u> study results in deciding how Glen Canyon Dam should be operated in the future.	97% (1,262)	96% (1,071)
Believe public officials <u>will consider</u> study results in deciding how Glen Canyon Dam will be operated in the future.	63% (1,250)	59% (1,065)

( ) Numbers in parentheses indicate the number of valid cases.

In summary, respondents generally believed they would have to pay if the proposal was passed. The payment vehicle appeared to be binding on nearly all respondents. Respondents felt that the results of the survey should be considered by public officials when making decisions about the operation of Glen Canyon Dam. Taken together, these results suggest that respondents took the valuation exercise seriously and felt their responses provided valuable information that should be considered in the decision-making process, even though they were not confident that results would be used.

5.6 DISCRETE CHOICE MODELS OF WILLINGNESS-TO-PAY

Responses to Question 3 (Figure 5-1) were evaluated using two different approaches. In the first approach, respondents choosing the "Definitely Yes" category in Question 3 were considered to have voted "YES." Respondents choosing the "Definitely No," "Probably No," "Unsure," and "Probably Yes" categories were classified as having voted against the proposal ("NO"). Under the second approach, respondents choosing either the "Definitely Yes" or the "Probably Yes" category were considered to have voted in favor of the proposal and those choosing "Unsure," "Probably No," and "Definitely No" were considered to have voted against the proposal.

Question 3 data were analyzed using a discrete choice model based on a logistic cumulative density function:

Eq. **(1)** $$\text{prob (vote in favor)} = (1 + \exp - \underline{\beta}\, \underline{X})^{-1}$$

In Equation 1, X represents a vector of explanatory variables and β represents the parameters to be estimated.

For this study, the logistic regression model estimated the probability that a respondent would vote in favor of a proposal as a function of several variables. These variables reflect the perceived reality and validity of the valuation process, and respondents' understanding of the critical features of the proposal. Also included was a dummy variable reflecting which proposal was being evaluated, a series of environmental attitude items, respondent education and income, and the cost to the respondent if the proposal were to pass. Cases with missing data for any variable included in the model were excluded from this analysis. Results are presented in Table 5-19 for the models used with the national sample, and in Table 5-20 for the marketing area. Variable definitions are found in Table 5-21.

Positive coefficients in Tables 5-19 and 5-20 indicate that respondents are more likely to vote in favor of a proposal when the value of the associated variable is increased. The variable "score" for example, reflects the score respondents received on a set of true or false questions asked about the components of the survey materials. The coefficient on "score" is positive and significant for all the econometric models shown in Tables 5-19 and 5-20, indicating that respondents who achieved higher scores were more likely to vote "Yes" for the proposed dam operation alternative. The probability of voting **in favor** of a proposal was typically increased by:

- Higher expectations of visiting the Grand Canyon in the future;
- Better understanding of the survey materials;
- A belief that the study results would be used to determine future dam operations;
- Attitudes favoring the environment;
- Higher levels of income; and
- Higher levels of education.

The probability of voting **against** the proposal was typically increased by:

- A belief that the respondent would actually pay money if the proposal passed; and
- The cost to respondent if the proposal passed.

Table 5-19
Estimated Logistic Regression Model Parameters for the National Sample[a]

Variable	Definitely Yes Models	Definitely / Probably Yes Models
constant	**-3.8933** (0.9670) P=0.000	**-2.4317** (0.7142) P=0.001
score	**1.4920** (0.9489) P=0.116	**2.4681** (0.6729) P=0.000
taxincrease	**-0.3774** (0.1761) P=0.032	**-0.3698** (0.1557) P=0.018
useresults		**0.2239** (0.1458) P=0.125
futuregc	**0.1801** (0.0948) P=0.058	**0.1521** (0.0763) P=0.046
factor1	**-0.2954** (0.1095) P=0.007	**-0.3585** (0.0823) P=0.000
factor2	**0.6938** (0.1124) P=0.000	**0.5070** (0.0861) P=0.000
factor3	**-0.1530** (0.0903) P=0.090	**-0.1169** (0.0747) P=0.118
factor4	**0.1892** (0.0964) P=0.050	
school	**0.1946** (0.0814) P=0.017	
income		**0.000008** (0.000003) P=0.004
D2	**0.2355** (0.2493) P=0.345	**0.3266** (0.2024) P=0.107
D3	**0.3360** (0.2477) P=0.175	**0.2316** (0.2031) P=0.254
D4	**0.4552** (0.2432) P=0.062	**0.3855** (0.2006) P=0.055
annbid1	**-0.0101** (0.0015) P=0.000	**-0.01111** (0.0011) P=0.000
-2 * Log Likelihood	919.6081	1203.4691
Chi-squared	158.9979 P=0.000	223.6875 P=0.000
Correctly predicted responses	82.45%	70.16%
Number of observations	1,094	1,039

[a] Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Table 5-20
Estimated Logistic Regression Model Parameters for the Marketing Area Sample[a]

Variable	Definitely Yes Models	Definitely / Probably Yes Models
constant	**-4.0312** (0.9989) P=0.000	**2.5619** (0.8281) P=0.002
score	**1.3772** (0.9191) P=0.134	**1.7688** (0.7490) P=0.018
utilityincrease		**-0.5393** (0.2194) P=0.014
useresults	**0.6777** (0.1919) P=0.000	**0.6125** (0.1642) P=0.000
futuregc	**0.2556** (0.1210) P=0.035	**0.5445** (0.0940) P=0.000
factor1	**-0.5568** (0.1143) P=0.000	**-0.3542** (0.0878) P=0.000
factor2	**0.5250** (0.1081) P=0.000	**0.5919** (0.0904) P=0.000
factor3	**-0.2864** (0.0888) P=0.001	**-0.3008** (0.0793) P=0.000
factor4	**0.3942** (0.1037) P=0.000	**0.1722** (0.0899) P=0.056
income	**0.000009** (0.000004) P=0.029	
D6	**-0.1796** (0.2297) P=0.434	**0.4786** (0.2017) P=0.018
D7	**0.1936** (0.2194) P=0.378	**0.3045** (0.1919) P=0.113
annbid1	**-0.0163** (0.0018) P=0.000	**-0.0161** (0.0013) P=0.000
-2 * Log Likelihood	765.8547	962.2454
Chi-squared	213.8576 P=0.000	328.1274 P=0.000
Correctly predicted responses	80.18%	74.47%
Number of observations	908	948

[a] Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Table 5-21
Model Variable Definitions

Variable	Definition
constant	constant = 1
score	Quiz score computed from mail survey true/false questions. Maximum score = 1.
taxincrease	Question 7 in the national version of the mail survey. (Do you believe your taxes will increase if this proposal passes?) 0 = no, 1 = yes
utilityincrease	Question 7 in the marketing area version of the mail survey. (Do you believe your utility bills will increase if this proposal passes?) 0 = no, 1 = yes
useresults	Question 8 in the mail survey. (Do you think public officials will consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future?) 1 = no, 2 = yes
futuregc	Question 23 in the mail survey and question 13 in the phone survey. (How likely do you think it is that you will visit the Grand Canyon National Park in the future?) 1 = not at all likely, 4 = very likely
factor1	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 12 (nep scale), items 1,3,5,8, and 10. Labeled "Impacts of human intervention on nature." Expected sign: -
factor2	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 13 (economic/environmental issues), items 1,3,4, and 6. Labeled "Economic security." Expected sign: +
factor3	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 12 (nep scale), items 12 and 13. Labeled "Limits to growth." Expected sign: -
factor4	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 12 (nep scale), items 2 and 9. Labeled "Human ingenuity will ensure balance." Expected sign: +
school	Question 26 in the mail survey and question 17 in the telephone survey. Respondent education, coded in categories where 1 = eight years or less and 6 = post graduate work.
income	Question 30 in the mail survey and question 19 in the telephone survey. House hold income. Recoded from categories to midpoint values.

(Continued)

Table 5-21
Model Variable Definitions

Variable	Definition
D2	Dummy variable for national survey version. 1 = low fluctuating flow (Version 2), 0 = other
D3	Dummy variable for national survey version 1 = seasonally adjusted steady flow (Version 3), 0 = other
D4	Dummy variable for national survey version. 1 = seasonally adjusted steady flow with moderate flow price impacts (Version 4), 0 = other
D6	Dummy variable for marketing survey version. 1 = low fluctuating flow (Version 6), 0 = other
D7	Dummy variable for marketing survey version. 1 = seasonally adjusted steady flow (Version 7), 0 = other
annbid1	Annual cost of proposal.

5.7 ESTIMATED WILLINGNESS-TO-PAY

The estimated logistic regression parameters reported in Tables 5-19 and 5-20 specify the cumulative density function for willingness-to-pay. Estimates of average, or mean, willingness-to-pay can be calculated using the following formula:

Eq. (2)

$$\overline{WTP} = \frac{\ln\left(1 + \exp \sum_{i=1}^{n-1} B_i * X_i\right)}{-B_n}$$

In Equation 2, B_1 represents the constant; B_2 through B_{n-1} represent coefficients on all the variables except the cost of the proposal; and B_n is the coefficient on the cost of the proposal. In calculating the mean willingness-to-pay, all of the non-cost variables must be set at appropriate levels. In carrying out this calculation, the relevant national-sample averages and marketing-area sample averages from the mail survey data were used. The one exception was the variable that measured whether respondents really believed they would have to pay if the proposal passed. This variable was set at a level that indicated respondents believed they would have to pay if the proposal passed. This step served to correct for the upward bias that would otherwise have been present because some respondents indicated they did not really believe they would have to pay the stated amount if the referendum passed. Dummy variables representing the various proposals were set at appropriate levels in order to determine mean willingness-to-pay for the different proposals. Mean willingness-to-pay values are reported in Table 5-22 for the national sample, and in Table 5-23 for the marketing area sample.

Table 5-22
Annual Estimated Mean Willingness-to-Pay for a Change in Dam Operations for the National Sample[a]

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Moderate Fluctuating Flow (Version 1)	$23.96	$107.31
Low Fluctuating Flow (Version 2)	$29.45	$128.75
Seasonally Adjusted Steady Flow (Version 3)	$32.11	$122.32
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	$35.52	$132.82

[a] Reported values were calculated for all cases where respondents supported a change in dam operations at zero cost and believed their tax bills would increase with the passage of the referendum.

Table 5-23
Annual Estimated Mean Willingness-to-Pay for a Change in Dam Operations for the Marketing Area Sample[a]

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Moderate Fluctuating Flow (Version 5)	$32.43	$100.11
Low Fluctuating Flow (Version 6)	$28.14	$124.93
Seasonally Adjusted Steady Flow (Version 7)	$37.59	$115.68

[a] Reported values were calculated for all cases where respondents supported a change in dam operations at zero cost and believed their utility bills would increase with the passage of the referendum.

5.8 THE ROLE OF POWER PRICE INCREASES IN THE SCENARIOS

The qualitative research indicated that some members of the national sample were likely to feel empathy toward individuals who would experience increases in their electric rates as a result of changes in the operation of Glen Canyon Dam. As a result, these increases were included as a part of the contingent valuation scenarios in surveys sent to members of the national sample. Furthermore, inclusion of these price impacts posed a potential problem. Specifically, protection for the environment increases as dam operations move from moderate fluctuating flows to seasonally adjusted steady flows. Furthermore, as environmental protection increases, so do the price impacts to power consumers. Table 5-24 summarizes these relationships. While many of the environmental improvements were described in qualitative terms (for example, "a major improvement in conditions for native fish," or "a substantial reduction in the risk of erosion"), the power price impacts were described in quantitative terms (dollars per month). Some concern was expressed during the OMB approval process that the higher degree of specificity for power price impacts might serve as a cue that would affect responses to the contingent valuation question in an undesirable manner. It was argued that respondents might reason along the following lines, "If the power price impacts are high, then the problem must be serious, and I should be willing to pay a lot to solve a serious problem." Reasoning along these lines would produce a pattern of higher willingness-to-pay for the seasonally adjusted steady flow alternative and lower willingness-to-pay for the moderate and low fluctuating flow alternatives.

This issue of power price anchoring can be partially addressed by examining the average willingness-to-pay expressed for the moderate and low fluctuating flow scenarios. Recall that the power price impacts were identical for these two proposals, but the environmental improvements were greater for the low fluctuating flow proposal (Table 5-24). If respondents are paying attention to the environmental benefits, we would expect a higher willingness-to-pay for the low fluctuating flow proposal. Table 5-22 shows that in the national sample, willingness-to-pay for the low fluctuating flow proposal exceeds willingness-to-pay for the moderate fluctuating flow proposal. This result indicates that, given constant power price impacts, respondents in the national sample tended to place higher value on the proposal that had larger environmental improvements.

Survey Version 4 was designed to provide a further examination of the role of power price impacts. The proposal in Version 4 combined the environmental improvements of the seasonally adjusted steady flow alternative with the power price impacts of the low and moderate fluctuating flow alternative. If respondents used the power price impacts as a cue for answering the contingent valuation question, we would expect to see a lower willingness-to-pay for the proposal in Version 4 than for the seasonally adjusted steady flow proposal (Version 3). One the other hand, if respondents felt empathy for power consumers, a higher willingness-to-pay would be expected for the proposal in Version 4 than for Version 3. Table 5-22 shows that in the national sample, willingness-to-pay for the seasonally adjusted steady flow proposal is less than the willingness-to-pay for the proposal in Version 4. This result supports the hypothesis that responses to the contingent valuation question were partially motivated by feelings of empathy toward power consumers and did not seem to suffer from the power price anchoring issue raised during the OMB approval process.

Table 5-24
Overview of Environmental Improvements and Power Price Impacts in the National Sample Surveys

Survey Version	Environmental Improvements[a]	Cost to Power Consumers	
		Average	Maximum
Moderate Fluctuating Flow (Version 1)	Smallest	$3/month	$9/month
Low Fluctuating Flow (Version 2)	Moderate	$3/month	$9/month
Seasonally Adjusted Steady Flow (Version 3)	Largest	$9/month	$21/month
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	Largest	$3/month	$9/month

[a] For complete descriptions used in the survey instruments, see Appendix E.

5.9 CALCULATION OF POPULATION AVERAGE WILLINGNESS-TO-PAY

The means reported in Table 5-22 represent the average willingness-to-pay only for those respondents in the national sample to the mail survey who voted in favor of the proposal at no cost. Equivalent values for marketing area sample respondents are reported in Table 5-23. Determining an average value that can be aggregated across relevant populations requires taking account of the values held by three additional groups: (1) respondents to the mail survey who indicated they would vote against the proposal at zero cost; (2) respondents to the mail survey who would choose to not vote on the proposal, and; (3) non-respondents to the mail survey.

Mail survey respondents who voted against a proposal even at zero cost provided a clear indication that they did not place a positive value on the proposal. In the analysis that follows, these individuals are assigned a willingness-to-pay amount of zero.
Mail survey respondents who chose not to vote either for or against the proposal may have been expressing a protest against the valuation process. It could be argued that these

individuals should be excluded from the analysis, since they chose not to participate in the valuation process. On the other hand, if these respondents had been forced to vote on the proposal, it is very likely that some would have voted in favor of the proposal and expressed a positive value. However, in the absence of any information about the potential values the individuals might have, a willingness-to-pay of zero is assumed in the analysis that follows.

Accounting for nonrespondents to the mail survey raises more complex issues. Recall that telephone interviews were carried out with these nonrespondents. The results of this telephone survey indicated that nonrespondents tended to have lower incomes, lower educational attainment, lower probabilities of future visits to the Grand Canyon, and slightly less environmentally oriented attitudes than respondents to the mail survey. While it might be reasonable to assume that some nonrespondents would have expressed a positive willingness-to-pay if they had completed the mail survey, it is also reasonable to assume that the average willingness-to-pay for nonrespondents would have been less than the average willingness-to-pay for the mail survey respondents.

Assigning willingness-to-pay values to nonrespondents was carried out in two ways. The first approach used the mail survey data to estimate a model predicting whether a respondent would vote in favor of the proposal at zero cost. This model was then applied to data collected during the telephone interview with mail survey nonrespondents to estimate the probability that they would have voted in favor of the proposal at zero cost.[2] Next, an average willingness-to-pay for nonrespondents was estimated using the models reported in Tables 5-19 and 5-20 but evaluated at relevant average values from the telephone survey of nonrespondents. The second approach simply assumed that all nonrespondents to the mail survey had a zero willingness-to-pay.

The population average willingness-to-pay was calculated as a weighted average of the estimated or assumed willingness-to-pay values for four groups:

- Mail survey respondents who would vote for the proposal at zero cost;
- Mail survey respondents who would either not vote for the proposal at zero cost or who would choose not to vote;
- Nonrespondents to the mail survey estimated, or assumed, to support the proposal at zero cost; and
- Nonrespondents to the mail survey estimated, or assumed, to either not support the proposal at zero cost or not vote.

The weight for each component of population average willingness-to-pay is the proportion of each of these groups in the sample. Details of the calculation of population average

2 The model used to predict the percentage of nonrespondents who would support the proposal at zero cost is discussed in Appendix G.

willingness-to-pay are presented in Tables 5-25 and 5-26 for the national and marketing area "Definitely Yes" models, and in Tables 5-27 and 5-28 for the national and marketing area "Definitely/ Probably Yes" models. A summary of population average willingness-to-pay is presented in Tables 5-29 and 5-30 for the national and marketing area tables, respectively.

Table 5-25

Weighted Mean Values for Willingness-to-Pay for a Change in Dam Operations National Sample Definitely Yes Models

	Response Rate Weights	Support Weight	Total Weight	Estimated Mean Willingness to Pay	Contribution to Weighted Mean	Population Weighted Average Willingness to Pay
Moderate Fluctuating Flow Alternative (Version 1)						
Mail Respondents	0.6435					
Support at $0 cost		0.71	0.456885	$23.96	$10.95	
Not support / not vote		0.29	0.186615	$0.00	$0.00	
Nonrespondents	0.3565					
Support at $0 cost		0.65	0.230377	$11.75	$2.71	
Not support / not vote		0.35	0.126123	$0.00	$0.00	
			1.000000			$13.65
Low Fluctuating Flow Alternative (Version 2)						
Mail Respondents	0.6651					
Support at $0 cost		0.83	0.552033	$29.45	$16.26	
Not support / not vote		0.17	0.113067	$0.00	$0.00	
Nonrespondents	0.3349					
Support at $0 cost		0.79	0.265388	$14.65	$3.89	
Not support / not vote		0.21	0.069512	$0.00	$0.00	
			1.000000			$20.15
Seasonally Adjusted Steady Flow Alternative (Version 3)						
Mail Respondents	0.6713					
Support at $0 cost		0.77	0.516901	$32.11	$16.60	
Not support / not vote		0.23	0.154399	$0.00	$0.00	
Nonrespondents	0.3287					
Support at $0 cost		0.75	0.245912	$16.08	$3.95	
Not support / not vote		0.25	0.082788	$0.00	$0.00	
			1.000000			$20.55
Seasonally Adjusted Steady Flow Alternative With Moderate Flow Price Impacts (Version 4)						
Mail Respondents	0.6545					
Support at $0 cost		0.81	0.530145	$35.52	$18.83	
Not support / not vote		0.19	0.124355	$0.00	$0.00	
Nonrespondents	0.3455					
Support at $0 cost		0.80	0.276606	$17.94	$4.96	
Not support / not vote		0.20	0.068894	$0.00	$0.00	
			1.000000			$23.79

Table 5-26

Weighted Mean Values for Willingness-to-Pay for a Change in Dam Operations Marketing Area Sample Definitely Yes Models

	Response Rate Weights	Support Weight	Total Weight	Estimated Mean Willingness to Pay	Contribution to Weighted Mean	Population Weighted Average Willingness to Pay
Moderate Fluctuating Flow Alternative (Version 5)						
Mail Respondents	0.7401					
Support at $0 cost		0.76	0.562476	$32.43	$18.24	
Not support / not vote		0.24	0.177624	$0.00	$0.00	
Nonrespondents	0.2599					
Support at $0 cost		0.75	0.195211	$19.54	$3.81	
Not support / not vote		0.25	0.064689	$0.00	$0.00	
			1.000000			$22.06
Low Fluctuating Flow Alternative (Version 6)						
Mail Respondents	0.7484					
Support at $0 cost		0.85	0.636140	$28.14	$17.90	
Not support / not vote		0.15	0.112260	$0.00	$0.00	
Nonrespondents	0.2516					
Support at $0 cost		0.84	0.212124	$16.73	$3.55	
Not support / not vote		0.16	0.039476	$0.00	$0.00	
			1.000000			$21.45
Seasonally Adjusted Steady Flow Alternative (Version 7)						
Mail Respondents	0.7523					
Support at $0 cost		0.85	0.639455	$37.59	$24.04	
Not support / not vote		0.15	0.112845	$0.00	$0.00	
Nonrespondents	0.2477					
Support at $0 cost		0.85	0.209951	$23.01	$4.83	
Not support / not vote		0.15	0.037749	$0.00	$0.00	
			1.000000			$28.87

Table 5-27
Weighted Mean Values for Willingness-to-Pay for a Change in Dam Operations
National Sample Definitely/Probably Yes Models

	Response Rate Weights	Support Weight	Total Weight	Estimated Mean Willingness to Pay	Contribution to Weighted Mean	Population Weighted Average Willingness to Pay
Moderate Fluctuating Flow Alternative (Version 1)						
Mail Respondents	0.6435					
Support at $0 cost		0.71	0.456885	$107.31	$49.03	
Not support / not vote		0.29	0.186615	$0.00	$0.00	
Nonrespondents	0.3565					
Support at $0 cost		0.65	0.230377	$80.45	$18.53	
Not support / not vote		0.35	0.126123	$0.00	$0.00	
			1.000000			$67.56
Low Fluctuating Flow Alternative (Version 2)						
Mail Respondents	0.6651					
Support at $0 cost		0.83	0.552033	$128.75	$71.07	
Not support / not vote		0.17	0.113067	$0.00	$0.00	
Nonrespondents	0.3349					
Support at $0 cost		0.79	0.265388	$98.95	$26.26	
Not support / not vote		0.21	0.069512	$0.00	$0.00	
			1.000000			$97.33
Seasonally Adjusted Steady Flow Alternative (Version 3)						
Mail Respondents	0.6713					
Support at $0 cost		0.77	0.516901	$122.32	$63.23	
Not support / not vote		0.23	0.154399	$0.00	$0.00	
Nonrespondents	0.3287					
Support at $0 cost		0.75	0.245912	$93.34	$22.95	
Not support / not vote		0.25	0.082788	$0.00	$0.00	
			1.000000			$86.18
Seasonally Adjusted Steady Flow Alternative With Moderate Flow Price Impacts (Version 4)						
Mail Respondents	0.6545					
Support at $0 cost		0.81	0.530145	$132.82	$70.41	
Not support / not vote		0.19	0.124355	$0.00	$0.00	
Nonrespondents	0.3455					
Support at $0 cost		0.80	0.276606	$102.52	$28.36	
Not support / not vote		0.20	0.068894	$0.00	$0.00	
			1.000000			$98.77

Table 5-28
Weighted Mean Values for Willingness-to-Pay for a Change in Dam Operations Marketing Area Sample Definitely / Probably Yes Models

	Response Rate Weights	Support Weight	Total Weight	Estimated Mean Willingness to Pay	Contribution to Weighted Mean	Population Weighted Average Willingness to Pay
Moderate Fluctuating Flow Alternative (Version 5)						
Mail Respondents	0.7401					
Support at $0 cost		0.76	0.562476	$100.11	$56.31	
Not support / not vote		0.24	0.177624	$0.00	$0.00	
Nonrespondents	0.2599					
Support at $0 cost		0.75	0.195211	$67.53	$13.18	
Not support / not vote		0.25	0.064689	$0.00	$0.00	
			1.000000			$69.49
Low Fluctuating Flow Alternative (Version 6)						
Mail Respondents	0.7484					
Support at $0 cost		0.85	0.636140	$124.93	$79.47	
Not support / not vote		0.15	0.112260	$0.00	$0.00	
Nonrespondents	0.2516					
Support at $0 cost		0.84	0.212124	$88.73	$18.82	
Not support / not vote		0.16	0.039476	$0.00	$0.00	
			1.000000			$98.29
Seasonally Adjusted Steady Flow Alternative (Version 7)						
Mail Respondents	0.7523					
Support at $0 cost		0.85	0.639455	$115.68	$73.97	
Not support / not vote		0.15	0.112845	$0.00	$0.00	
Nonrespondents	0.2477					
Support at $0 cost		0.85	0.209951	$80.69	$16.94	
Not support / not vote		0.15	0.037749	$0.00	$0.00	
			1.000000			$90.91

Table 5-29
Summary of National Sample Population Average Willingness-to-Pay

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Values Imputed for Nonrespondents[a]		
Moderate Fluctuating Flow (Version 1)	$13.65	$67.56
Low Fluctuating Flow (Version 2)	$20.15	$97.33
Seasonally Adjusted Steady Flow (Version 3)	$20.55	$86.18
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	$23.79	$98.77
Zero Values Assumed for Nonrespondents[b]		
Moderate Fluctuating Flow (Version 1)	$10.95	$49.03
Low Fluctuating Flow (Version 2)	$16.26	$71.07
Seasonally Adjusted Steady Flow (Version 3)	$16.60	$63.23
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	$18.83	$70.41

[a] Adjusted to reflect values of nonrespondents and to reflect a belief that respondents would actually pay if the proposal passed.

[b] Adjusted to reflect a zero dollar value for nonrespondents and to reflect a belief that respondents would actually pay if the proposal passed.

Table 5-30
Summary of Marketing Area Sample Population Average Willingness-to-Pay

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Values Imputed for Nonrespondents[a]		
Moderate Fluctuating Flow (Version 5)	$22.06	$69.49
Low Fluctuating Flow (Version 6)	$21.45	$98.29
Seasonally Adjusted Steady Flow (Version 7)	$28.87	$90.91
Zero Values Assumed for Nonrespondents[b]		
Moderate Fluctuating Flow (Version 5)	$18.24	$56.31
Low Fluctuating Flow (Version 6)	$17.90	$79.47
Seasonally Adjusted Steady Flow (Version 7)	$24.04	$73.97

a Adjusted to reflect values of nonrespondents and to reflect a belief that respondents would actually pay if the proposal passed.
b Adjusted to reflect a zero dollar value for nonrespondents and to reflect a belief that respondents would actually pay if the proposal passed.

5.10 STATISTICAL VARIABILITY IN WILLINGNESS-TO-PAY ESTIMATES

The values reported in Tables 5-29 and 5-30 represent point estimates of per household population average willingness-to-pay for the national and marketing area samples, respectively. These point estimates are a function of the parameters of the models presented in Tables 5-19 and 5-20 and assumptions made about the values held by non-respondents to the mail survey. Both the assumptions made, and the statistical uncertainties about the estimated parameters introduce some uncertainty about the point estimates. The variability introduced by making different assumptions is explored in more detail in Appendix I. This section explores the statistical uncertainty associated with the point estimates of population average willingness-to-pay derived from the "Definitely Yes" models.

Since the parameters reported in Tables 5-19 and 5-20 are subject to statistical uncertainty, the point estimates reported in Tables 5-29 and 5-30 are also subject to statistical uncertainty. However, given the process used to calculate the population average willingness-to-pay, it would be difficult to analytically derive variance estimators. As an alternative, a monte-carlo technique was used to construct empirical distributions for the estimated (as opposed to assumed) components of the population average willingness-to-pay point estimates. This was accomplished by repeated sampling from the estimated distribution of parameters reported in Tables 5-19 and 5-20 (Krinsky and Robb, 1986). A total of three thousand random draws was made, and estimates of mean willingness-to-pay for one alternative were constructed for each of the three thousand sets of parameters. This resulted in 3000 estimates of mean willingness-to-pay for each alternative which were then arranged in order from lowest to highest. Empirical 95 percent confidence intervals were then constructed by dropping the lowest 25 and the highest 25 willingness-to-pay estimates. This process was repeated for each alternative and was carried out for both respondents and non-respondents. Lower 95 percent confidence limits for population average willingness-to-pay were estimated by recalculating the estimate using lower 95 percent confidence limits for respondents and non-respondent willingness-to-pay estimates (Table 5-31). Likewise, upper 95 percent confidence limits were estimated by using the upper 95 percent confidence limits for willingness-to-pay estimates (Table 5-32).

Table 5-31
Percent Change in Mean Willingness-to-Pay between Definitely Yes Models with Values Imputed for Nonrespondents and the Lower 95 Percent Confidence Interval for the Same Model

	Values Imputed for Nonrespondents	Lower 95% CI	Percent Change from Base
National Sample			
Moderate Fluctuating Flow	$13.65	$9.27	-32.09%
Low Fluctuating Flow	$20.15	$14.22	-29.43%
Seasonally Adjusted Steady Flow	$20.55	$14.57	-20.10%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	$23.79	$17.17	-27.83%
Market Area Sample			
Moderate Fluctuating Flow	$22.06	$16.68	-24.39%
Low Fluctuating Flow	$21.45	$15.84	-26.15%
Seasonally Adjusted Steady Flow	$28.87	$22.50	-22.06%

Table 5-32
Percent Change in Mean Willingness-to-Pay between Definitely Yes Models with Values Imputed for Nonrespondents and the Upper 95 Percent Confidence Interval for the Same Model

	Values Imputed for Nonrespondents	Upper 95% CI	Percent Change from Base
National Sample			
Moderate Fluctuating Flow	$13.65	$20.39	49.38%
Low Fluctuating Flow	$20.15	$29.29	45.36%
Seasonally Adjusted Steady Flow	$20.55	$29.84	45.21%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	$23.79	$33.39	40.35%
Market Area Sample			
Moderate Fluctuating Flow	$22.06	$29.39	33.23%
Low Fluctuating Flow	$21.45	$29.28	36.50%
Seasonally Adjusted Steady Flow	$28.87	$37.24	28.99%

5.11 AGGREGATION

The household average willingness-to-pay values were aggregated across relevant populations. At the time the sample was purchased, Survey Sampling, Inc. estimated there were 94,836,300 households in the United States.[3] A total of 1,500,000 households were estimated to reside in the marketing area (Energy Information Administration, 1991).

The procedures used to aggregate the population average household willingness-to-pay are consistent with the aggregation procedures used to develop the estimates of recreational values and power values reported in the GCDEIS. Aggregation was carried out using a fifty-year time period from 1991 to 2040. The gross national product (GNP) price deflator series reported by the GCES Power Resources Committee was used to construct estimates of average household willingness-to-pay for each year from 1991 to 2040. Since projections of the future number of U.S. households were not readily available, increases in the number of households were based on the rate of increase in the population. For the national sample, the rate of increase in the number of households was calculated using U.S. Census estimates of the total U.S. population. In the marketing area, the rate of increase in the number of households was estimated using U.S. Census estimates of total population for the states of Wyoming, Utah, Colorado, New Mexico, Arizona, and Nevada.

Household series were constructed so that the 1994 estimated number of households was 94,836,300 for the nation, and 1,500,000 from the marketing area. Consistent with the work of the GCES Power Resources Committee, population growth was assumed to occur only during the first 20 years of the 50-year aggregation period.[4]

For each proposal analyzed, the estimated annual value per household was multiplied by the corresponding estimated number of households to arrive at an estimate of the annual total value associated with the alternative. Present value and levelized annual value estimates were calculated using a discount rate of 8.50 percent. The interest rate used by the federal water agencies in economic analyses is specified by the Water Resources Council in accordance with Section 80(a) Public Law 93-251. That rate reflects the average yield during the preceding fiscal year on United States interest-bearing securities which have terms of 15 years or more remaining to maturity rounded to the nearest one-eight percent. Changes in the rate are limited to no more than one-forth percent per year. This is intended to eliminate the effects of short-term changes, and thus more appropriately reflects the relatively long-term

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3 The estimate of the total number of U.S. households from SSI is slightly lower than estimates provided by U.S. Census Bureau. For example, in 1993 the Census Bureau estimated a total of 96,391,000 households in the United States.

4 This assumption was made to reflect the fact that while the GCES Power Resources Committee escalated costs throughout the 50-year period, electrical loads were held constant after the twentieth year.

period of economic analysis for water resource projects. The rate is provided annually by the Treasury Department for each fiscal year based on the average yield for the preceding fiscal year. For fiscal year 1992 (beginning with October of 1991) the rate is 8.50 percent. This rate is used for all economic analyses in the Glen Canyon Dam EIS. Levelized annual values are presented in Tables 5-33 and 5-34 for the national and marketing area samples.

Table 5-33
Aggregate Levelized Annual Willingness-to-Pay for Changes in Dam Operations for the National Sample (Millions of Dollars)

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Values Imputed for Nonrespondents[a]		
Moderate Fluctuating Flow (Version 1)	$2,286.4	$11,316.4
Low Fluctuating Flow (Version 2)	$3,375.2	$16,302.9
Seasonally Adjusted Steady Flow (Version 3)	$3,442.2	$14,435.2
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	$3,984.8	$16,544.1
Zero Values Assumed for Nonrespondents[b]		
Moderate Fluctuating Flow (Version 1)	$1,834.1	$ 8,212.6
Low Fluctuating Flow (Version 2)	$2,723.6	$11,904.3
Seasonally Adjusted Steady Flow (Version 3)	$2,780.5	$10,591.1
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts (Version 4)	$3,154.0	$11,793.8

a Adjusted to reflect values of nonrespondents and to reflect respondents' stated belief that they would actually pay if the proposal passed.
b Adjusted to reflect a zero dollar value for nonrespondents and to reflect respondents' stated belief that they would actually pay if the proposal passed.

Table 5-34
Aggregate Levelized Annual Willingness-to-Pay for Changes in Dam Operations for the Marketing Area Sample (Millions of Dollars)

Water Release Alternative	Definitely Yes Models	Definitely / Probably Yes Models
Values Imputed for Nonrespondents[a]		
Moderate Fluctuating Flow (Version 5)	$62.2	$196.1
Low Fluctuating Flow (Version 6)	$60.5	$277.3
Seasonally Adjusted Steady Flow (Version 7)	$81.4	$256.5
Zero Values Assumed for Nonrespondents[b]		
Moderate Fluctuating Flow (Version 5)	$51.5	$ 158.9
Low Fluctuating Flow (Version 6)	$50.5	$224.2
Seasonally Adjusted Steady Flow (Version 7)	$67.8	$208.7

[a] Adjusted to reflect values of nonrespondents and to reflect respondents' stated belief that they would actually pay if the proposal passed.
[b] Adjusted to reflect a zero dollar value for nonrespondents and to reflect respondents' stated belief that they would actually pay if the proposal passed.

5.12 DISCUSSION OF ASSUMPTIONS USED

The values reported in Tables 5-33 and 5-34 span a relatively large range. A substantial portion of this range is a direct result of various assumptions that could be made during the process of calculating population average willingness-to-pay. We believe that the best estimates of willingness-to-pay are those that are based on the "Definitely Yes" models and for which values were imputed for nonrespondents. These best estimates for the national sample are presented in Table 5-35. Best estimates for the marketing area sample follow in Table 5-36. A large number of decisions were made during survey design, implementation, and data analysis. In this section we discuss these decisions, the justification for them, and their implications.

Table 5-35
Best Estimates of Willingness-to-Pay for Changes in the Operation of Glen Canyon Dam -- National Sample

	Population Weighted Willingness-to-Pay Per Household	Levelized Annual Value[a]
Moderate Fluctuating Flow	$13.65	$2,286.4
Low Fluctuating Flow	$20.15	$3,375.2
Seasonally Adjusted Steady Flow	$20.55	$3,442.2

[a] Millions of dollars

Table 5-36
Best Estimates of Willingness-to-Pay for Changes in the Operation of Glen Canyon Dam -- Marketing Area Sample

	Population Weighted Willingness-to-Pay Per Household	Levelized Annual Value[a]
Moderate Fluctuating Flow	$22.06	$62.2
Low Fluctuating Flow	$21.45	$60.5
Seasonally Adjusted Steady Flow	$28.87	$81.4

[a] Millions of dollars

Proposed federal regulations governing contingent valuation studies of non-use values strongly support the use of a single-bounded dichotomous choice framework. The GCES Non-Use Values Study used a modified version of the single-bounded dichotomous choice question format. Instead of asking respondents to simply vote "Yes" or "No" to a proposal, they were asked to indicate how they would vote on a five-point scale. The five-point scale ranged from "Definitely No" to "Definitely Yes." This decision was based partially on early results from a criterion validity study (Champ, 1994) showing that individuals who are more sure of their preferences seem to provide "better" contingent valuation responses.

Respondents were also given a chance to "opt out" of the contingent valuation question. Respondents were first asked if they would vote in favor of the proposal if passage of the proposal cost them nothing. They were provided with three response categories: "No," "Yes," and "I would choose not to vote on this proposal." All individuals choosing the first category ("No") were assigned a willingness-to-pay of zero. Some might argue that respondents voting against the proposal at zero cost were actually indicating they held a negative value for the proposal. There is no easy way to investigate this issue in a quantitative manner short of contacting these individuals and asking about their willingness-to-pay to <u>avoid</u> implementation of the proposal. We suspect that such an effort would reveal very small, if not zero, willingness-to-pay to maintain current dam operations. During the qualitative research, we saw no indication that respondents felt that they would experience a decrease in utility as a result of a change in the operations of Glen Canyon Dam. Results clearly indicated that, with the possible exception of impacts to power consumers, respondents in the national sample were either indifferent to or in favor of changes in the operations of Glen Canyon Dam. This finding did not support assigning negative values to individuals who voted against the proposal at zero cost and we feel justified in assigning zero willingness-to-pay to these respondents.

Making assumptions about willingness to pay for respondents choosing the third category ("Choose not to vote") was more problematic. Based on the qualitative research, we suspect that at least a portion of these respondents elected not to vote because they did not want to vote in favor a proposal that increased electricity prices for residents of the marketing area, <u>not</u> because they felt the proposal had no value. In fact, the results of the qualitative research led us to believe that it's probable that some respondents who objected to the payment vehicle may have a positive value for changes in dam operations. However, in the absence of information about these values, these respondents were assigned a willingness-to-pay of zero.

The logistic regression equations reported in Tables 5-19 and 5-20 were used to estimate willingness-to-pay values for survey nonrespondents. Some might argue that all nonrespondents to the mail survey should be assigned a zero value, thereby decreasing the estimated average willingness-to-pay by approximately 20 to 30 percent. However, a substantial effort was made to contact nonrespondents to the mail survey via telephone and collect data that would address issues of potential nonresponse bias. These data were combined with the models estimated from the mail survey data to provide our best estimate of the willingness-to-pay of nonrespondents. Thus, in the presence of a model and sufficient data from nonrespondents to the mail survey, it would be inappropriate to simply assume that all nonrespondents to the mail survey had a willingness-to-pay of zero.

Finally, the portion of the sample identified as out-of-scope was excluded from the analysis for this report. The calculation of aggregate willingness-to-pay implicitly assumed that the distribution of willingness-to-pay among out-of-scope individuals is identical to the estimated distribution of willingness-to-pay for respondents to the mail and telephone surveys. The only other feasible assumption would be that all out-of-scope sample points have a willingness-to-pay of zero. We are not aware of any precedent for assigning a zero willingness-to-pay to out-of-scope members of the original sample. In fact, a strong argument could be made that some of these individuals would express a positive willingness-to-pay if they could have been contacted. Consequently, it seemed more appropriate to exclude the out-of-scope cases as was done in the analysis contained in this report.

CHAPTER 6
VALIDITY OF RESULTS

This chapter discusses the accuracy, or validity, of the study's results. We start by admitting that validity is not a simple issue. Willingness-to-pay (WTP) is defined as the amount of money that the idealized consumer in economic theory could give up before he or she would be indifferent about changes in dam operations. As such, WTP is unobservable in the real world. We cannot measure it directly to assess the accuracy of valuation techniques, including contingent valuation (CV). Less direct forms of evidence must be used to evaluate the validity of economic values. This measurement problem is confronted in the first section of this chapter. Fortunately, the problem is not unique to economics. Drawing on the efforts of psychologists and other social scientists to address similar measurement problems, economists are developing a theory of measurement that is described in the second section. Based on the validity criteria described and applied in early parts of this chapter, we will argue later in this chapter that values estimated in this study have sufficient validity to warrant their use in economic analysis of Glen Canyon Dam operating alternatives for purposes of public decision making.

6.1 THE MEASUREMENT PROBLEM

The goal of economic valuation studies is to measure WTP for some change in people's economic circumstances.[1] Such changes are brought about by "interventions." These interventions can take the form of public projects, changes in governmental policies or regulations, and intentional or unintentional releases of pollutants into the environment.[2] In theory, consumers are willing to pay to obtain "interventions" that increase their utility and to avoid interventions that reduce their utility. WTP for an intervention represents just the right amount of money paid to make consumers indifferent about it.

In applied studies, we can estimate WTP using revealed preference methods or stated preference methods. Revealed preference methods typically involve estimating a demand function. The theory of consumer behavior leads economists to expect that the area below the estimated demand function and above the price line (the so-called welfare triangle) will,

1 Alternatively, willingness to accept compensation might be the ideal measure for some studies. Most of what is said in this chapter also applies to measurement of willingness-to-accept, but is not discussed directly because this study deals exclusively with WTP.

2 Indeed, the operational alternatives for Glen Canyon Dam are examples of such interventions.

after adjusting for the income effect, equal aggregate WTP for consumption of that good. WTP represents a payment that, if collected, would lead real-world consumers to be indifferent about consuming the good at its current price as opposed to not consuming it at all. If an intervention causes the welfare triangle to change, thus changing aggregate WTP for the good, then the change in the welfare triangle (again after proper allowance for the income effect) is taken to represent aggregate WTP for the intervention.

Stated preference methods, of which CV is the most widely applied example, are more direct. Rather than estimating welfare triangles, people are asked to reveal their WTP values for the intervention during a survey.

Regardless of whether revealed preference or stated preference methods are used, judging the accuracy of WTP estimates is difficult. The problem stems from the fact that WTP cannot be observed directly. It is an abstraction. It exists only in the idealized theory of the consumer. If it is unobservable, then it cannot be measured and used as a standard to evaluate the accuracy of estimated values from either revealed preference or stated preference studies. Less direct methods to assess the accuracy or "validity" of value measures are required.

Historically, revealed preference methods dominated in valuation studies. The market transactions used in these studies were (rightly or wrongly) considered highly credible indicators of WTP. It is not apparent why market transactions should be considered credible indicators. How do economists know that changes in welfare triangles are indicative of the amount of money required to make consumers indifferent about interventions? Unfortunately, this question did not attract much attention from researchers applying revealed preference methods.

On the other hand, responses to stated preference questions have lacked the presumed credibility of market transactions and have been widely questioned. Throughout CV's history, numerous doubts have been raised about whether people are willing and able to reveal their WTP values in this way. Respondents might be unwilling to reveal their values if they see strategic advantages to giving misleading answers. For example, if the intervention is favorable to them and they realize that they will not really have to pay, then they may answer CV questions in ways that imply larger WTP values than they would really pay. On the other hand, even if they were willing to reveal their values, respondents may be unable to judge how much they really would pay simply because they have no past experience with buying or selling the environmental resources being valued.

Alternative views on the overall validity of the CV method will be examined more closely later in this chapter. The point to be made here is that the validity of alternative methods of measuring values is now on the economic agenda.

If such questions are raised about CV and other stated preference methods, they must be raised about revealed preference methods as well. Ultimately, consistent standards of validity will need to be applied across the full range of methods.

Fortunately, this sort of measurement problem is not unique to economic valuation. Throughout the social sciences, observable potential indicators of unobservable constructs must be evaluated for accuracy. In psychology, for example, tests have been devised to try to measure such concepts as intelligence and self-esteem. Intelligence and self-esteem are ultimately abstract theoretical constructs not unlike WTP, at least up to a point. To the extent that they exist at all in reality, intelligence, self-esteem, and payments sufficient to produce indifference about interventions exist only inside the minds of people and cannot be observed directly. Instead, evidence must be acquired using IQ tests, personality tests, and either market data or stated preference surveys to attempt to estimate their magnitudes. Economics can draw on psychology in developing its own theory of measurement.

6.2 TOWARD A THEORY OF ECONOMIC MEASUREMENT

Psychologists (e.g., Bohrnstedt, 1983) have applied three strategies to assess the accuracy of their methods. These are content validity, construct validity, and criterion validity -- the "Three Cs." Environmental economists have already begun to adapt the Three Cs to contingent valuation (Mitchell and Carson, 1989; Champ, 1994; Bishop et al., 1994; Bishop and McCollum, 1995). Although CV is the focus of this discussion, all three strategies for validity assessment should be of interest for a full range of measurement issues within economics.

Content validity has to do with whether the design and execution of a study were conducive to revealing theoretical WTP. Assessing content validity involves examining the "content" of the study procedures.

Construct validity -- the second of the Three Cs -- looks at the degree to which the measure under scrutiny (in this case CV estimates of WTP) relates to other measures as predicted by theory and intuition. Mitchell and Carson (1989) discuss two forms of construct validity -- convergent and theoretical. Tests of convergent validity consider the relationship between the CV-measure and alternative measures of the value of the same intervention. For example, convergent validity could be assessed by comparing values estimated from a CV study to values estimated using revealed preference methods such as a travel cost model or an hedonic pricing model.

Because non-use values are not fully reflected in revealed preference measures, convergent validity will not play a direct role in evaluating the validity of the results of the current study.[3] Nevertheless, convergent validity studies will prove interesting in discussing the overall validity of CV.

Theoretical validity--the other form of construct validity--is assessed by testing theory-based hypotheses about relationships between WTP and other variables. In CV, it is often assessed by considering the relationship between the CV measure and independent variables that are thought to be potential determinants of WTP. A common example is a test to see if income and WTP are positively related. Assessing the theoretical validity of a measure may involve simple contingency table analyses. Or, more sophisticated multivariate regression procedures may be applied and coefficients on potentially important independent variables scrutinized for statistical significance, appropriate signs, and relative magnitudes.

Diamond et al. (1993), among others, have recently advocated a different form of the theoretical validity test. They advocate testing theory-based hypotheses about relationships between two or more CV values from the same study. For example, one would expect WTP to be greater when a larger environmental amenity is provided or when a larger environmental insult is avoided. CV estimates of values should, if they are measuring theoretical WTP, exhibit relative magnitudes consistent with this hypothesis. Tests of hypotheses about expected variations in estimated values associated with changes in the scope of environmental improvements or insults have come to be known as "scope tests." Within the taxonomy being followed here, scope tests are theoretical validity tests. Many other such tests are conceivable.

The third of the Three Cs is *criterion validity*. To assess criterion validity, Mitchell and Carson (1989) point out that "It is necessary to have in hand a criterion which is unequivocally closer to the theoretical construct than the measure whose validity is being assessed." The closer the contingent value is to the criterion, the more valid it is judged to be.

Given the credibility of market choices as indicators of true values, actual market prices would be a criterion to use in evaluating contingent values; however, because such market prices are rare for environmental amenities (especially when non-use values come into play),

3 Revealed preference approaches to valuation by definition infer consumer preferences from the actual behavior of people, usually as a result of buying and selling things in markets. Non-use values may not fully manifest themselves in easily observable behavior. People who value oil spill prevention in coastal environments they never visit or endangered fishes even though they have no hope of benefiting personally from preservation, cannot express those preferences directly by buying oil spill prevention or endangered fish preservation in markets. Joining an environmental organization or writing to one's congressional representatives are forms of behavior that are more subtle and difficult to interpret in a valuation study.

so-called "simulated market" values are perhaps a more promising alternative for judging the criterion validity of contingent values. Simulated markets involve creating situations in the field or laboratory where subjects have the opportunity to actually pay for the good or service or receive compensation for it. The same good or service is also valued using CV, and the simulated market value is used as a criterion for assessing criterion validity.

An example will illustrate both the potential usefulness of criterion validity studies and their limitations in evaluating the validity of individual CV studies like the one under review here. Champ et al. (1995) conducted a criterion validity study involving removal of some old dirt roads from the North Rim of the Grand Canyon. These old roads allow unauthorized public access using motor vehicles into some remote areas there. Removal of the roads would reduce disturbance to wildlife and those attempting to enjoy wilderness recreation in these areas. Removal would also fulfill one of the requirements for designating the area as an official Wilderness Area. For these reasons, removal of the roads is a National Park Service goal. However, the Park Service lacks money to provide support for volunteers to carry out the work. Champ et al. asked a random sample of Wisconsin residents if they would actually donate money for road removal. Members of a second sample drawn from the same population were asked CV questions about their willingness to donate money. The actual donations then served as simulated market-like criteria for evaluating the validity of the CV donations. This study found a large potential upward bias in the CV responses. That is, people expressed willingness to donate more money for this purpose in the CV exercise than they would actually have donated.

Now, on the surface, Champ et al. appears to raise serious questions about the current study. Both studies dealt with environmental resources of Grand Canyon National Park. Both employed CV methods. Both involved values that were heavily weighted toward non-use values. If they found a substantial bias in an upward direction, would it not follow that our results as presented in Chapter 5 are also likely to be biased?

The answer to this question is not so clear as it might seem at first glance, however. The Champ et al. study differed from this one in that they used a donation framework while we used a referendum framework with taxes (or utility bills) as the payment vehicle. The donation vehicle invites underestimation of the economic value of the resource, especially when actual donations will be collected. Donations encourage people to engage in "free rider" behavior. That is, respondents in simulated markets using donation vehicles may have positive values for the resource and yet hold back from actually paying in the hope that other will donate enough to assure the intervention. In theoretical terms, donation vehicles are "incentive incompatible" with revelation of theoretical WTP.[4] In fact, one might argue that values based on donation vehicles ought not be considered satisfactory criteria for purposes

4 Recall that theoretical WTP is taken to be an amount of money paid by a respondent sufficient to make that respondent indifferent about the intervention.

of validity testing. On the other hand, referenda with tax vehicles are "incentive compatible." They provide respondents with incentives to vote according to their preferences. The conclusions regarding bias of Champ et al. may only apply to CV studies employing donation payment vehicles. Based on theory, we would expect incentive compatible formats to work better than donation vehicles. How much better is impossible to judge from the Champ et al. study.

We nevertheless did draw on the Champ et al. study in choosing to offer respondents an opportunity to express various degrees of uncertainty about how they would vote in a real referendum, from definitely yes to definitely no. Champ et al. found that allowing respondents to express their uncertainty in such ways could be used to predict who would really donate money and who would not. If "Definitely Yes" models predict well for incentive incompatible donations, then there was reason to hope that they would also predict at least as well who would really vote yes in an incentive compatible referendum. Given that such models predict well for donations, they ought, if anything, to err on the low side, all else equal, in predicting the positive votes in a real referendum.

In the broader context, criterion validity studies will nearly always have limited direct applicability in evaluating the validity of individual CV studies. As the comparison of the road removal study and the current effort illustrates well, the "match" between one study that was able to develop a criterion and another that was not will rarely be perfect. If a method of valuation superior to CV (i.e., valuation methods capable of yielding values for criterion validity tests of CV) could be applied in most situations where CV is applied, there would be much less need for CV.

Still, criterion validity tests, in those instances where they are feasible, are capable of yielding useful insights. Support for the definitely yes models in the current study is one example. In general, criterion validity tests should help to improve content validity criteria.

In applying the Three Cs, an important, although often overlooked, distinction must be made between the validity of individual studies and the overall validity of the CV method. Content validity assessment is exclusively applicable at the level of the individual study. It would be nonsense to ask whether the CV method as a whole has content validity. Some studies will be more content-valid than others. Construct validity testing also occurs at the level of the individual study. However, as such testing is done in more and more studies, the results can have implications for the overall validity of the method. If, for example, CV studies consistently fail construct validity tests, this would raise questions about whether the method as a whole is capable of producing valid value estimates. As we just saw, criterion validity tests are likely to have limited applicability in evaluating the validity of individual studies. Criterion validity studies are mainly relevant to the overall assessment of CV's validity.

Before we turn to a detailed assessment of the content and construct validity of this study, we will first briefly consider the available evidence about the overall validity of the CV method.

6.3 OVERALL VALIDITY OF THE CV METHOD

The question of whether CV is capable of yielding valid economic values is among the most hotly contested issues in economics today, with distinguished economists lining up on both sides. This controversy is all the more confusing to outsiders because some of the most vehement opponents of CV are econometricians from among America's best universities. Much of the body of this criticism is found in various chapters of the book edited by Hausman (1993). Further discussion of the critique may be found in a paper by McFadden (1994). We will attempt only a sketch of the dimensions of the debate here.

Those most critical of CV begin from the standard presupposition that only revealed preference data hold reliable information about economic values. Many economists are dubious about the credibility of verbal reports about economic preferences. That verbal reports are untrustworthy goes back at least Samuelson's (1954) classic theoretical article on public goods. Critics of CV nevertheless agree that ultimately empirical evidence should be consulted to determine whether CV data might also provide valid information about values. However, they believe that there is a major impediment to empirical research on the problem. They reason that revealed preference methods, and most notably market valuation methods, are subject to external validation by comparing market behavior to predictions from econometric models. The problem with CV, as they see it, is that it is not subject to external validation. If people hold non-use values, they will not leave such market or other behavior-based evidence to use for external validation of CV. Hence the critics reason that CV will, even at best, remain inferior to revealed preference measures. They do recognize the possibility of internal validation, though they consider it less potent than external validation. That is, critics of CV do recognize that CV might gain some economic credibility if it could produce results consistent with prior expectations based on economic theory. In the terminology of this report, critics have proposed that CV results be subjected to strict theoretical validity testing. To this end, they carried out a few CV studies, found that the results failed scope tests and other tests based on theory, and concluded that CV cannot even stand up to internal validity tests.

Proponents of CV have been less than convinced by these arguments. In-print support for the method can be found in many places including Mitchell and Carson (1989) and Hanemann (1994). At least lukewarm support has also come from the NOAA Panel on Contingent Valuation, a panel of distinguished scholars co-chaired by Nobel Laureates in Economics Kenneth Arrow and Robert Solow (U.S. Department of Commerce, 1993). We will not attempt to do justice to all the counter arguments, but will attempt to summarize, from our own point of view, the current state of knowledge about the overall validity of CV.

On the conceptual side, we would argue that CV and revealed preference methods have more in common than the critics are admitting. The alleged external testability of revealed preference methods seems to us to be largely an illusion. Theoretically speaking, the welfare triangles from revealed preference valuation studies do not constitute the true values of the commodity being valued. As we have already stressed, the true value of any intervention is the amount of money paid or received that would leave the people affected by the intervention indifferent about it. As we have also stressed already, indifference is an internal mental state that cannot be observed directly. Relationships between estimated welfare triangles and states of indifference must be inferred through theory. Based on theory, we are led to expect that demand functions (in particular, Hicksian compensated demand functions) are determined by consumers in such a way as to make the area under them and above the price line indifference-producing amounts of money, but there is no way to externally validate this theoretical result. Instead, the validity of revealed preference measures of value, like the validity of stated preference measures, can only be addressed using strategies that we have attempted to capture in the Three Cs.

Now, from the standpoint of the Three Cs, one might observe that, for economists, revealed preference data have a high level of content validity a priori. Stated preference data do not. We accept this as a starting point for the debate over CV.[5] Nevertheless, this does not obviate the need to test for validity at the level of the individual study.

It is interesting to consider the theoretical validity of modern market demand studies. Despite the fact that theory clearly points to systems of demand equations where the quantity demanded of each good is a function of all prices and income, it is still not unusual, even today, to find applied studies that estimate a single demand equation. Those studies that do estimate systems of equations generally estimate only a limited subset of the full demand system. Estimation of the subset is justified using separability assumptions that are rarely tested. Furthermore, researchers sometimes impose the fundamental structural requirements of demand theory econometrically, by assuming that functional forms meeting theoretical requirements hold and imposing them on the data. Attempts to estimate flexible functional forms have met with mixed success at best.

Though it has not been referred to explicitly as theoretical validity testing, such testing does normally occur in market demand studies. Demand studies routinely examine regression coefficients for expected signs and statistical significance. More sophisticated studies may test for more complex theoretical prior expectations, such as additivity or whether the Slutzky matrix is negative semi-definite. As might be expected, theoretical validity tests in market demand studies frequently reveal violations of prior expectations.

5 One caveat might be inserted at this point. In our view, economists would do well to worry a bit more about the content validity of market data. However, this point is not central here and will not be pursued.

The manner in which failures of validity tests are dealt with in market valuation studies is rather interesting in light of the criticisms being leveled at CV. In market studies, a wrong sign or insignificant coefficient here or there is not taken as a serious problem. The real world has its imperfections, after all. Furthermore, many studies do not do very much validity testing beyond an examination of signs and significance once the functional form that "fits best" is determined. Where systems of demand equations are estimated and the structural requirements of demand theory have not simply been imposed on the data a priori, the inability of demand studies to meet theoretical prior expectations is certainly viewed with concern. However, such failures are not necessarily considered to be grounds for rejecting a study outright. Certainly, outright failures of some studies to successfully meet a minimum set of theoretical priors would not be considered grounds for throwing out market demand studies in general.

How economists view validity in market studies has important implications for CV validity assessment. First, given that CV lacks a priori content validity, it is especially incumbent on the investigators in CV studies to give careful attention to the content validity of their procedures. At a minimum, in other words, it is incumbent on researchers to measure values well. Otherwise, progress in determining whether resulting values ought to have economic credibility will be hampered. Secondly, estimation of valuation equations and theory-driven hypothesis testing to establish or reject the theoretical validity of CV results seems very much in keeping with normal practice in market demand studies. Basically, this requirement boils down to asking whether there is evidence to indicate that market behavior and responses to CV questions appear to be rooted in mental processes like those modeled in economic theory. The more such evidence one sees, the stronger the foundation for interpreting market values and contingent values as economic values. However, following the same sort of approach as is normal in market studies, one should not be surprised or overly upset to find that not all theoretical expectation are fulfilled all the time. Empirical work is a messy business whether one is dealing with market data or CV data. Finally, and now we return to the question of the overall validity of CV, attempts to draw sweeping conclusions about the validity of CV from a few studies, as the more vociferous critics of CV have done, cannot be justified scientifically. They may have shown that their CV studies are invalid, but judgments about the overall validity of the method must be based on the preponderance of evidence across a full range of studies.

Given the credibility of revealed preference data in economics, comparisons of values from applications of revealed preference methods with CV values for the same interventions are particularly potent evidence. In a recent paper, Carson et al. (forthcoming) considered 83 separate studies that supported 616 comparisons of contingent values to revealed preference values for the same interventions. Some of the revealed preference results came from criterion validity studies in which simulated market or actual market comparisons were feasible. Other studies involved comparisons of CV values with hedonic price, travel-cost, and averting expenditure studies and would probably be more properly considered convergent validity comparisons.

All 83 studies involved WTP. Summary statistics of the ratios of contingent values to revealed preference values were constructed for the full set of studies, for a 5 percent trimmed set of studies, and for a data set that gave equal weight to each study rather than to each CV-revealed preference comparison. For the full set of comparisons, the ratios of contingent values to revealed-preference values averaged 0.89 with a 95% confidence interval of [0.81-0.96] and a median of 0.75. Comparable statistics for the trimmed and weighted comparisons were 0.77 [0.74-0.81] and 0.75 and 0.92 [0.81-1.03] and 0.94, respectively. The Spearman rank correlation coefficients for contingent values and associated revealed-preference values were 0.78, 0.88, and 0.92, respectively.

These results would support the conclusion that CV studies are capable of producing value estimates that are rather close to those that would be obtained from revealed-preference studies in cases where both approaches are possible. If anything, the work by Carson et al. suggests that CV tends to err on the low side compared to revealed-preference valuation procedures. These are rather encouraging results, although more evidence regarding non-use values, where revealed-preference methods are more difficult to apply, would be helpful.

Although the debate over CV continues, many economists have concluded that CV studies, if carried out well, are capable of producing estimates of WTP that are sufficiently accurate to be useful in estimating WTP for environmental interventions like the ones in this study. This was the overall conclusion of the NOAA Panel on Contingent Valuation (U.S. Department of Commerce, 1993), for example. In summary, well-done CV studies have considerable credibility and poorly-done studies may have none at all. This leads us to a more detailed examination of the content and construct validity of the current study.

6.4 CONTENT VALIDITY ASSESSMENT OF THE GCES NON-USE VALUE STUDY

Assessing content validity involves four dimensions. First, the study design must be reviewed for consistency with the underlying economic theory of value. If CV values are to be interpreted as economic values, they must be estimated in ways that are compatible with theory. Among the issues that have to be considered here are those associated with budget constraints, the availability of substitutes and complements, and the incentive compatibility of the valuation mechanism. Second, the extent to which the study communicates effectively to potential respondents must be evaluated. These first two dimensions might be summarized by saying that a valid CV study must deal with both Homo economicus and Homo sapiens in ways that are conducive to value revelation. Third, whether various facets of study execution were adequate must be considered. Such matters as sampling and response rates are examined here. Fourth, procedures followed as the study results were analyzed and reported must be considered. Here, attention is focused on econometrics and quality of reporting.

In an attempt to flesh out these principles, Bishop and McCollum (1995) have proposed the rating form presented as Figure 6-1. The form is composed of 12 detailed questions about study procedures plus additional related questions. Certain parts of the form are specifically designed for use by outside reviewers of CV studies. For example, the rating form suggests that points be assigned for each of the 12 detailed questions depending on how well the study did in addressing the issues raised in each question. It also asks for a total score (Question 13) and for a qualitative rating of the study (Question 15) on a scale ranging from Excellent to Unacceptable. While it would make little sense for us as the researchers to assign points or qualitative ratings to our own study, we can use the 12 detailed questions to organize our reasons for believing that our study was designed and executed in ways that give it high content validity.

Figure 6.1
Content Validity Rating Form for Contingent Valuation Studies

1. Was the theoretical true value clearly and correctly defined? (5 points) .... ______

2. Were the environmental attributes relevant to potential subjects fully identified? (10 points) .... ______

3. Were the potential effects of the intervention on environmental attributes and other economic parameters adequately documented and communicated? (10 points) .... ______

4. Were respondents aware of their budget constraints and of the existence and status of environmental and other substitutes? (5 points) .... ______

5. Was the context for valuation fully specified and incentive compatible? (10 points) ______

6. Did survey participants accept the scenario? Did they believe the scenario? (10 points) .... ______

7. How adequate and complete were survey questions other than those designed to elicit values? (10 points) .... ______

8. Was the survey mode appropriate? (10 points) .... ______

9. Were qualitative research procedures, pretests, and pilots sufficient to find and remedy identifiable flaws in the instrument and associated materials? (5 points) .... ______

10. Given study objectives, how adequate were procedures employed to choose study subjects, assign them to treatments (if applicable), and encourage high response rates? (10 points) .... ______

11. Was the econometric analysis adequate? (10 points) .... ______

12. How adequate are the written materials from the study? (5 points) .... ______

13. Total points .... ______

(continued)

Figure 6.1 ***(continued)***
Content Validity Rating Form for Contingent Valuation Studies

14. Are there other concerns relating to the design and execution of the study that have not already been addressed? .... ______

15. Considering the issues raised in Question 1 through 12, your total score as calculated for Question 13, and any additional issues raised under Question 14, how would you rate this study overall?

    ______ Excellent
    ______ Good
    ______ Fair
    ______ Poor
    ______ Unacceptable (Study Fatally Flawed)

(1) Was the theoretical true value clearly and correctly defined? Soon after the GCES Non-Use Value Study was conceived in general terms, the values to be estimated were defined in theoretical terms and presented in a report along with a discussion of various theoretical issues and a review of the literature on total value (Bishop et al., 1991). This work was subjected to a peer review by four experts in the field of environmental economics who provided numerous comments and suggestions.

(2) Were the environmental attributes relevant to potential subjects fully identified? Eight focus groups were conducted early in the process of designing the study. To probe in a preliminary way for relevant regional differences among potential future survey respondents, these groups were held in New York State, Tennessee, Nebraska, Arizona, and Utah. The groups were evenly split between urban and rural participants. An additional seven focus groups were later held at various locations and six observed personal interviews using the draft survey instrument were conducted in Madison, WI. Results from the focus groups and interviews are presented in Appendix B of this report. Throughout this process, a great deal of attention was devoted to investigating which of the potential effects of changing dam operations were relevant to people and why. We incorporated what we learned into the survey instruments.

(3) Were the potential effects of the intervention on environmental attributes and other economic parameters adequately documented and communicated? Potential effects of changing dam operations on environmental and cultural resources were tailored to correspond to the effects identified in the GCDEIS (U.S. Bureau of Reclamation, 1995). Effects of changes in dam operations on power costs were studied by the Power Resources Committee under the auspices of the Glen Canyon Environmental Studies and associated agencies. Their estimates of power cost impacts were translated into potential effects on retail power rates with the help of the Western Area Power Administration. Drafts of the survey instruments were repeatedly revised for effective communication through the process of focus groups, observed interviews, pretests, and the pilot study. Throughout this process the researchers worked with the Non-Use Value Committee. This committee, as described above, was composed of representatives from relevant federal and state agencies, Indian tribes, and interest groups. Much attention was devoted during committee meetings to the accuracy of the information presented to respondents as well as effectiveness and neutrality of communication.

Respondents' understanding of the information provided about potentially affected resources and the effects of dam operations were investigated within the survey through a set of true-false questions. In the final survey, respondents in the national sample averaged 89 percent correct in answering these questions, and respondents in the marketing area sample averaged 90 percent correct.

(4) Were respondents aware of their budget constraints and of the existence and status of environmental and other substitutes? We addressed this issue by including the following statement just prior to the valuation question in the national survey (emphasis in original):

> The higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal. Taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? <u>As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues</u>.

The comparable statement in the marketing area survey was (emphasis in original):

> How would you vote on this proposal if passage meant your utility bill would increase? <u>As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues</u>.

The budget constraint was further emphasized by asking respondents to list the items on which they would spend less money if the proposal passed. After explicitly considering their expenditure alternatives, respondents were offered the opportunity to change their vote on the proposal.

(5) Was the context for valuation fully specified and incentive compatible? Context refers to all dimensions of the possible transactions posed in the CV question: how decisions about implementing the intervention will be made and how money referred to in the CV question will be paid. Examples may include the timing of payments, who else will be paying (the "extent of the market," see Smith, 1993), and the payment vehicle (e.g., taxes, prices of goods and services, user fees). A context is "complete" when respondents have enough such details to feel that they understand the terms of the transaction proposed in the valuation exercise (Fischoff and Furby, 1988). For example, if respondents feel that they do not have adequate information about the timing of the payment or the decision process that determines whether the intervention will be implemented, then the context would be incomplete.

Throughout the focus groups and other steps in instrument design reported in Appendix B, we probed for possible incompleteness of the context and corrected the instruments accordingly. Respondents were told that government officials who would be deciding how to operate the dam in the future needed to know, among other things, whether the proposal presented in the survey would be worthwhile to people like them. Specific payment mechanisms in the form of federal taxes for the national sample and electric utility bills for the marketing area sample were specified. The extent of the market was taxpayers for the national sample and electric power consumers for the marketing area. If proposals were passed, payments were to last for the indefinite future. A referendum format with single-bounded discrete choice responses was adopted. Such a format is widely considered to be incentive-compatible (Hoehn and Randall, 1987; Mitchell and Carson, 1989).

(6) Did survey participants accept the scenario? Did they believe the scenario? A study subject <u>accepts the scenario</u> when he or she at least implicitly agrees to proceed with the valuation exercise based on the information and context provided. Scenario rejection can lead either to poor quality valuation data or item non-response for CV questions. Thus, a valid CV study will strive to develop an acceptable scenario. Study subjects <u>believe the scenario</u> to the extent that they are convinced that their responses to the CV question will actually affect the availability and/or quality of the environmental amenity being evaluated and how much they will actually pay or receive in compensation. Although not a requirement for a content-valid study, belief in the scenario is highly desirable.

One purpose of the focus groups and observed personal interviews was to develop respondent-acceptable survey materials. For example, the use of utility bills as a payment vehicle for the national sample was ruled out because focus group participants outside the West found this vehicle implausible.

Further evidence on acceptance and belief is provided by the survey respondents themselves. Nearly all survey respondents felt that the results of the study should be considered when making decisions about future operations of Glen Canyon Dam (97 percent in the national sample and 96 percent in the marketing area sample). Furthermore, a large proportion of these respondents believed they would actually have to pay if the proposal passed. In the national sample, 72 percent of individuals answering the CV question believed their taxes would increase if the proposal passed. In the marketing area sample, 83 percent of respondents believed their utility bills would increase if the proposal passed. In summary, respondents tended to believe they would have to pay if the proposal passed and that their vote on the proposal ought to be a factor in determining future dam operations. We believe this indicates a high degree of belief in and acceptance of the contingent valuation scenario.

However, one source of some concern about the believability of the scenario did arise from our analysis. For the national sample, those who did not believe that their taxes would rise if the proposal passed were more likely to vote definitely yes than those who thought their taxes would rise (see Table 5-19). One possible interpretation of this result is that these people might have answered the CV question with strategic intentions. That is to say, desiring to see the proposal in question instituted, those who figured they would not have to actually pay, may have answered definitely yes to amounts larger than they would really be willing to pay. If accepted, this interpretation would reduce the validity of the study results. In response to this concern, the values for the national sample were adjusted as explained in Chapter 5. Furthermore, other interpretations of this result are possible. For one, rather than responding to the CV question strategically, it is conceivable that those who tended to answer definitely yes may have also been sufficiently sophisticated in their understanding of government to have realized that their taxes would not really rise. Comparisons of the socioeconomic characteristics of those who did and did not believe that their taxes would rise did not identify any significant differences. Thus, further support for these and other alternative interpretations of the result in question are not forthcoming. Beyond the adjustment for beliefs about taxes just mentioned, more drastic steps to somehow correct for possible strategic influences did not seem warranted.

(7) How adequate and complete were survey questions other than those designed to elicit values? Questions other than the valuation questions provide data to support construct validity testing and may also provide decision makers with useful information of a non-economic nature. Our survey contained standard environmental attitude questions, as well as questions on attitudes toward cultural resources, American Indians, and national parks.

Demographic data were also gathered. Pilot study results were used to select questions that were most promising in predicting WTP.

The questions discussed in the preceding paragraph regarding whether survey respondents felt the results ought to be used and would be used, as well as those asking whether respondents believed their taxes or utility bills would increase were adopted for the final survey to help assess the validity of the exercise.

(8) Was the survey mode appropriate? Except for telephone interviews with nonrespondents to the mail survey, this study was conducted entirely by mail. This survey method is a potential source of trouble in a study of this type. It is probable that in a sample of U.S. residents or even in the marketing area sample, many people would not be familiar with the environmental and cultural resources at the bottom of the Grand Canyon or how those resources would be affected under alternative dam operations. Thus, a great deal of information had to be communicated to survey recipients at the beginning of the survey. Informing potential respondents of all the relevant issues through written information and related material required a substantial effort to ensure that the materials conveyed the correct information. The NOAA Panel and the proposed rules for damage assessment (U.S. Department of Commerce, 1993; U.S. Department of the Interior, 1994; U.S. Department of Commerce, 1994) recognize the potential for such problems by recommending that CV studies be conducted using personal interviews.

Although we do not want to minimize the potential problems of mail surveys for non-use value studies, we have some evidence that indicates our mail survey performed well. First, there were the relatively high scores on the true-false questions, as previously reported. The scores indicated that most respondents had an excellent grasp of the information we provided. Second, our pilot results showed that responses were not sensitive to minor changes in how the information was worded (Appendix C). Third, nearly all respondents felt that the results of the study should be used in future decision making, which can be interpreted as a vote of confidence that respondents felt they had participated in a sound survey. Fourth, a further vote of confidence from respondents came in the high response rates both nationally and especially in the market area. Low response rates can be indicative of poor communication in the survey and other design problems. Finally, as we shall see below, the results of the construct validity testing were quite positive. Poor data due to an overly complex survey that failed to communicate would not have faired so well.

(9) Were qualitative research procedures, pretests, and pilots sufficient to find and remedy identifiable flaws in the instrument and associated materials? As already discussed, this study involved extensive efforts to refine the survey instruments. Focus groups, observed one-on-one interviews, and a large pilot study all contributed to the evolution of the surveys. The study was scrutinized at each step in its design and execution by the Non-Use Value Committee. The design process and the survey instruments at various stages of development were also reviewed by our panel of peer reviewers. Pilot and final instruments were approved by the Office of Management and Budget.

(10) Given the study objectives, how adequate were the procedures for choosing study subjects, assigning them to treatments (if applicable), and encouraging high response rates? Our samples were purchased from a firm that is widely recognized for the quality of its mail survey samples. Potential respondents were carefully assigned at random to the various cells for both the pilot and final surveys. The marketing area sample was selected from households with ZIP codes in areas served by utilities holding long-term firm-power contracts with the Salt Lake City office of the Western Area Power Administration (WAPA). The contracts held by these utilities represented approximately one-half of the firm power marketed from the Salt Lake City Area integrated projects, of which Glen Canyon represents approximately 80 percent of all the power generated. Although power from Glen Canyon Dam is marketed from several other WAPA offices, representatives from WAPA felt that the areas served by the Salt Lake City office would be typical of other areas served by power produced at Glen Canyon Dam. The ZIP codes list provided by WAPA included ZIP codes in Utah, New Mexico, Arizona, Nevada, Colorado, and Wyoming.

Samples provided by the sampling firm typically identify a head of household (usually a male). To avoid a potential bias associated with surveying only heads of households, the survey was addressed to the entire household in care of the identified sample point. For example, if John Smith was the sampled individual, the survey was sent to the John Smith household in care of John Smith. Instructions in the cover letter and on a post-it note attached to the survey materials requested that the survey be completed by the adult member of the household with the latest birthday in the calendar year. This method allowed us to more randomly select adult members of the household to complete the survey and thus resulted in a nearly even gender split among the respondents.

Two sources of concern arise with respect to mail surveys. First, mail surveys samples are assembled using telephone directory listings. Such samples are subject to potential non-coverage errors, to the extent that households either have no telephone or have an unlisted telephone number. For this particular study, the potential for non-coverage errors was reduced by augmenting telephone directory listings with drivers license records in the three states where Department of Motor Vehicles license records were available. The second concern with the mail survey methodology is that non-response to the survey may mean that respondents are not representative of the initial sample. High response rates minimize the potential bias resulting from survey non-response. As described in Chapter 4 and Appendix C, several steps, including the use of a prepaid monetary incentive and extensive follow up contacts of nonrespondents, were used to increase the survey response rate.

While we believe this study achieved as high a rate of coverage and as high a response rate as was possible given the resources available, coverage and response rate are a matter of degree. Unless one achieves a 100 percent coverage and response rate, there remains a possibility of bias. To help assess the adequacy of the sample coverage and the response rate, we compare basic background characteristics of the U.S. population with estimates of these same characteristics for the sampling frame and the respondents to the mail and telephone surveys (Table 6.1).[6]

6 Additional information regarding sampling and sources of data for Table 6-1 are found in Appendix D.

Table 6-1
Characteristics of the Population, Sample Frame, and Survey Respondents

	Population Characteristics[a]	National Sample Frame Characteristics[b]	National Sample Respondent Characteristics[c]
Age:			
18 - 24 Years	13.4%	14.4%	4.1%
25 - 34 Years	22.0	22.0	17.5
35 - 44 Years	21.4	20.7	22.7
45 - 54 Years	15.0	14.5	19.8
55 - 64 Years	11.0	11.3	12.5
65 Years or older	17.2	17.1	23.4
	(190,674,000)	(190,282,531)	(1,913)
Percent Male:	47.9%	NA	52.8%
	(190,674,000)		(1,878)
Education:[d]			
High school graduate or higher	80.2%	NA	91.6%
	(165,012,000)		(1,789)
Bachelors degree or higher[e]	21.9%	NA	43.8%
	(165,012,000)		(1,789)
Average Household Size:	2.6 people	NA	2.7 people
	(96,391,000)		(1,765)
Household Income:			
$0 - $9,999	NA	14.2%	7.1%
$10 - $14,999		8.4	7.2
$15 - $24,999		16.5	15.1
$25 - $34,999		15.3	18.0
$35 - $49,999		17.9	19.4
$50 - $99,999		21.9	26.9
$100,000 or more		5.7	6.3
		(94,705,985)	(1,741)

(continued)

Table 6-1
Characteristics of the Population, Sample Frame, and Survey Respondents
(Continued)

Income:[f]			
Average household	NA	$41,911 (94,705,985)	$42,856 (1,741)
Median household	$30,786 (96,391,000)	NA	$37,250 (1,741)
Median family	$36,950 (68,100,000)	NA	NA

a U.S. Census projected estimates for 1993.
b Information provided by SSI, projected forward from the 1990 U.S. Census.
c To more fully represent the portion of the national sample contacted, results are reported for the combined mail and telephone survey data. For cases where respondents might be represented in both data sets, the mail survey data is excluded.
d Education is reported for individuals 25 years old or older.
e Information reported for national sample respondent characteristics represents respondents who reported being a college or technical school graduate or having completed post graduate work.
f Median household income reported for the population is projected for 1992, in 1992 dollars, and the median family income is projected for 1993, in 1993 dollars.
( ) Numbers in parentheses indicate the number of valid cases.
NA Information is not available.

Respondents to the survey appear to be slightly older and have a higher level of educational attainment than the population at large. The average household income of respondents is close to the estimated average household income for the sampling frame. Furthermore, the median household income of respondents is very close to the median family income as estimated by the U.S. Census Bureau. In summary, while the characteristics of survey respondents do not exactly replicate those of the population, the differences are not substantial. In combination with the procedures used to extrapolate the survey data to the population to calculate an average willingness-to-pay for the relevant population, we believe the procedures used in this study have been successful in minimizing the potential biases associated with non-coverage and non-response.

(11) Was the econometric analysis adequate? We endeavored to be thorough and statistically sound in the econometric procedures applied. Econometric suggestions from our peer review panel and the Non-Use Value Committee were implemented to the extent practical.

(12) How adequate are the written materials from the study? We fully agree with and have attempted to meet, the reporting requirements set by the NOAA Panel (U.S. Department of Commerce, 1993):

> Every report of a CV study should make clear the definition of the population sampled, the sampling frame used, the sample size, the overall sample non-response rate and its components (e.g., refusals), and item non-response on all important questions. The report should also reproduce the exact wording and sequence of the questionnaire and of other communications to respondents (e.g., advance letters). All data from the study should be archived and made available to interested parties . . .

In addition, we have described the qualitative research done as part of instrument development and the results of those efforts; the pilot study results; how the survey instrument was modified after the pilot study; and the final study results. Procedures for estimating aggregate values were explained. Finally, and here we believe our study is unusual, we have attempted to explicitly and systematically assess the validity of the study's procedures and results.

6.5 CONSTRUCT VALIDITY ASSESSMENT

Construct validity assessment offers another strategy for judging the accuracy of contingent values. Given the potential role of non-use values in this study, convergent validity comparisons were not relevant. However, theoretical validity testing was a high priority from the beginning. To re-emphasize a basic point of this chapter, the stronger the linkages are between a study's results and economic theory, the firmer the foundation is for interpreting CV values as economic values. Weaknesses identified during theoretical validity testing could indicate flaws in study design that were not detected when content validity was assessed or they could be symptomatic of unknown factors outside the theory that are influencing results. In either case, the link between observed CV values and the theoretical ideal is weakened.

Bishop et al. (1994) proposed that a distinction be made between "rudimentary" and "advanced" theoretical validity tests. Rudimentary tests use regression analyses, contingency tables, and other such procedures to explore whether prior expectations about the relationships between responses to CV questions and other types of data were met by the study's results. For rudimentary tests, it is worth explicitly recognizing that an important role exists for common knowledge and intuition as well. An example from market demand estimation would be the commonly made assumption that meats like beef and pork are substitutes for each other. There is no reason in theory for this hypothesis, but it would certainly be supported by introspection and casual observation. Likewise, one might hypothesize that members of environmental organizations would have higher values for environmental improvements than non-members. Thus, relationships between CV question responses and income, socioeconomic characteristics, self-reported past behavior (e.g., having visited the area where the environmental resource is located), and attitudinal measures are often evaluated in rudimentary tests. To the extent that such relationships are significant and accompanied by expected signs, the study is judged to have higher construct validity.

In contrast to the rudimentary tests, advanced theoretical validity tests involve prior expectations about the relationships between contingent values, most often from the same study. Scope tests, one example of advanced tests, have been much discussed lately. The credibility of the advanced tests is enhanced if the survey instrument (or instruments) has high content validity and the values to be compared come from independent samples. Passing advanced tests is potent evidence that CV survey responses are rooted to a significant degree in decision processes consistent with economic theory.

Bishop et al. (1994, pp. 22-23) suggest that results from rudimentary and advanced tests should be interpreted in the following way:

> We propose that studies be categorized into a three-level hierarchy expressing increasing degrees of construct validity. At the lowest level would be studies that either have not included any construct validity tests or have failed to pass rudimentary tests . . . Such studies may still be useful for scientific purposes or as exercises involving the training of students, but should be used in policy analysis and litigation only with the heaviest caveats. The second level of the hierarchy would involve studies that have achieved a fair amount of success in the rudimentary tests, but that either do not have the budget to support advanced testing or have not succeeded in passing advanced tests. Second-level studies may be usable in cost-benefit analyses, since normally such analyses are simply interested in determining whether the benefits of an intervention exceed the costs. Of course, suitable caveats would need to be introduced into such studies. Unless benefits exceed costs by a fairly wide margin or vice versa, potential imprecision in second level studies may mean that the issue of whether benefits exceed costs remains open. Second level studies may be less useful for litigation, where relatively precise estimates of value are needed to assess damages, but they may still be useful in preliminary damage assessments . . . Third level studies are studies that have conducted and achieved substantial success in sophisticated rudimentary tests and/or have conducted and passed advanced tests. Provided that such studies are judged to have a high degree of content validity as well, they would have the highest level of credibility for benefit-cost analysis and litigation.

To consider the level of the current study in this hierarchy, consider first how well the study performed in rudimentary tests. Logistic equations presented in Tables 5-19 and 5-20 indicate that willingness to pay is strongly related to factors like income, education, environmental attitudes, and expectations of future visits to the Grand Canyon in ways that are quite consistent with prior expectations.

Several advanced tests were passed as well. First, theory would lead one to expect that responses to CV questions should not be sensitive to seemingly innocuous wording changes. Pilot test results confirmed (Appendix C) that values did not change in statistically significant ways when minor wording changes and changes in the order of the information were introduced.

A second advanced test relates to prior expectations about how electricity price impacts would affect WTP estimates. Recall that for the national sample in the final study, each version contained descriptions of the environmental benefits and electricity price impacts for a specific alternative dam operation. Furthermore, for increasingly severe restrictions on power generation--from the moderate fluctuating flow alternative to the low fluctuating flow alternative and then the seasonally adjusted steady flow alternative--increasing levels of environmental improvements were associated with increasing power price impacts. Based on the focus groups results, we were confident that environmental improvements were viewed by many potential respondents as positive attributes of the alternatives, whereas increasing price impacts were often viewed as negative impacts. In the pilot study, values increased as more stringent constraints on dam operations were introduced. We tended to interpret this as evidence that environmental concerns were outweighing empathy for power consumers. However, an alternative interpretation arose in reviewing the pilot results. It was suggested that higher contingent values expressed for the seasonally adjusted steady flow alternative may have resulted because respondents used the power price impacts as a cue to the value they should express for that proposal. This concern was addressed by including Version 4 in the final study. Version 4 contained the environmental impacts of Version 3 (the seasonally adjusted steady flow alternative) but the power impacts of Version 2 (the low fluctuating flow alternative). That is, the environmental effects in Version 3 and Version 4 were identical, while the power price impacts in Version 4 were lower than in Version 3. If respondents were weighing environmental positives against power price impact negatives in a theoretically consistent way then Version 4 ought to generate higher values than Version 3. If the price impacts were providing a cue for respondents then, contrary to what would be expected based on theory and the focus groups, Version 4 ought to have had a lower value. As we saw in the preceding chapter, Version 4's value was larger, supporting the theoretical validity of the study.

Finally, several scope tests were applied using the pilot and final survey results. In both the pilot test and the final survey, the portion of respondents who would support proposals if the cost to them were zero varied significantly across proposals in ways that were consistent with prior expectations. In the pilot survey for the national sample, among those who would vote for the proposals at zero cost to them, mean WTP for the seasonally adjusted steady flow alternative was rather consistently more than the mean WTP for the moderate fluctuating flow alternative based on the various statistical tests performed. Furthermore, in the national-sample pilot test, Version 8, which was identical to Version 3 except that impacts to Native Americans, trout, and native fish were deleted, produced a lower value than Version 3. This lower value was marginally significant in the definitely-yes models and quite significant in the combined definitely-yes and probably-yes models. This outcome confirmed prior expectations.

Interpretation of the scope tests was somewhat more complicated in the final survey. Some changes made to the scenarios between the pilot survey and the final survey reduced the likelihood of finding significantly different values for the seasonally adjusted steady flow alternative compared to the modified fluctuating flow alternative. For example, the description of the seasonally adjusted steady flow alternative was modified to make it less environmentally beneficial. In particular, the pilot version indicated that endangered native fish populations would increase. To conform to more recent conclusions in the GCDEIS, the final version said that "Native fish . . . would most likely increase in numbers. However, competition from non-native species may still limit the growth of native fish populations." (See Appendix C for additional changes in the scenario between the pilot and final surveys.) Also, the statistical tests performed during the pilot study had the benefit of the greater statistical precision associated with the multiple-bounded CV questions; the final study did not. Because the multiple-bounded approach is still relatively new and unproven, a decision was made to implement the final survey using the traditional single-bounded approach. This reduced the statistical precision of the final estimates, making scope more difficult to demonstrate.

Tables 5-19 and 5-20 list the dummy variables for the different survey versions (variables D2-D7). Tests of significance of these dummy variables can be interpreted as scope tests. D3 has the expected sign but is not significant. In other words, for the national sample, the estimated distribution of values for the seasonally adjusted steady flow alternative was not significantly different from the distribution for the moderate fluctuating flow alternative. However, the difference is close to significant with P=0.175 and P=0.254 for the definitely yes and the definitely/probably yes models, respectively.

It is also worth noting that these two alternatives are less than perfect as scope tests because the environmental improvements are counterbalanced by heavier power price impacts. Not only does the dummy variable D4 stand counter to the hypothesis that respondents were basing their values on cues provided by the power impacts (as we learned above), it also serves as a clearer scope test because it combines the environmental improvements of the seasonally adjusted steady flow alternative with the power impacts of the low fluctuating flow alternative. And D4 is statistically significant (P=0.062 for the definitely yes model and

P=0.055 for the definitely/probably yes model). Thus, based on both the pilot study results and the significance of D4, we conclude that our study passes scope tests for the national survey.

For the marketing area, results of the final study also show some signs of passing scope tests, but the evidence is somewhat less compelling. The positive result is for D6 which is significant at P=0.018 for the definitely/probably yes model. For that model, the estimated WTP for the low fluctuating flow alternative is significantly larger than for the moderate fluctuating flow alternative. However, that result does not carry over to the definitely yes model. There, D6 is not only insignificant, but has the wrong sign. D7, the dummy variable for the seasonally adjusted steady flow alternative, is not significant in either model, but comes close in the definitely/probably yes model (P=0.113). Combined with the lack of demonstrated sensitivity to scope for the marketing area in the pilot survey, the case for stating that the marketing area study has passed advanced tests is somewhat weaker than for the national survey.

Of course, as with many empirical data sets, anomalies can be present. In this data set, for example, one would expect, all else equal, that the percentage of "Yes" votes would decrease as the dollar value of the bid amount increases. In actuality, the percentage of "Yes" votes (when aggregated across all survey versions) appears to be too low for the $150 bid amount when judged against the percentage of "Yes" votes at the $120 and $200 bid amounts. Furthermore, this anomaly appears to be present for female respondents, but absent for male respondents.[7] We have been unable to find an explanation for this anomaly and have simply accepted it for the present analysis as a quirk of this particular data set. However, as reported in Tables 5-19 and 5-20, even in the presence of this anomaly the coefficient for the bid amount still has the expected (negative) sign.

We conclude that the national survey should be categorized as a Level 3 study in the framework proposed above. That is, the national sample results are of sufficient validity to be used in decision making with minimal reservations. Though the scope test results are mixed for the marketing area sample, its strong showing in the rudimentary tests and the one positive scope test is encouraging. In terms of construct validity, it should probably be placed toward the bottom of Level 3 or at the very top of Level 2.

7 Appendix H provides a discussion of this issue.

6.6 CONCLUSION

A content-valid CV study is rooted throughout in a clear theoretical definition of the true value of the intervention. Using well-documented evidence of the respondent-relevant effects of the intervention, a sound study will effectively communicate the potential effects of the intervention to respondents. It includes whatever information respondents might need regarding substitutes for the environmental resources in question and reminds them of their budget constraints if necessary. It also includes a fully specified and incentive-compatible context for valuation. The sound study does all this in ways that potential respondents will accept and, if possible, believe. Looking beyond the scenario, a content-valid survey instrument includes well-designed questions to support construct validity testing and achieve other goals. The mode chosen for administering the survey must be appropriate for the complexity of the scenario and the ultimate goals of the study. Prior to administration, the instrument must be subjected to sufficient qualitative investigation, pretesting, and, if needed, pilot testing to eliminate as many problems as possible. Econometric analysis of the results must be adequately performed and the final results effectively reported. We believe that the GCES Non-Use Value Study meets these standards well.

A construct-valid CV study has passed both rudimentary and advanced theoretical validity tests. The valuation equations estimated in this study showed a high degree of consistency between study results and prior expectations. Furthermore, with the caveats expressed at the end of the last section about the marketing area surveys, we were able to achieve considerable success in passing scope tests.

Our conclusion, then, is that the GCES Non-Use Value Study has demonstrated sufficiently high levels of content and construct validity to be used in choosing the criteria for operating Glen Canyon Dam in the future. Integrating the results of this study with results of the power and recreation valuation studies should help to judge the economic implications of alternative criteria for operation of Glen Canyon Dam.

REFERENCES

Bishop, R.C. and D.W. McCollum. 1995. “Assessing the Content Validity of Contingent Valuation Studies.” Presented at W-133, Benefits and Costs Transfer in Natural Resource Planning. Monterey, CA, March 13, 1995.

Bishop, R.C., P.A. Champ, T.C. Brown, and D.W. McCollum. "Measuring Non-Use Values: Theory and Empirical Applications." Proceedings from the Conference on Determining the Value of Non-Market Goods: Economics, Psychological, and Policy Relevant Aspects of Contingent Valuation Methods, Werner Rieners Stiftung, Bad Hamburg, Germany. (July 1994).

Bishop, R.C. and M.P. Welsh. 1992. “Strategy for Estimating Total Value: A Case Study Involving Grand Canyon Resources.” *In* R.B. Rettig, compiler. *W-133, Benefits and Costs in Natural Resource Planning: Fifth Interim Report.* Corvallis: Oregon State University, Department of Agricultural and Resource Economics.

Bishop, R.C. , M.P. Welsh, and T.A. Heberlein. 1991. *Assessing the Potential for a Total Valuation Study of Colorado River Resources.* Glen Canyon Environmental Studies. Final Report. July 10, 1991.

Bishop, R.C., K.J. Boyle, M.P. Welsh, R.M. Baumgartner, and P.C. Rathbun. 1987. *Glen Canyon Dam Releases and Downstream Recreation: An Analysis of User Preferences and Economic Values.* Glen Canyon Environmental Studies Report No. 27/87. Springfield, VA: National Technical Information Service (PB88-183546/AS).

Bohrnstedt, G.W. 1983. "Measurement." In *Handbook of Survey Research.* Eds. P.H. Rossi, J.D. Wright, and A.B. Anderson. New York: Academic Press, Inc.

Carson, R.T., N.E. Flores, K.M. Martin, and J.L. Wright. Forthcoming. Contingent Valuation and Revealed Preference Methodologies Comparing the Estimates for Quasi-Public Goods. (An earlier version of this paper was presented at the Annual U.S. Department of Agriculture W-133 Meeting on Benefits and Costs in Natural Resources Planning, Tuscon, Arizona.)

Carson, R.T., W.M. Hanemann, R.J. Kopp, J. A. Krosnick, R.C. Mitchell, S. Presser, P.A. Ruud, and V.K. Smith. 1994. “Prospective Interim Lost Use Value Due to DDT and PCB Contamination in the Southern California Bight.” NOAA contract no. -DGNC-1-00007.

Champ, P.A., R.C. Bishop, T.C. Brown, and D.W. McCollum. 1995. “A Comparison of Contingent Values and Actual Willingness to Pay Using a Donation Provision Mechanism with Implications for Calibration.” U.S.D.A. Forest Service, Fort Collins, CO. Manuscript.

Champp, P.A. 1994. *Nonmarket Valuation of Natural Resource Amenities: A Validity Test of the Contingent Valuation Method.* Dissertation, Department of Agricultural Economics, University of Wisconsin-Madison.

Diamond, P., J.A. Hausman, G. Leonard, and M. Denning, 1993. "Does Contingent Valuation Measure Preferences? Experimental Evidence." *In Contingent Valuation: A Critical Assessment.* J.A. Hausman, editor. Amsterdam; New York: North Holland.

Dillman, D.A. 1978. *Mail and Telephone Surveys - The Total Design Method.* (New York, Wiley).

Energy Information Administration. 1991. *Electric Sales and Revenue.* Office of Coal, Nuclear, Electric, and Alternative Fuels. U.S. Department of Energy. Washington, D.C. Tables 5 and 8.

Fischoff, B. and L. Furby. 1988. "Measuring Values: A Conceptual Framework for Interpreting Transactions with Specific Reference to Contingent Valuation of Visibility." Journal of Risk and Uncertainty. 1:147-184.

Freeman III, M. 1993. *The Measurement of Environmental and Resource Values.* (Washington, D.C.: Resources for the Future).

Glen Canyon Environmental Studies Power Resources Committee. 1995. *Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations. Phase III Final Report.* Prepared by the Glen Canyon Environmental Studies Power Resources Committee. July.

Haab, T.C. and K.E. McConnell. 1995. "Referendum Models and Negative Willingness to Pay: Alternative Solutions." Department of Agricultural and Resource Economics. University of Maryland, College Park, MD. Manuscript.

Hanemann, W. Michael. 1994. "Valuing the Environment Through Contingent Valuation." *Journal of Economic Perspectives* 8(4):19-44.

Hausman, Jerry A., Ed. *Contingent Valuation: An Assessment.* Amsterdam: North-Holland Publishing. 1993.

Hoehn, J. P. and A. Randall. 1987. "A Satisfactory Benefit Cost Indicator from Contingent Valuation." Journal of Environmental Economics and Management. 14(3):226-247.

Krinsky, I. and A.L. Robb. 1986. "On Approximating the Statistical Properties of Elasticities". Review of Economics and Statistics. 16(11):715-719.

Kristrom B. 1990. "A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies." *Land Economics.* 66:135-139

Krutilla, J.V. 1967. "Conservation Reconsidered." *American Economic Review.* 57:787-796.

McFadden, D. 1994. "Contingent Valuation and Social Choice." American Journal of Agricultural Economics. 76:689-708.

Mitchell, R.C. and R.T. Carson. 1989. *Using Surveys to Value Public Goods, The Contingent Valuation Method.* (Resources for the Future, Washington, D.C.).

Piekarski, L.B. 1989. "Choosing Between Directory Listed and Random Digit Sampling in Light of New Demographic Findings." Presented at AAPOR Conference. May 19, 1989.

Samuelson, P. 1954. "The Pure Theory of Public Expenditure," Review of Economics and Statistics. 36:387-389.

Smith, V. Kerry. 1993. "Nonmarket Valuation of Environmental Resources: An Interpretive Appraisal." Land Economics. 69(1):1-26.

Survey Sampling, Inc. 1992. SSI Information Sheet. Fairfield, CT.

U.S. Bureau of Reclamation. 1995. *Operation of Glen Canyon Dam: Environmental Impact Statement.* Denver, CO: Bureau of Reclamation, U.S. Department of the Interior.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1994. Natural Resource Damage Assessment Under the Oil Pollution Act of 1990. *Federal Register.* 59(5):1062-1191.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1993. Natural Resource Damage Assessments Under the Oil Pollution Act of 1990. *Federal Register.* 58(10):4601-4614.

U.S. Department of the Interior. 1994. Natural Resource Damage Assessments: Final Rule. *Federal Register* 59(58):14262-14288.

APPENDIX A
GCES NON-USE VALUE STUDY TIMELINE

GCES Non-Use Value Study Timeline

December, 1990	GCES authorizes study on conceptual framework and prospects for a successful Non-Use Value Study
April, 1991	Conceptual framework proposed and submitted for peer review
July, 1991	Submit final report on conceptual framework and prospects for a successful study
January, 1992	Begin qualitative research on instrument design
September, 1992	Submit preliminary report on findings from qualitative research
January, 1993	Conduct additional qualitative research on instrument design. Submit description of water release alternatives to EIS members for review
July, 1993	Receive approval to proceed with study plan for a pilot test
January, 1994	Finalize pilot test survey and experimental design
	Receive OMB approval of proposed pilot test and study plan
	Pilot test implementation and analysis
May, 1994	Submit results of pilot test for peer review, and discuss prospects for a successful final study
June, 1994	Review of pilot test results by Non-Use Value Committee
May-June, 1994	OMB review of pilot test study and approval of final study plan

July, 1994	Submit results of pilot test to cooperating agencies for review and recommendation for final study
August, 1994	Finalize experimental design and survey materials in coordination with non-use value committee and OMB
October, 1994	Field mail survey
January, 1995	Field telephone survey
March, 1995	Present preliminary results to Non-Use Value Committee. Receive recommendations for additional analyses
May, 1995	Present a draft summary report for review
July, 1995	Submit a draft report of the final study results for review
August, 1995	Final study results subjected to peer review and recommendations
September, 1995	Submit Final Report of Non-Use Value Study Results to GCES Non-Use Values Committee

APPENDIX B
GCES NON-USE VALUE QUALITATIVE RESEARCH

B.1 INTRODUCTION AND INTERPRETATION OF QUALITATIVE RESEARCH

Many features of the final GCES (Glen Canyon Environmental Studies) non-use value survey were the result of a substantial qualitative research program that began in early 1992 and continued for two years. The GCES Non-Use Value qualitative research program included focus groups and in-depth personal interviews. This appendix provides an overview of this research. Before discussing the research program, however, it is important to reiterate several general points about the appropriate use and reporting of qualitative data. In this study, qualitative research provided valuable insights into the ways that people thought about the Grand Canyon and clarified how to best present the technical information about dam operations and the consequences of changes in dam operations. These insights were then used to help design better questionnaires for the quantitative general population surveys.

It is important to remember that the results from qualitative research are not generally used to make quantitative estimates of the proportion of people who hold a certain attitude or belief. One reason is because participants in focus groups and in-depth personal interviews may not represent the population from which they are selected. Furthermore, the sample sizes for qualitative research are generally small. These two characteristics of qualitative research usually make it inappropriate to report quantitative type results, such as "65 percent of the participants said this." Rather, the results of qualitative research are usually reported by using qualitative terms, such as "<u>some</u> people said this," or "<u>most</u> people said this."

Although the results from qualitative research are not generally used to estimate the percentage of individuals who hold a certain attitude or belief, they are frequently used to determine the range of attitudes and beliefs that different people hold about a topic, as well as the degree to which potential survey respondents comprehend the potential survey materials.

B.2 RECRUITING PARTICIPANTS FOR THE QUALITATIVE RESEARCH

Even if participants are selected from a random sample of residents near the focus group site, many factors can result in a set of participants that is not representative sample of the population. For instance, it can often be difficult to get a sufficient number of people to attend a focus group meeting. Even though participants were offered $25 to $35 to participate in this study, it was difficult to get individuals to agree to come to a discussion (or an interview) at a specific time and place. A second important factor is the salience of the topic to be discussed. If the topic is specifically identified during recruitment and if is of special interest to a subgroup of the population, there is a risk that only those individuals most interested will agree to attend. If this happens, participants will be more representative of people who are interested in the topic than of the population from which they were selected. To avoid this second type of problem, potential participants were told during recruitment only that the discussion would involve issues related to national parks or to trade-offs between economics and the environment. They were also told that even if they felt they had very little information about the topic, they would still be able to participate. Recruiting scripts were designed to sound interesting to a wide range of potential participants without telling them the specific topic that was to be addressed.

B.3 DECISION RULES FOR EVALUATING QUALITATIVE RESEARCH RESULTS

Because qualitative research provides data on the range of attitudes and beliefs (and the degrees of comprehension) rather than on the proportion of people holding these attitudes and beliefs, the criteria used to evaluate the results of the non-use value focus group discussions did not take the form of quantitative decision rules. As the name suggests, qualitative research results in data that are qualitative in nature and that require the application of qualitative decision criteria. For example, in this study a target percentage of participants who felt that the alternative dam operations had value did not have to be specified in order to proceed with general population surveys. Rather, the observation that alternative dam operations had value to <u>some</u> of the participants was sufficient evidence for proceeding to the quantitative research phase of the study. Only the general population surveys in the quantitative phase can indicate the percentage of people for whom the alternative dam operations have value, or estimate the aggregate values across respondents. Similarly, as long the qualitative research program indicated that the technical information on dam impacts was understandable to at least <u>some</u> of the participants, the decision could be made to proceed with the quantitative research phase to determine the actual percentage of people who could understand this technical information.

Practically speaking, these rather gross decision criteria suggest that the chances of proceeding to a quantitative research phase were quite high. Only if the qualitative research had indicated that virtually no one understood the impacts of various alternative dam operations or saw value in the environmental changes that might occur if dam operations were changed, would we have recommended not proceeding with the design and pretesting of a contingent valuation survey. Because of this, the qualitative research program was primarily viewed by the research team as an aid to survey design.

The qualitative research program for the GCES Non-Use Value study was carried out in two steps. The first step consisted of a series of eight focus groups held in various locations around the country. The purpose of these focus groups was to explore the feasibility of designing and implementing a study of the non-use values associated with resources affected by the operation of Glen Canyon Dam. The first step of the program was carried out in different parts of the country to help ensure that we would hear most (or all) of the different attitudes and beliefs about the impacts of dam operations on the Colorado River environment in the Grand Canyon. Upon successful completion of the first step, the second step was carried out. The purpose of the second step was to evaluate and refine various drafts of potential survey instruments.

B. 4 INITIAL FOCUS GROUP DISCUSSIONS

The first step in the program was initiated with a series of eight focus group discussions held at various locations around the country. The locations were chosen to represent a broad geographic spectrum of U.S. citizens and to include residents in both urban and suburban/rural areas. Four geographic areas were chosen: New York, Tennessee, Nebraska, and Arizona/Utah. Two focus groups discussions were held in each location, one in an urban area and one in a suburban or rural location nearby. In New York, participants in the urban discussion groups were chosen at random from the metropolitan area of Buffalo, New York. Participants in the suburban/rural discussion group were chosen from the city of Batavia. In Tennessee, the urban group was recruited from the metropolitan Nashville area, and participants in the suburban/rural group were chosen from the area around Murfreesboro. In Nebraska, the urban group was recruited from the city of Omaha, while the participants in the suburban/rural group were chosen from the Columbus area. The urban group in the Arizona/Utah area was held in Phoenix and the suburban/rural group was held in St. George, Utah. In addition to being a smaller town, St. George was also chosen because electric utilities serving the city have firm power contracts for power generated at Glen Canyon Dam. Table B-1 summarizes the dates and locations of the initial round of focus group discussions.

Table B-1
Dates and Locations of the Focus Group Discussions

Location	Date	Number of Participants	Presentation of Information	Contingent Valuation Vehicle
Buffalo, NY	February 5, 1992	10	Oral/Visual	Monthly Utility Bill
Batavia, NY	February 6, 1992	6	Oral/Visual	Monthly Utility Bill
Nashville, TN	March 18, 1992	10	Oral/Visual	Monthly Utility Bill
Murfreesboro, TN	March 19, 1992	10	Oral/Visual	Monthly Utility Bill
Omaha, NE	August 20, 1992	10	Written	Monthly Utility Bill
Columbus, NE	August 31, 1992	12	Written	Lump Sum Tax Increase
Phoenix, AZ	September 9, 1992	10	Written	Monthly Utility Bill
St. George, UT	September 10, 1992	10	Written	Monthly Utility Bill

B.4.1 Focus Group Discussion Topics

Focus group discussions are typically controlled by an agenda summarizing the major topics to be covered during the discussion. In these eight initial focus groups, the agenda centered around four major topics:

1. A general discussion of information, knowledge, attitudes, and beliefs about the Grand Canyon that participants brought with them to the focus group discussion.

2. Presentation and evaluation of information describing how Glen Canyon Dam has altered the flows of the Colorado River in the Grand Canyon. Participants were also asked to predict how these changes in flow patterns might have affected the ecosystem associated with the Colorado River in the Grand Canyon.

3. Presentation and evaluation of information describing how the construction and operation of Glen Canyon Dam has affected the ecosystem associated with the Colorado River in the Grand Canyon.

4. A contingent valuation exercise to determine whether participants could express, in monetary terms, values for various dam operation alternatives.

B.4.2 Participants' Knowledge, Attitudes, and Beliefs About the Grand Canyon

To introduce the first topic listed above, participants were asked, "What do you think of when you think of the Grand Canyon?" Participants mentioned a wide variety of items, including scenic qualities, wilderness values, threats from pollution and overuse, a desire to see the Grand Canyon, and mule rides to the bottom of the Grand Canyon. In all of the focus groups in which this question was asked, at least one participant mentioned either the Colorado River or rafting in the Grand Canyon. Although the above question was not asked at the two locations closest to the Grand Canyon (Phoenix and St. George), it was obvious that awareness of the Colorado River as part of the Grand Canyon ecosystem was higher at these locations, which are closer to the Grand Canyon. Thus, the data from the initial focus groups indicated that at least some of the general population in all locations were aware that the Colorado River is at the bottom of the Grand Canyon.

Participants in all of the initial focus groups were also asked if they were aware of any recent controversies surrounding the Grand Canyon. The most frequently mentioned included problems with pollution, problems with aircraft overflights, and problems stemming from releases of water from Glen Canyon Dam. Identification of problems associated with the operations of Glen Canyon dam occurred in Batavia, New York; Phoenix, Arizona; and St. George, Utah.

B.4.3 Information on Operations of Glen Canyon Dam

Participants were provided with information about how the construction and operation of Glen Canyon Dam had changed the pattern of flows of the Colorado River in the Grand Canyon. This information was presented in slightly different ways in different groups. Participants in the first three focus groups (Buffalo, New York; Batavia, New York; and Nashville, Tennessee) were provided with a short visual and oral presentation describing the human and natural environment along the Colorado River in the Grand Canyon. This presentation identified trout, trout fishing, archeological sites, native fish, rafting, wildlife, and birds as parts of the natural and human environment along the Colorado River in the Grand Canyon. Following this presentation, participants were provided with a short visual and oral discussion of how Glen Canyon Dam had changed the flow patterns of the Colorado River in the Grand Canyon. Participants in the Murfreesboro discussion group were not provided with the information about the resources at the bottom of the Canyon, but were provided with information about how the dam had altered the flow patterns of the Colorado River. Participants in the Nebraska, Arizona, and Utah groups were provided with only written information. Furthermore, this written information related only to how the Glen Canyon Dam had altered the flow patterns of the Colorado River.

In each of the eight initial focus group discussions, participants were first presented with the "background" information and then asked if they thought the changes in flow patterns might have caused any changes along the Colorado River in the Grand Canyon. If so, participants were asked what they thought these changes might have been. At each of the focus groups, participants identified changes in the rate of erosion, changes in vegetation, and impacts to fish and wildlife as possible consequences of the construction and operation of Glen Canyon Dam. Some participants identified the affected resources and the type of change that has resulted from dam operations. Others correctly identified those resources that have been affected, but incorrectly identified the direction of the change. For instance, while erosion was frequently mentioned as a result of the construction and operation of Glen Canyon Dam, several participants thought that rates of erosion would be lower after completion of the dam than before. These participants reasoned that the pre-dam spring floods were much higher than typical daily peaks resulting from power operations. As a result, these participants felt that erosion should be less with the dam than without it.

In spite of the slightly flawed logic of some participants, the initial focus groups indicated that some members of the general public were able to identify many of the environmental impacts of Glen Canyon Dam operations. This was an important result. Because some participants were able to predict the types of changes that have actually been observed, it was reasoned that at least a portion of the general population would be familiar with, or be able to identify, the types of changes that would have to be conveyed as part of a contingent valuation survey of the non-use values of the Colorado River-related resources in the Grand Canyon.

Participants were generally able to understand how the Glen Canyon Dam has changed flow patterns on the Colorado River. They required very little clarification of the information that was presented. Some felt the description of how the dam had changed flow patterns may have been biased "in favor of the dam." They cited the elimination of spring floods, improvements in water clarity, and reductions in water temperature as being good, but perhaps not the whole story of what had occurred as a result of the construction and operation of Glen Canyon Dam.

B.4.4 Understanding and Evaluating the Impacts of Dam Operations

Although it was encouraging that some participants were already familiar with the process through which the operation of Glen Canyon Dam affects downstream resources, this was not a necessary condition for the successful completion of a contingent valuation study of non-use values. What was required was for survey respondents to feel they could understand the impacts that are occurring and could evaluate them in a contingent valuation question.

To assess whether participants could understand and evaluate the impacts, respondents were provided with information on the actual impacts of the operations of Glen Canyon Dam. Impacts to native fish, archeological sites, sites of cultural importance to Native Americans, erosion of beaches, vegetation and associated birds and wildlife, and impacts on the recreational use of the Colorado River in the Grand Canyon were presented. For example, participants were told that rates of erosion had increased so that some beaches, archeological sites, and Native American cultural sites were being affected. Participants were also told that large daily fluctuations had a negative impact on the quality of white water rafting trips in the Grand Canyon and that the long-term reduction in the number of beaches could adversely affect the quality of rafting trips. In addition, participants were told that native fish populations, including some federally endangered species had been reduced as a result of the dam. While these impacts were not described as negative impacts (they were described in a factual and neutral manner), we expected that these impacts would be evaluated as negative by participants in the focus groups. Participants were also provided information about other impacts that we expected would be evaluated as positive or good changes. For example, participants were told that elimination of the large spring floods had allowed increases in vegetation, which in turn had resulted in increases in the number of birds and wildlife. Participants were also told that construction and operation of the dam had allowed for the establishment of a high-quality sport fishery for rainbow trout.

After presenting this information, participants were asked if they had questions about the impacts that had been described and if the impacts seemed believable. Participants did not report difficulty in either understanding or believing the description of the changes that had resulted from the construction and operation of Glen Canyon Dam. This result indicated that the impacts of the operation of Glen Canyon Dam could be described within the context of a general population survey.

After discussing the impacts that have resulted from the construction and operation of Glen Canyon Dam, participants were asked for a personal evaluation of the impacts that had just been described. As expected, most participants typically evaluated the increase in erosion and associated impacts to beaches, archeological sites, and Native American cultural sites, and reductions in native fish populations as being negative changes. The changes most often cited as being positive included increases in bird populations and the establishment of a trout fishery. Many of the participants indicated that impacts to white water rafters were not a large concern. In addition, several participants indicated that they did not rate the increase in bird populations or the establishment of a trout fishery as positive changes. The reason most often offered for this point of view was that these species were not native to the Grand Canyon. Consequently, establishment of these populations was not viewed in a favorable light if it occurred at the expense of native species.

B.4.5 Contingent Valuation Questions

In the final portion of the focus group discussion, participants were asked to complete a contingent valuation exercise for various changes in operations at Glen Canyon Dam. They were first told that changes in operations at Glen Canyon Dam could reduce some of the negative downstream effects. They were then asked to imagine that these changes would result in some economic impacts such as higher electric bills, either because a reduction in peak power would have to be met by using more expensive sources of power, or because the value of power would be reduced, requiring the federal government to find other sources of revenue to repay the expense of building the dam.

The contingent valuation exercise asked participants to imagine that they could vote on whether to change operations at Glen Canyon Dam. They were told that if a majority voted to change operations, either their taxes or their monthly utility bill would go up (depending upon the specific focus group), but that dam operations would be changed so that downstream impacts would be reduced. If a majority voted no, participants were told their taxes or utility bills would remain the same, but that operations would also remain the same.

One of the focus groups (Columbus, Nebraska) was carried out using increases in taxes as the contingent valuation vehicle. Although most participants in this group were able to deal with this payment vehicle, at least some indicated they would not be willing to pay any additional amount in taxes to change operations at Glen Canyon Dam. These participants indicated that concerns about the general level of taxes was more important to their response than their evaluation of the benefits of changing operations at Glen Canyon Dam. For the remainder of the focus groups, an increase in the monthly utility bill was used as the payment vehicle Some participants in the New York and Tennessee focus groups had minor difficulties with the utility bill vehicle. Some of these indicated that although they tried to reflect in their vote their own personal evaluation of the changes in operations, they also thought about how much money would be raised if all utility bills in the United States were increased by a small amount

At some groups, after discussing the motivations for their responses to the contingent valuation questions, participants were asked why they thought these questions had been asked. In several of the focus groups, participants said they thought the contingent valuation questions had been asked to find out how important they felt it was to change operations at Glen Canyon Dam Some participants reported that we were asking them "to put our money where our mouth is."

B.4.6 Initial Focus Group Results

These general results from the initial focus groups were evaluated in terms of four specific criteria. These criteria included:

1. Could most participants' attention be directed to the Colorado River environment, rather than to the Grand Canyon as a whole?

2. Can at least some people understand the impacts that they were asked to evaluate?

3. Do at least some of the participants have enough information on the potential impacts of current and alternative dam operations to determine the value for them?

4. Do at least some people express non-zero values for alternative dam operations, and are they unwilling to lower these values under direct questioning by the focus group moderator?

For the first criterion, the initial focus group discussions indicated that participants were able to direct their attention to the Colorado River environment and away from the Grand Canyon as a whole. Prior to receiving information about the effects of operations at Glen Canyon Dam, participants typically mentioned scenic vistas and unspoiled wilderness as thoughts that came to mind when they thought of the Grand Canyon. Near the end of the focus groups, they were asked to discuss the motivations for their responses to the contingent valuation questions. Participants typically cited how the proposed alternatives would affect rates of erosion, loss of beaches and archaeological sites, and impacts to native fish and trout. Because participants cited this different set of factors as reasons for their contingent valuation responses, we believe they were able to focus on the described impacts to river-related resources and not on their general feelings about the Grand Canyon as a whole.

In Criterion 2, the focus group discussions also demonstrated that a significant portion of the participants were able to understand the impacts they were asked to evaluate. This conclusion was based on two factors. First, at least some of the participants possessed a basic knowledge of the mechanisms by which dams can affect downstream river-related resources prior to the presentation of information on the impacts of dam operations. Second, most participants did not appear to have difficulty understanding or believing the oral, visual, and written descriptions of how the construction and operation of Glen Canyon Dam affects downstream resources.

For the third criterion, participants generally felt they had sufficient information to evaluate the downstream impacts of dam operations. This conclusion was based on the ability of participants to evaluate whether they felt the impacts to various resources were either positive or negative. Some issues were discovered that may require additional research. For example, some participants expressed frustration with the use of phrases such as "are likely to cause" or "may result" in the descriptions of the impacts of changes in dam operations. For at least some participants, the uncertainty associated with the impacts of changes in dam operations may have reduced the amount they said they would be willing to pay for various alternatives. A few participants also expressed a desire for more details in the description of the impacts of changes in dam operations. Notably absent from their requests for additional information were requests for information about impacts to individuals using power produced at Glen Canyon Dam or requests for additional details on how dam operations would be changed under the various alternatives. Taken together, the above results indicated that survey respondents would be able to respond to a well-designed contingent valuation scenario that focussed on impacts to river-related resources.

In Criterion 4, majority of participants expressed non-zero dollar values for their alternative operations. Among those individuals expressing a zero willingness-to-pay for specific alternatives, one of two reasons was typically offered. Some participants in the focus groups that used taxes as the contingent valuation vehicle indicated they would not agree to a tax increase for any reason. The others typically indicated that the described impacts of the alternative dam operations were simply not worth anything to them. This ability to successfully deal with the contingent valuation questions as part of the focus group discussion indicated that participants in a general population survey that was designed to measure the non-use values of various dam alternatives would also be able to respond to well-designed contingent valuation questions.

The initial focus group discussions indicated that certain areas, such as the choice of a contingent valuation vehicle and the descriptions of the impacts of various alternative dam operations, would require additional work. However, the bulk of the evidence from the initial focus groups provided support for continuing research into the non-use values associated with dam operation alternatives. Participants in focus groups held at locations far from the Grand Canyon, near the Grand Canyon, and even in locations that obtain power from the Glen Canyon Dam all indicated that they would like to see something done to reduce the impacts of the operations of Glen Canyon Dam on downstream resources. Participants in all of these groups seemed to be able to understand and believe descriptions of how various alternative operations would affect downstream resources. Finally, a majority of participants seemed to be able to provide valid responses to the contingent valuation questions that were designed to measure the non-use values of alternative operations.

Subsequent to the initial focus groups, a decision was made to proceed with the design of a contingent valuation instrument using a mail survey format and to subject this survey to an additional round of qualitative research.

B.5 SECOND PHASE OF QUALITATIVE RESEARCH

Several members of the GCES Non-Use Value Committee expressed concern that the survey materials used in that the initial focus groups did not solicit values for the loss of hydropower capacity that would occur as a result of changes in the operation of Glen Canyon Dam. Consequently, the first additional focus group dealt with potential non-use values for hydro-power and was held in Albuquerque on June 17, 1993. A total of 10 individuals attended this discussion. At the beginning of the discussion, participants were handed an information sheet describing the traditional operation of Glen Canyon Dam for generating on-peak electricity. Hypothetical changes in the ability to produce on-peak power were attributed to the age of the power plant. The information sheet indicated that, as the dam and power plant had aged, conditions had developed that would soon reduce the ability of the power plant to produce on-peak electricity. If these conditions were not remedied, three consequences would occur: (1) some power consumers would experience increases in their power bills; (2) patterns of electricity production would change; and (3) a small number of farmers in areas heavily dependent on power from Glen Canyon Dam would see their incomes decrease. No mention was made of the downstream environmental effects of dam operations.

After reading this information, participants were asked to discuss how they felt about the above-described impacts. While participants expressed concern about all three impacts, they tended to be confused about the changes in patterns of electrical generation. Furthermore, they expressed a great deal of interest in knowing more about the conditions that would cause a loss of on-peak capacity at the Glen Canyon Dam power plant. The absence of this information made them feel that perhaps there had been an engineering or design problem during the construction of the dam, and that the responsible party should be identified and required to fix the problem

Three conclusions were reached after this group. First, that it would be difficult to make survey respondents understand and then value a loss in hydro-power capacity. Second, that participants expressed empathy for residential and agricultural users of power from Glen Canyon Dam. Third, it would be difficult (if not impossible) to design a survey that focussed solely on changes in power production.

After the Albuquerque focus group, a preliminary survey instrument was developed. This instrument contained many of the features eventually included in the pilot test and final study surveys. The background information consisted of two sheets. One sheet identified how the construction and operation of Glen Canyon Dam had affected the characteristics of in-stream flow in the Colorado River below Glen Canyon Dam. The second sheet identified the impacts of the construction and operation of the dam. Information on this second sheet identified both negative impacts (loss of beaches and reductions in native fish, for example) and positive impacts (establishment of a trout fishery and increases in bird populations along the river corridor).

This preliminary survey draft was tested in a focus group held in Milwaukee, Wisconsin, on July 14, 1993. Eight individuals participated in the discussion. After reading the background materials, participants were asked to complete a draft mail survey instrument. This instrument included a true-false quiz covering the important points presented in the background material, as well as four contingent valuation questions, one for each of four alternative dam operations. These four scenarios were developed in cooperation with the physical and biological scientists who were preparing the draft GCDEIS (Glen Canyon Dam Environmental Impact Statement). The scenarios did not include descriptions of price impacts to consumers of electric power.

Several issues were explored during the July 14 focus group. First, the question was asked whether potential survey respondents would be able to deal with multiple scenarios and perceive differences between them? Second, would potential survey respondents be "put off" by the quiz? Finally, how would potential survey respondents react in general to the draft mail survey instrument?

Results from this group indicated that potential respondents were able to deal with four scenarios in one survey and that they were able to perceive differences between the scenarios. Second, this group indicated that potential survey respondents would not react negatively to the quiz as long as it was introduced as a way to determine whether the designers of the survey had effectively communicated important facts to the respondents. Finally, the group did not identify any major obstacles that would prohibit the implementation of this study using a mail survey format.

Up to this point in the qualitative research, the background materials had been developed in order to highlight the changes that had occurred as a result of the construction and operation of Glen Canyon Dam. This was done on the assumption that many respondents would want to evaluate the consequences of a change in dam operations relative to the conditions that existed prior to construction of the dam. Some members of the GCES Non-Use Value Committee were concerned that a discussion of the impacts of the construction of and operation of Glen Canyon Dam would predispose potential survey respondents to vote in favor of changes in dam operations. Furthermore, these members of the committee pointed out that the Glen Canyon Environmental Impact Statement explored the operations, not the existence of the dam.

To address these concerns, a new version of the survey instrument was developed. In this new version, the background information was modified to remove references to pre-dam conditions, as well as to remove any indication that either the operation or the construction of the dam had resulted in any downstream impacts. Instead, the background material defined the study area (including a map), identified trends in downstream resources, and indicated that the operations of the dam could be modified to benefit these resources. Several modifications were also made to the survey. An informational box was added to the survey pointing out that changes in the operation of the dam would change the pattern of electricity production, increase electric bills for some individuals, and decrease the income of a few farmers.

Performance of the new background information sheets and the new survey was evaluated in a focus group held in Milwaukee, Wisconsin, on August 5, 1993, and in-depth personal interviews on the evenings of August 9 and 11, 1993, in Madison, Wisconsin. Ten individuals participated in the Milwaukee focus group, and six individuals were interviewed in Madison. In the draft of the survey used for this round of qualitative research, each respondent was asked to evaluate only one contingent valuation scenario. The contingent valuation question following the scenario was modified to first ask respondents how they would vote on the proposal if passage would not cost them anything. Respondents voting in favor of the proposal were asked how they would vote if passage cost them various amounts.

Although several participants expressed a desire for more information about pre-dam conditions and the relationship between dam operations and downstream resources, these concerns did not seem to have a significant effect on their responses. Many participants reported that the impacts on power consumers and farmers were factors they considered when deciding how to vote on the proposal. Probing on the descriptions of impacts to Native American sites revealed that use of the phrase "sacred sites" conveyed an image of burial grounds to many of the respondents.

Based on the results of this round of qualitative research, it was concluded that future survey versions would include references to price impacts to consumers of power produced at Glen Canyon Dam. Furthermore, the background information would focus only on the current status of the affected resources and mention only that changes in the operations of the dam could benefit some of these resources.

Two more focus groups were conducted in Orem, Utah, on the evening of August 25, 1993. These groups had two purposes. First, it was important to test the survey in the marketing area. This was accomplished by recruiting participants for the focus group from two communities in which the local utility received a large percentage of its power from Glen Canyon Dam.

A second purpose was to explore how respondents with differing levels of education and income would react to the survey instrument. This topic was explored because of a concern that in a typical focus group, individuals with lower educational attainment might be embarrassed to admit they were having trouble understanding the survey. This issue was addressed by restricting participation in one of the focus groups to non-students without college degrees and a lower level of income. Five individuals participated in the lower-educational attainment and lower-income group. None of the five participants had college degrees, and four of the five had household incomes of less than $15,000. Nine individuals participated in the higher educational attainment/income group.

The survey instrument used in Orem was identical to those used in Milwaukee and Madison with one exception. The Orem survey reminded participants that they lived in areas served by power produced at Glen Canyon Dam and that if dam operations were changed, they would have to pay higher utility bills. The contingent valuation questions were framed as a referendum on changes in dam operations, and increased utility bills were used as the payment vehicle.

Participants in the lower educational attainment group generally comprehended most aspects of the background information and were able to complete the survey. Participants in both groups expressed a positive willingness-to-pay for the changes in the operation of Glen Canyon Dam.

Up to, and including the Orem focus groups, the program of qualitative research consisted of a total of 13 focus groups and two evenings of in-depth personal interviews involving a total of 126 participants. The result of this qualitative research was a survey instrument that was submitted to OMB (Office of Management and Budget) for approval. OMB approval was granted with the condition that a final round of focus groups be carried out to document that respondents correctly understood the key portions of the contingent valuation scenarios. To satisfy this requirement, two additional focus groups were conducted in Phoenix, Arizona, on February 22 and February 23, 1994. Phoenix was chosen in order to make it possible for GCES physical and biological researchers to observe the focus group discussion. After observing the groups, these GCES researchers were satisfied that participants' interpretation of the contingent valuation scenarios was consistent with their own.

In addition to performing a final check on participants' understanding of the survey materials, the Phoenix focus groups were used to make a final attempt to explain the concept of lost hydroelectric capacity. This issue was raised because some members of the GCES Non-Use Value committee felt that hydroelectric capacity lost as a result of changes in dam operations might have a non-use value. The results of previous focus groups had indicated that the concept of hydroelectric capacity was extremely difficult to explain in a survey context. Most survey respondents erroneously assumed that if hydroelectric capacity was lost, hydroelectric energy would also be lost. A significant effort was made to explain how hydroelectric energy could remain the same while capacity decreased. Some participants were simply unable to understand the concepts as presented. Those who did understand indicated that the loss of hydroelectric capacity was not a major concern.

APPENDIX C
OVERVIEW OF PILOT TEST

This appendix presents a discussion of the pilot test conducted for this study prior to the implementation of the final study. This is not intended to provide the reader with complete documentation of the pilot test, but rather to provide an overview of it, its purpose, and results. Study objectives and experimental design for the pilot test are discussed, followed by an explanation of the distribution of the dollar amounts used in the contingent valuation question. Sampling and survey implementation procedures are reviewed, and results of the pilot test are presented. The final two sections include the results of hypotheses tests that address study objectives and a summary of the pilot test results overall. The appendix concludes with an overview of changes made to experimental design and survey materials subsequent to the pilot test but prior to the final study.

C.1 STUDY OBJECTIVES AND EXPERIMENTAL DESIGN

Upon completion of the qualitative research program, a draft research plan and survey instruments were developed for a pilot by the GCES Non-Use Value Committee and submitted to the Office of Management and Budget (OMB) for approval. After further review by the committee and OMB, the final study plan and survey instruments were prepared for the pilot test.

Two sets of objectives were explored during the pilot test. The first set related to methodological issues relevant to assessing the eventual performance of the survey instrument in a final study. A second set of objectives was to further evaluate the survey design and to test survey implementation procedures.

Methodological issues explored during the pilot tests included a determination of whether the survey instrument was sensitive to what we shall term the "scale" and "scope" of the resource impacts of alternative operating regimes for Glen Canyon Dam.[1] The term "scale" is used to refer to the degree or extent of resource impacts relative to the baseline or "No action" alternative. Changing dam operations will affect beaches, American Indian cultural and religious sites, conditions for both native and non-native fish, and other characteristics of the environment in the Grand Canyon. Some alternatives will have small effects on these resources compared to the "No Action" alternative and other alternatives will have larger impacts. The term "scope," on the other hand, refers to the array of resources considered. An

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1 The definitions of scope and scale used in this appendix evolved during evaluation of the proposed pilot study by the Office of Management and Budget. More specifically, we wish to acknowledge Richard Belzer and Richard Theroux for suggesting the concepts. Scope has been used by the National Oceanic and Atmospheric Administration (NOAA) Panel on Contingent Valuation and appears in the proposed NOAA damage assessment regulations, but to our knowledge, the concept of scale and the useful distinction between scope and scale which we applied here have not been previously discussed in the literature.

instrument that is narrow in scope might cover only beaches and vegetation while a instrument with broader scope would include American Indian sites, native fish, and other resources as well. In addition, one would expect a valid survey instrument to produce statistically indistinguishable values when the order in which information is presented to respondents is changed, provided that the nature of the information is invariant. Likewise, the survey instrument should produce values that are stable with respect to minor changes in wording. Thus, the technical testing of the instrument was designed to achieve three objectives:

Objective 1: To determine whether non-use value estimates for Glen Canyon Dam Environmental Impact Statement (GCDEIS) alternatives are sensitive to the scale of resource impacts under those alternatives.

Objective 2: To determine whether non-use values for GCDEIS alternatives would be sensitive to the scope of the resources impacted by those alternatives.

Objective 3: To determine whether estimates of non-use values based on the draft instruments would be affected by seemingly innocuous changes in the wording and order of presentation of background information.

These objectives are central to evaluating the scientific credibility of results from a final survey using those instruments. Lack of value differences relating to scale and scope would raise doubts about whether the researchers had correctly identified resource impact relevant to respondents and communicated those impacts to respondents effectively to support meaningful economic valuations. If values are sensitive to the order in which information is presented, or to minor changes in wording, then doubts would arise about whether resulting non-use value estimates are sufficiently stable and otherwise meaningful to be used in policy analysis.

In addition to the methodological objectives, the pilot tests had three additional objectives. These objectives related to information needed for planning a possible final survey. The additional objectives included:

Objective 4: To determine whether non-use values for GCDEIS alternatives differ between the marketing area and the nation as a whole.

Values expressed by residents of the market area may have special significance for this study. These individuals will actually have to pay higher prices if dam operations are changed. Documentation of significant values for marketing area residents would lend validity to the ultimate study results. If values in the marketing area are indistinguishable from zero, the expense of a separate survey in the marketing area could be avoided in a final study.

Objective 5: To determine whether non-use values measured using a multiple-bounded format for contingent valuation questions would be significantly different than non-use values measured using a single-bounded contingent valuation question.

The multiple-bounded contingent valuation questioning format was the primary question format used in the pilot test. The multiple-bounded technique was chosen to increase the precision of the results given the relatively small sample sizes available. However, the multiple-bounded technique had not previously been tested against the more widely applied, and more widely accepted single-bounded framework. Both formats involve a referendum where respondents vote to say whether they are willing to pay specified amounts to support a water flow alternative. The multiple-bounded format allows respondents to give a range of responses from “Definitely Yes” to “Definitely No” for a wide range of dollar amounts. The single-bounded format allows respondents to give only a “Yes” or “No” response to one dollar amount. Concerns about the performance of the multiple-bounded technique prompted a decision to include a traditional single-bounded, dichotomous choice contingent survey version as part of the pilot test. Concerns about the multiple-bounded technique included a concern that the range and/or the increment of values presented in a multiple-bounded question may have an undesired influence on the survey responses. Information regarding the performance of the multiple-bounded technique relative to the dichotomous choice single-bounded technique could be used to assist in the choice of a valuation questioning technique in the final study.

Objective 6: To determine whether empathy for the effects of the alternatives on the amounts paid by consumers of power from Glen Canyon Dam has significant effects on overall non-use values for the alternatives.

The qualitative research phase had determined that survey respondents were likely to feel empathy towards individuals who would experience increases in utility bills as a result of changes in dam operations. Theoretical issues arise regarding the appropriateness of including interpersonal empathy as a motivation for non-use values. If empathy does not affect values then these issues would become less relevant for this particular application.

Accomplishing these study objectives required an experimental design consisting of nine survey versions. Table C-1 identifies the differences between each questionnaire version.

Table C-1
Identification of Glen Canyon Studies Non-Use Questionnaire Versions

Questionnaire Version	Water Release Alternative[a]	CV Question Format	Background Information/ Scenario
National Sample			
Version 1	MFF	Multiple Bounded	Base Background
Version 2	L FF	Multiple-Bounded	Base Background
Version 3	SASF	Multiple Bounded	Base Background
Version 6	SASF	Multiple Bounded	Changed Background
Version 7	SASF	Single Bounded	Base Background
Version 8	SASF	Multiple Bounded	Scope Test
Version 9	SASF	Multiple Bounded	Empathy Impact Test
Marketing Area Sample			
Version 4	MFF	Multiple Bounded	Base Background
Version 5	SASF	Multiple Bounded	Base Background

[a] MFF = Moderate fluctuating flow alternative.
LFF = Low fluctuating flow alternative.
SASF = Seasonally adjust steady flow alternative.

C.2 DISTRIBUTION OF DOLLAR AMOUNTS

Survey versions with the multiple-bounded format (all versions except 7) contained the following dollar amounts, which respondents were asked to consider in the contingent valuation question: 10¢, 50¢, $1, $5, $10, $20, $30, $40, $50, $75, $100, $150, and $200. For each amount, respondents were requested to indicate if they would definitely pay, probably pay, were unsure, probably not pay, or definitely not pay the stated amount. In Version 7, respondents were asked to consider only one dollar amount in the contingent valuation question. In this version, a dichotomous choice, yes/no response, was required. A uniform distribution of the following amounts was used: $5, $10, $20, $30, $40, $50, $75, $100, and $150 (Table C-2). One randomly selected amount was assigned to each respondent.

Table C-2
Distribution of Dollar Amounts Used in Questionnaire Version 7

Dollar Value ($)	Frequency	Percent of Sample
5	28	11.2%
10	28	11.2
20	29	11.6
30	28	11.2
40	28	11.2
50	28	11.2
75	28	11.2
100	26	10.4
150	27	10.8
Total Sample	250	100.0%

C.3 SAMPLING

Two separate random samples were constructed for the pilot test. A national sample was drawn from a sampling frame consisting of residential telephone directory listings. A marketing area sample was drawn from a sampling frame consisting of residential telephone directory listings for ZIP codes of areas served by utilities holding Salt Lake City Area Integrated Projects (SLCA/IP) firm power contracts with the Salt Lake City Office of Western Area Power Administration.[2] A total sample of 2,250 individuals was selected: 1,750 for the national sample and 500 for the marketing area sample. Individuals residing in the marketing area were eligible for inclusion in either the national sample or the marketing area sample, but not both. The sample was split into nine subsamples of 250 respondents each. Each subsample was administered one version of the questionnaire that contained a specific combination of background information and a scenario description of a proposed flow alternative as described in Table C-1.

2 Glen Canyon Dam represents nearly 80% of the total power marketed as the SLCA/IP.

C.4 IMPLEMENTATION

The pilot test was carried out in January through March of 1994. Survey procedures included an advance letter, an initial survey copy with a $2 incentive, a reminder postcard, and up to two additional survey copies sent to non-respondents. The final survey copy was sent via certified mail. Response rates to the pilot test are summarized in Table C-3. Response rates for completed surveys and refusals are calculated as a percent of deliverable questionnaires.

Table C-3
Glen Canyon Studies Non-Use Survey Response Rates -- Pilot Test[a]

	Sample Size	Out of Scope[b]	Completed Questionnaire	Response Rate[c]
National Sample				
Version 1	250	24	138	61%
Version 2	250	39	131	62
Version 3	250	30	127	58
Version 6	250	35	126	59
Version 7	250	42	118	57
Version 8	250	28	133	60
Version 9	250	34	126	58
TOTAL	1,750	232	899	59%
Marketing Area Sample				
Version 4	250	46	149	73%
Version 5	250	35	168	78
TOTAL	500	81	317	76%

a Response rates shown are calculated from the final day that completed questionnaires were included in the data set, April 12, 1994.
b Includes cases where the addressee was deceased or the survey mailing was returned as undeliverable.
c Calculated as a percentage of deliverable questionnaires (sample size minus out of scope).

C.5 PILOT TEST RESULTS

Statistical analyses performed to test the study hypotheses are presented below. First, for each survey version, mean willingness-to-pay is estimated using multiple-bounded logistic regression analysis. These results are then compared with results from models estimating multiple-bounded data as though it were single-bounded. Additional mean willingness-to-pay estimates were derived by treating the multiple-bounded data as though it were a payment card. Following these results is the analysis of mean willingness-to-pay for survey Version 7, which received the single-bounded question format. Results from Version 7 are compared with the multiple-bounded analysis of Version 3. (Both Versions 3 and 7 addressed the seasonally adjusted steady flow alternative.) Hypothesis tests were performed for each type of analyses and are discussed at the conclusion of this section.

Mean willingness-to-pay values, reported in Table C-4, were derived from a multiple-bounded logistic regression analysis of the pilot test data. Results are reported for simple models in which the dependent variable is the response to the contingent valuation question, and the independent variable is the amount of money asked about. A separate logistic regression model was estimated for each survey version. The results reported in Table C-4 are not based on the set of all completed questionnaires. Just prior to the willingness-to-pay question, respondents were asked how they would vote on the proposal if passage of the proposal would cost them nothing. Respondents could answer that they would (1) vote "No," (2) vote "Yes," or (3) choose not to vote. The means are based only on those respondents who indicated they would vote for the proposal. In addition, a small percentage of respondents indicating they would support the proposal at zero cost did not go on to complete the valuation question. Individuals not completing not completing the valuation question are not included in the analysis logistic regression analysis. As a consequence, the mean willingness-to-pay values reported in Table C-4 cannot be directly extrapolated to national or marketing area populations.

Discrete choice analysis requires assigning a yes or no response to each dollar amount asked about in the multiple-bounded question. The mean values reported in Table C-4 are calculated in two ways. First, analysis was carried out by coding "Definitely Yes" as a "Yes" and "Probably Yes," "Unsure," "Probably No," and "Definitely No" as a "No." A second analysis was performed by coding "Definitely Yes" and "Probably Yes" as a "Yes" and "Unsure," "Probably No," and "Definitely No" as a "No." The values reported in the three left-hand columns are based on a multiple-bounded logistic regression analysis. A second set of logistic regression models were estimated using data from the multiple-bounded question format, but analyzed as though the data had been generated by a single-bounded question format. The results of this analysis is shown in the three right-hand columns of Table C-4. In the single-bounded analysis of the multiple-bounded data, each row (dollar amount) in the multiple-bounded question format is treated as an independent single-bounded response to a willingness-to-pay question. Admittedly, this approach ignores the potential interdependence of the responses given to various dollar amounts in multiple-bounded contingent valuation questions. The usefulness of the single-bounded analysis approach was that it allows estimation of discrete choice models in which the implied sample size is much larger, making it possible to tentatively explore the implications of larger sample sizes combined with single-bounded question formats which are planned for the final study. This increased effective sample size also increases the precision of the estimated parameters. Our confidence that this practice was justified was bolstered by finding that mean willingness to pay changes by only a small amount between the two approaches, with the single-bounded approach providing slightly higher estimates of willingness-to-pay.

As expected, mean willingness-to-pay increases as we move from moderate fluctuating flows (Versions 1 and 4) to seasonally adjusted steady flows (Versions 3 and 5) in both the national and the marketing area samples. Mean values for the marketing area are lower than mean values for the national sample for identical scenarios. Small changes in the wording of the background information and changes in the order of presentation of the impacts within the seasonally adjusted steady flow alternative (Version 3 versus Version 6) induced a small decrease in willingness-to-pay. Dropping impacts to Native American cultural sites, trout, and native fish from the seasonally adjusted steady flow alternative (Version 3 versus Version 8) resulted in a substantial decrease in mean willingness-to-pay. Finally, contrary to prior expectations, dropping electricity price impacts from the seasonally adjusted steady flow alternative (Version 3 versus Version 9) decreased mean willingness-to-pay.

Table C-4
Mean Willingness-To-Pay for Stated Proposal -- Discrete Choice Analysis of Data Collected Using Multiple Bounded Questioning Format[a]

	Multiple-Bounded Mean Willingness-To-Pay			Single-Bounded[b] Mean Willingness-To-Pay		
	Definitely Yes[c]	Definitely/ Probably Yes[d]	n[e]	Definitely Yes[c]	Definitely/ Probably Yes[d]	n[e]
National Sample						
Version 1	$42.3	$69.2	85	$45.6	$72.4	1,105
Version 2	$45.9	$73.6	83	$49.0	$77.2	1,079
Version 3	$58.2	$95.5	73	$62.7	$97.0	949
Version 6	$53.4	$91.9	67	$56.5	$92.3	871
Version 8	$42.0	$66.1	66	$45.2	$69.1	858
Version 9	$33.3	$57.0	80	$37.2	$62.0	1,040
Marketing Area Sample						
Version 4	$26.2	$47.5	94	$28.5	$51.5	1,222
Version 5	$30.2	$54.6	112	$33.8	$59.4	1,456

a Analysis was carried out using cases where respondents supported the proposal and responded to all dollar amounts given. Not applicable for survey Version 7.
b Data were analyzed as if the response to each dollar amount in the multiple-bounded question represented an independent response to traditional single-bounded questions.
c Definitely yes responses to dollar amounts coded as a "yes"; all other responses coded as a "no".
d Definitely yes and probably yes responses to dollar amounts coded as a "yes"; all other responses coded as a "no".
e n equals the number of valid cases.

In addition to the logistic regression analysis, another estimate of mean willingness-to-pay was derived by treating the multiple-bounded willingness-to-pay question as if it were a payment card. Again, two separate analyses were performed. For one analysis, the highest amount a respondent would "definitely pay" was recorded as a point estimate of willingness-to-pay. In a second analysis, the point estimate of willingness-to-pay was recorded as the highest amount the respondent would "probably pay." The analysis was carried out only for those respondents indicating previously they would vote for the proposal and who completed the multiple-bounded willingness-to-pay question. The results of this analysis (Table C-5) are very similar to the results based on the discrete choice analysis of the multiple-bounded data.

Table C-5
Mean Willingness-To-Pay for Stated Proposal -- Payment Card Analysis [a]

	Definitely Yes[b]		Definitely/ Probably Yes[c]		
	Mean Willingness-To-Pay	s[d]	Mean Willingness-To-Pay	s[d]	n[e]
National Sample					
Version 1	$37.9	$49.0	$60.9	$54.0	85
Version 2	$41.2	$54.7	$65.2	$63.6	83
Version 3	$53.2	$63.0	$80.5	$71.5	73
Version 6	$47.5	$55.7	$77.1	$68.6	67
Version 8	$37.6	$51.2	$58.1	$59.0	66
Version 9	$30.9	$50.5	$52.1	$65.3	80
Marketing Area Sample					
Version 4	$23.5	$38.5	$43.6	$54.3	94
Version 5	$28.0	$43.9	$50.2	$59.8	112

[a] Computed using the highest dollar amount that respondents who supported the proposal said they would be willing to pay.
[b] Definitely yes responses to dollar amounts coded as a "yes"; all other responses coded as a "no."
[c] Definitely yes and probably yes responses to dollar amounts coded as a "yes"; all other responses coded as a "no."
[d] s equals the sample standard deviation.
[e] n equals the number of valid cases.

To this point the discussion has focussed primarily on the comparisons of mean willingness-to-pay derived from survey versions using the multiple-bounded question format. Version 7 of the survey asked respondents to evaluate the seasonally adjusted steady flow alternative in the context of a single-bounded dichotomous choice contingent valuation question. The estimated average willingness-to-pay derived from the data collected using a single-bounded dichotomous choice contingent valuation question was $121.80

C.6 TESTS OF HYPOTHESES

Tables C-6 and C-7 report the test statistics for pair-wise tests of hypotheses concerning estimated mean willingness-to-pay. These tests were carried out in three ways. First, Monte Carlo methods were used to create empirical distributions of willingness-to-pay using the estimated discrete choice model for each treatment. Then pairs of empirical distributions were tested using the method of convolutions. The method of convolutions tests the hypothesis that the difference between two random variables is equal to zero. In this study, the two random variables are the mean willingness-to-pay estimates from two experimental treatments. The probabilities in Tables C-6 and C-7 report the probability of a test of the hypothesis that the convolution (i.e., the difference between the two empirical distributions of willingness-to-pay) is equal to zero. Small probabilities indicate rejection of the null hypothesis. Tables C-6 and C-7 also report the 95 percent confidence interval for the convolution.

Statistical tests were also carried out to evaluate the hypothesis of equality between the parameters for pairs of logistic regression models. If two parameters have nearly identical estimated parameters, they will produce nearly identical willingness-to-pay values. The test of identical parameters is performed using a log likelihood ratio test. This test produces a chi-square statistic. In this case, the chi-square statistic will have two degrees of freedom. Chi-square values larger than 4.6 result in the rejection of the null hypothesis of equality at the 10 percent level. Tables C-6 and C-7 also report a Z value. This simply represents the value of a test of the difference of means, where the means being tested are mean willingness-to-pay estimates using the payment card approach (Table C-5).

Table C-6
Hypothesis Tests for Models in Which a Yes is Recorded for "Definitely Yes" and a No is Recorded for All Other Response Categories

	Multiple Bounded			Payment Card	Single Bounded		
	Convolutions		Likelihood Ratio Test		Convolutions		Likelihood Ratio Test
Pairwise Comparison of Survey Versions	P	95% Confidence Interval	χ^2	Z	P	95% Confidence Interval	χ^2
1 versus 2	0.67	(-11,13)	1.6	-0.42	0.40	(-4,10)	2.3
3 versus 2	0.18	(-6,29)	2.1	-1.25	0.00	(5,22)	16.2
3 versus 1	0.05	(0,32)	5.0	-1.68	0.00	(9,25)	20.1
1 versus 4	0.00	(5,27)	8.9	2.17	0.00	*	50.8
3 versus 5	0.00	(14,43)	19.8	3.54	0.00	*	83.3
5 versus 4	0.40	(-5,12)	0.8	-0.78	0.05	(0,10)	8.5
6 versus 3	0.58	(-24,13)	0.4	0.56	0.21	(-3,15)	1.9
3 versus 8	0.07	(-2,34)	3.6	1.60	0.00	(8,25)	24.3
3 versus 9	0.00	(9,41)	10.5	2.40	0.00	*	63.5

* Convolution does not include zero.

Table C-7
Hypothesis Tests for Models in Which a Yes is Recorded for "Definitely Yes" and "Probably Yes" and a No is Recorded for All Other Response Categories

Pairwise Comparison of Survey Versions	Multiple Bounded: Convolutions Z P	Multiple Bounded: Convolutions 95% Confidence Interval	Multiple Bounded: Likelihood Ratio Test	Payment Card	Single Bounded: Convolutions P	Single Bounded: Convolutions 95% Confidence Interval	Single Bounded: Likelihood Ratio Test χ^2
1 versus 2	0.63	(-14,24)	2.5	-0.48	0.34	(-5,14)	5.1
3 versus 2	0.07	(-2,47)	3.4	-1.40	0.00	(8,32)	13.1
3 versus 1	0.01	(5,50)	9.8	-1.92	0.00	(14,37)	21.9
1 versus 4	0.01	(5,37)	8.2	2.13	0.00	*	55.1
3 versus 5	0.00	(21,64)	16.9	3.00	0.00	*	68.4
5 versus 4	0.41	(-9,20)	1.2	-0.83	0.06	(0,15)	6.8
6 versus 3	0.71	(-32,22)	0.1	-0.28	0.53	(-9,18)	1.3
3 versus 8	0.01	(6,54)	7.1	2.02	0.00	(15,40)	25.3
3 versus 9	0.00	(15,63)	10.7	2.55	0.00	*	58.6

* Convolution does not include zero.

Comparisons between Version 7 and Version 3 allow an assessment of how well the multiple-bounded questioning technique performed relative to the more widely accepted single-bounded dichotomous choice technique. In making this assessment, it is important to remember that in Version 7, respondents were constrained to answering either "Yes" or "No" to the valuation question. In Version 3, respondents were allowed to choose from the response categories "Definitely Yes," "Probably Yes," "Unsure," "Probably No," or "Definitely No." The interpretation of the comparison between Version 3 and Version 7 depends, to some extent, on assumptions about how respondents in these two versions would have answered if they had been given a question with response categories of the other version. As a starting point, we might assume that all individuals in Version 3 who responded "Definitely Yes" or "Probably Yes" would have said "Yes" if they had been forced to choose between a "Yes" or "No" response category. Likewise we might assume that those who responded "Probably no" and "Definitely No" would have responded with a "No" if they had been offered only a "Yes" and "No" response category. Finally, those who responded "Unsure" could be assumed to be evenly split between "Yes" and "No." This suggests that willingness-to-pay from Version 7 (the single-bounded dichotomous choice treatment) would be bounded by willingness-to-pay estimates derived from two multiple-bounded logistic regression models based on Version 3. The first model would be one in which "Definitely Yes" and "Probably Yes" are coded as a "Yes" and all other response categories are recorded as a "No." The second model would be one in which "Definitely Yes," "Probably Yes," and "Unsure" are coded as a "Yes" and all other response categories are reported as a "No." The results from these two models for Version 3 and the results from the two relevant multiple-bounded models derived from Version 7 are presented in Table C-8.

Table C-8
Comparison of Mean Willingness-to-Pay Estimates for Versions 3 and 7

	Multiple-Bounded Analysis of Version 3		Single-Bounded Analysis of Version 3		Version 7
Mean	$95.5[a]	$136.7[b]	$97.0[a]	$130.2[b]	$121.8

a "Definitely Yes" and "Probably Yes" responses to dollar amounts coded as a "Yes"; all other responses coded as a "No."

b "Definitely Yes," "Probably Yes," and "Unsure" responses to dollar amounts coded as a "Yes"; all other responses coded as a "No."

The results reported in Tables C-6, C-7, and C-8 can be used to assess the results of the pilot test in terms of the six specific objectives of the pilot test.

Objective 1: To determine whether non-use value estimates for GCDEIS alternatives are sensitive to the scale of resource impacts under those alternatives.

Versions 1, 2, and 3 were all administered to a national sample, and differed only in the scale of the scenario being evaluated. Likewise Versions 4 and 5 were administered to residents of the marketing area and differed only in the scale of the scenario being evaluated. Significant test statistics for the comparison of Versions 1 and 3 indicates that in the national sample, survey respondents were sensitive to the scale of the scenario being evaluated. In the marketing area, the result is less clear. Based on the multiple-bounded analysis, a significant difference was not found for mean willingness-to-pay between Versions 4 and 5. However, the single-bounded analysis of the multiple-bounded data indicated that residents of the marketing area were sensitive to the scale of the scenario being evaluated.

Objective 2: To determine whether non-use values for GCDEIS alternatives would be sensitive to the scope of the resources impacted by those alternatives.

This objective is met by comparing the mean willingness-to-pay obtained in Versions 3 and 8. Both of these Versions we administered to a national sample and used the multiple-bounded questioning technique. The scenario in Version 8 was substantially smaller in scope than the scenario evaluated in Version 3. In particular, while Version 3 contained impacts to sediments, beaches, vegetation, Native Americans, native fish, trout, and power consumers, Version 8 contained impacts only to sediments, beaches and vegetation. A comparison of the estimated willingness-to-pay reveals that willingness-to-pay was significantly smaller for Version 8 than for Version 3. This is taken as evidence that survey respondents were also sensitive to the scope of the scenarios being evaluated.

Objective 3: To determine whether estimates of non-use values based on the draft instruments would be affected by seemingly innocuous changes in the wording and order of presentation of background information.

This objective was met by comparing the mean willingness-to-pay obtained from Version 3 with the estimated willingness-to-pay obtained from Version 6. The Version 6 survey materials were identical to those for Version 3 with two exceptions. First, Version 3 discussed the environmental impacts and then consequences for power consumers, whereas in Version 6, the consequences for power consumers were presented prior to the information of environmental impacts. Second, the background information for Version 6 was a slightly edited Version of the background information used for Version 3. Version 6 tended to provide slightly lower estimates of mean willingness-to-pay than Version 3. However, the low values for the statistical tests indicate that the differences between the two estimates of willingness-to-pay are not significantly different.

Objective 4: To determine whether non-use values for GCDEIS alternatives differ between the marketing area and the nation as a whole.

Residents of the marketing area tended to express lower willingness-to-pay for the moderate fluctuating flow and the seasonally adjusted steady flow alternative than did members of the national sample. The statistical analysis indicates that these differences are significant.

Objective 5: To determine whether non-use values measured using a multiple-bounded format for contingent valuation questions would be significantly different than non-use values measured using a single-bounded contingent valuation question.

While an exact statistical test was not performed, it was hypothesized that the value from the single-bounded dichotomous choice survey version would fall between the values based on a multiple-bounded model in which "Definitely Yes" and "Probably Yes" responses were coded as a yes, and one in which "Definitely Yes," "Probably Yes," and "Unsure" are coded as a yes. The result reported in Table C-8 supports this hypothesis. While not a statistical test, this result does support the contention that inferences based on data collected using the multiple-bounded question format are consistent with inferences based on data collected using the single-bounded dichotomous choice questioning format.

Objective 6: To determine whether empathy for the effects of the alternatives on the amounts paid by consumers of power from Glen Canyon Dam has significant effects on overall non-use values for the alternatives.

This objective was met by comparing results from Version 3 with the results obtained from Version 9. Version 9 was identical to Version 3 with one exception. In Version 9, survey respondents were told that changes in dam operations would have only a very small impact on power users (utility bills would increase by less than 1 percent). Because participants in the qualitative research phase had exhibited concern about utility bill increases for residents of the marketing area, it was expected that willingness-to-pay derived from Version 9 data would be greater than willingness-to-pay derived using data from Version 3. Contrary to expectations, willingness-to-pay in Version 9 was approximately 60 percent of willingness-to-pay in Version 3. Furthermore, this difference was statistically significant. Several possible explanations could be offered for this counter-intuitive result. One possible explanation is that in Version 3, respondents were told that individuals who receive power from the dam would pay higher utility bills as a result of changed dam operations. While respondents to Version 3 might have felt empathy toward marketing area residents, they might also have felt that marketing area residents were also "doing their part" to help address environmental issues along the Colorado River below Glen Canyon Dam. In Version 9, respondents were told that receiving power from the dam would be virtually unaffected by changes in operations. It is possible that respondents to Version 9 may have tended to reject the valuation scenario if they felt it was unfair to require taxpayers at large to address environmental concerns along the Colorado River below Glen Canyon Dam. An alternative explanation is that respondents in the national sample used the utility bill impacts as a cue in deciding how they would vote. If this cuing process was present, it would have led to higher mean values for scenarios with higher utility bill increases. The absence of a specific utility bill increase in the Version 9 scenario could not have provided this type of cuing and possibly resulted in a lower stated willingness-to-pay. However, because of the design of the pretest it was impossible to evaluate the relative merits of these two hypotheses. In particular, utility bill impacts increased along with the environmental benefits of changes in dam operations. Thus the increase in mean willingness-to-pay observed between Versions 1 and Version 3 could be explained as the consequence of survey respondents perceiving higher environmental benefits for the scenario described in Version 3.

C.7 SUMMARY OF PILOT TEST RESULTS

The results of the pilot test, in general, favored a decision to proceed to a final study. The pilot test showed that survey materials provided results that were sensitive to both scope and scale, and were not sensitive to minor changes in scenario and background information wording. Furthermore, marketing area residents expressed a positive willingness-to-pay for changes in dam operations and their values tended to be lower than values expressed by members of the national sample. The only unfavorable result from the pilot test concerned the role of empathy on the part of members of the national sample, towards individuals in the marketing area who would pay higher utility bills as a result of changed dam operations.

C.8 CHANGES TO SURVEY MATERIALS AND STUDY SUBSEQUENT TO THE PILOT TEST

Consideration of the results of the pilot test combined with review of the results by the GCES Non-Use Value Committee, an external peer review panel, and the Office of Management and Budget all resulted in a final study design that reflected a number of changes in survey materials, survey implementation procedures, and experimental design. This section summarizes the major differences between the pilot test and the final study.

C.8.1 Background Information

Changes were made to the background information materials provided with the surveys in an effort to clarify and, in some instances, correct the explanation of the impacts of various operating alternatives on riverine and power resources. There was some concern that in the pilot test, background information materials might have led survey respondents to believe that the decline in native fish species was due solely to changes in their environment caused by the operation of Glen Canyon Dam. The background materials for the pilot test specifically identified that cold water released from the Dam may be the most important factor contributing to the decline in native fish species and listed trout as the only non-native species residing in the river. This was modified the final study to mention the presence of other non-native fish species, and a separate bullet item was added indicating that competition with these species may have contributed to the decline of native fish populations.

The background information materials used for the pilot test also provided a discussion of how change in the operation of the dam would affect the production of energy. Results of the pilot test showed that the discussion did not clearly convey the fact that a change in dam operations would affect *when* power was produced, but not *how much* power was produced. The true/false items in the pilot test that asked respondents to indicate whether reducing daily fluctuations would reduce the amount of hydroelectricity produced was the one true/false item that was missed most frequently, indicating that the explanation given in the background materials or the question itself was unclearly written. Both the discussion in the background materials and the true/false question were rewritten for the final study in an effort to clarify this point.

C.8.2 True-False Questions

Participants in the pilot test were asked to answer a series of true-false questions prior to answering the valuation questions. As noted above, analysis of the responses to the true-false questions revealed a few questions with which the respondents had difficulty. Questions with high rates of incorrect responses were edited for the final study in an attempt to remove any ambiguities (Table C-9).

Table C-9
Changes to the True/False Statements

Pilot Survey:

1. Trout are one of the *native* fish species in the Colorado River below Glen Canyon Dam.
2. The *loss* of beaches is most severe along wide sections of the river.
3. The study area consists *only* of the area in and along the river.
4. Reducing daily fluctuations will *reduce* the total amount of hydroelectricity produced.

Final Study

1. Trout are **not native** to the study area.
2. The decrease in the number and size of beaches is most severe along **wide** sections of the river.
3. The Study Area consists **only** of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.
4. Reducing Daily fluctuations in the amount of water released from the dam will **reduce** the total amount of hydroelectricity produced.

C.8.3 Scenarios

The scenarios used in the pilot test to describe the impacts of alternative water flows were based on descriptions of the environmental consequences as they were understood in the fall of 1993 when the survey instruments were designed. Understanding of these consequences evolved between the fall of 1993 and the fall of 1994 when the final study was implemented. A decision was made to update the scenarios to reflect a more up-to-date understanding of the impacts of changes in dam operations. The majority of changes reflected an evolution of the scientific opinion regarding prospects for native fish under the low fluctuating flow and seasonally adjusted steady flow alternatives. Furthermore, additional analysis of the power systems impacts became available after completion of the pilot test. This additional information resulted in some changes in the descriptions of power price impacts for surveys administered to the national sample. The changes are summarized in Figures C-1, C-2, and C-3. In each of these figures, the pilot test scenario is reproduced in Part A and the final study scenario is produced in Part B. Shaded areas in Part B represent the items that were changed from the pilot test.

C.8.4 Contingent Valuation Question Format

The pilot test had made extensive use of the multiple-bounded questioning technique. Peer reviewers expressed strong reservations about the use of this new, and as yet unproved, question format in the final study. Thus, the final study was implemented using a single-bounded contingent valuation question. Respondents were asked if they would vote in favor of the proposal if passage of the proposal would cost them a specified amount. Response categories included "Definitely no," "Probably no," "Unsure," Probably yes" and "Definitely yes." Panel A of Figure C-4 shows a multiple bounded contingent valuation question used in the pilot test and Panel B shows the single-bounded format used in the final study for the national sample.

Since the final study used a single-bounded contingent valuation question it was necessary to select specific dollar amounts to insert in each survey booklet. Several schemes have been devised to select dollar amounts to be used in contingent valuation questions. The optimal set of dollar amounts depends on several factors. It has been shown that if the study objective is to provide the most precise estimate of median willingness-to-pay, then a single dollar amount equal to the median willingness-to-pay should be used. Obviously this approach requires that the researcher have prior knowledge of the parameter value that is to be estimated. In the absence of prior information, the use of a single dollar amount presents a high level of risk. For example, a single dollar amount would preclude the estimation of a distribution function. If the single dollar amount selected does not represent the median, the researcher would find it difficult, if not impossible, to derive estimates of mean willingness-to-pay. Other sampling schemes provide for a large number of distinct dollar amounts. For this study, a decision was made to use a small

Figure C-1
Moderate Fluctuating Flow Alternative
Pilot Test, Part A

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following environmental conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish. It is unlikely that the native fish populations, including those in danger of extinction, would increase from present levels.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to sustain the population.
- Monthly electric bills could increase by $6 per month for about 3,000 households in small cities in southwest Utah.
- Monthly electric bills could increase by $2 per month for another 1,500,000 rural and urban households in Arizona, Utah, Wyoming and New Mexico.
- Farmers in Colorado who use electricity for crop irrigation could experience a decrease in income of up to 1%.

(*continued*)

Figure C-1 (*continued*)
Moderate Fluctuating Flow Alternative
Final Study, Part B

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites, and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish.
- Native fish populations, including those in danger of extinction, would probably continue to decline in numbers.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to ***maintain*** the population.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households and a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

Figure C-2
Low Fluctuating Flow Alternative
Pilot Test, Part A

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following environmental conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish. It is not certain if native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.
- Monthly electric bills could increase by $6 per month for about 3,000 households in small cities in southwest Utah.
- Monthly electric bills could increase by $2 per month for another 1,500,000 rural and urban households in Arizona, Utah, Wyoming and New Mexico.
- Farmers in Colorado who use electricity for crop irrigation could experience a decrease in income of up to 1%.

(*continued*)

Figure C-2 (*continued*)
Low Fluctuating Flow Alternative
Final Study, Part B

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish.
- It is likely, but not certain, that native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households to a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

Figure C-3
Seasonally Fluctuating Steady Flow Alternative
Pilot Test, Part A

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following environmental conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 5% so that the area available for birds and other forms of wildlife would increase by about 5%.
- There would be a major improvement in conditions for native fish. Populations of most native fish, including one of the species in danger of extinction, would increase.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- Monthly electric bills could increase by $21 per month for about 3,000 households in small cities in southwest Utah.
- Monthly electric bills could increase by $7 per month for another 1,500,000 rural and urban households in Arizona, Utah, Wyoming and New Mexico.
- Farmers in Colorado who use electricity for crop irrigation could experience a decrease in income of up to 5%.

(*continued*)

Figure C-3 (*continued*)
Seasonally Adjusted Steady Flow Alternative
Final Study, Part B

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- The average electric bill would increase by $9 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $21 per month for 3,600 households to a minimum of no increase for 300,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 6%.

number of dollar amounts. One reason for this decision was a desire to preserve the option to use non-parametric methods to estimate mean willingness-to-pay. These non-parametric methods require multiple observations for a range of dollar amounts. The specific dollar amounts used in the final study were based on the results of the pilot test. Dollar amounts were selected to cover a range such that at the low end of the range a large percentage of respondents would vote in favor of the proposal, and at the upper end of the range, a large percentage of respondents would vote against the program. A same set of dollar amounts was used in all versions of the survey. This was done to avoid confounding any effects of the survey version with effects that might arise from a change in the structure of the dollar amounts on which respondents were asked to vote.

C.8.5 Emphasis of Budget Constraints

During the OMB approval process, concern was expressed whether the pilot test survey instruments had adequately reminded survey respondents of their budget constraints. To address this concern a decision was made to add three questions to the survey. In one question, survey respondents were asked to indicate the items on which they would spend less money if the proposal passed. After explicitly considering their budget constraints. respondents were provided an opportunity to change their votes. These three questions appear as Questions 4, 5, and 6 in the final study survey versions (see Appendix E).

C.8.6 Respondents Self-Reports on Perceived Validity

Three more questions were added to the final survey to collect data about various aspects of the respondents' perception of the validity of the survey and its results. The first question asked respondents if they thought they would be affected if the proposal passed. In the national sample, respondents were asked if they felt their taxes would really go up if the proposal passed. For the marketing area, respondents were asked if they thought their utility bills would actually increase if the proposal passed. A second question asked respondents if they believed government officials *would* consider the results of the survey when making decisions about the future operations of Glen Canyon Dam. The third question asked if respondents thought government officials *should* consider the results of the survey when making decisions about future dam operations. These questions appear as Questions 7, 8, and 9 in the final survey versions.

C.8.7 Were Payment Vehicles Relevant?

Some concern was expressed that survey respondents might express high willingness-to-pay amounts if the payment vehicles (taxes in the national sample versions and utility bills in the marketing area sample) were not relevant to the respondent. To address this concern, two questions were added. In the national sample versions, one question asked if respondents had taxes withheld from a paycheck in the previous year, and a second question asked if they had filed a federal income tax form in the previous year. In the marketing area sample versions, one question asked respondents if they owned or rented their residence, and the second question asked if the respondent was responsible for paying the utility bills. These two questions appeared as Questions 28 and 29 in the final survey revisions.

In addition to the changes to the survey materials themselves, several changes were made to the sampling and implementation procedures used in the final study.

C.8.8 Sampling

Pilot test samples were purchased from Survey Sampling Inc. (SSI), an independent firm that specializes in maintaining marketing databases. For the national sample, a sample of U.S. residents, 18 years old or older was purchased. Unfortunately, we were not aware that SSI routinely excludes Alaska and Hawaii from U.S. samples unless the purchaser specifically requests that they be included. However, since extrapolation to a national population was not a purpose of the pilot test, this error was unlikely to have affected the pilot test results in any significant way. This oversight was corrected for the final study, and Alaska and Hawaii residents were included in the national sampling frame. Including Alaska and Hawaii in the sample for the final study resulted in 21 cases from these two states being included in the sample.

Power from Glen Canyon Dam is marketed in five western states. These include Colorado, New Mexico, Utah, Arizona, and Wyoming. However, only a portion of the residents within these states actually receive power that is produced at the dam. Thus, the marketing area sample was defined by postal ZIP codes that fall within the service territories of utilities with long-term firm contracts for Salt Lake City Area Integrated Projects (SLCA/IP) power. The sample as originally defined for the Glen Canyon Nonuse Survey Pilot Test was provided by Clayton Palmer of Western Area Power Administration. Procedures by which appropriate ZIP codes were identified are described in an informal memorandum, written by Clayton Palmer to Marty Phillips (Figure C-5).

Figure C-4
Panel A: Multiple-Bounded Contingent Valuation Question Format

If the higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal, taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. How would you vote on this proposal if passage of the proposal would cost your household these amounts **every year** for the foreseeable future? *(CIRCLE ONE LETTER FOR EACH DOLLAR AMOUNT TO SHOW HOW YOU WOULD VOTE)*

Cost to you per year?	**Approx. cost per month?**	Definitely Yes	Probably Yes	Not Sure	Probably No	Definitely No
10¢	1¢	A	B	C	D	E
50¢	4¢	A	B	C	D	E
$1	8¢	A	B	C	D	E
$5	42¢	A	B	C	D	E
$10	83¢	A	B	C	D	E
$20	$1.67	A	B	C	D	E
$30	$2.50	A	B	C	D	E
$40	$3.33	A	B	C	D	E
$50	$4.17	A	B	C	D	E
$75	$6.25	A	B	C	D	E
$100	$8.33	A	B	C	D	E
$150	$12.50	A	B	C	D	E
$200	$16.70	A	B	C	D	E

(continued)

Figure C-4, continued
Panel B: Single-Bounded Contingent Valuation Question Format

> If the higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal, taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. How would you vote on this proposal if passage of the proposal would cost your household $ **every year** for the foreseeable future? *(CIRCLE ONE NUMBER)*

1 **Yes - I would vote for the proposal to change operations at Glen Canyon Dam even though I would have to pay more taxes.**

2 **No - I would vote against the proposal.**

Figure C-5
Procedures for Identifying ZIP Codes

Informal Memorandum

Date: January 5th, 1994

TO: Ms. Marty Phillips
HBRS, INC
585 Science Drive, Suite A
Madison, WI 53711

FROM: S. Clayton Palmer, Western Area Power Administration

SUBJECT: Zip Codes of Customer Service Areas

Enclosed you will find the zip codes that pertain to the service areas of long-term firm power customers of the Salt Lake City Area Integrated Projects (SLCA/IP) of Western Area Power Administration (Western).

These zip codes pertaining to customers' service areas were identified differently for municipalities than for Rural Electric Associations (REA) and Cooperatives. For municipalities, we selected the zip code pertinent to that municipality. In the few instances were more than one pertained, we included those zip codes that were entirely contained within the municipal's service area (exceptions are noted). For REAs, we first identified the service areas. We overlaid maps of service area with maps of the first three digits of a zip codes. We then identified the common geographic area of both. Once this was accomplished, we looked up the zip code of every city or town identified on the zip code map.

To clarify the process used for the zip code identification for the REAs, let me take an example. Moon Lake Electric Cooperative is a SLCA/IP firm power customer. Its service area is Northeast Utah. According to the zip code map, the three-digit zip codes 840 and 841 pertain to Northern central Utah. There are 13 towns that are in the common geographic area. By observation, the there are seven towns that are certainly within the service area boundaries. The other towns are enough on the border that we were uncertain about whether they were actually in the service area. What towns are included in our list are just those that we were certain about. For a few REAs (including Moon Lake Electric), we contacted by telephone in order to add certainty to the list provided.

There are two caveats that I wish to pass on to you at this time. The first relates to municipalities. A few households may be served by a post office but may be outside of the service area of a SLCA/IP customer. In bountiful, for example, some parts of unincorporated Davis County are served by the Bountiful Post Office, but receive electrical power service from Utah Power and Light. I don't know how wide-spread a problem this is. To use my previous example, Bountiful Power and Light has 13,212 electrical meters. All of these are in the Bountiful zip code: 84010. The Bountiful post office serves 14,356 mailing addresses. So, 144 residences and businesses have a 84010 zip code, but do not receive electrical power from Bountiful City.

The second caveat relates to REAs. There are pockets within our customers' service areas which are not served by our customers. These pockets are usually not on service area maps.

Despite these caveats, I am fairly confident that we have those zip codes which are wholly within the service areas of the SLCA/IP customer served by Western's Salt Lake Area Office.

Please call me at (801) 524-3522 (or Valarie Varallo, who did all of the work, at 4445) if your have any questions.

Sincerely:

S. Clayton Palmer
Natural Resource Economist

After completion of the pilot test, a random sub-sample of 100 cases were drawn from the full marketing area sample that was purchased for the pilot test. Using the addresses as a key, these cases were divided by service utility and sent to these utilities to verify that the sampled addresses were listed as residential accounts. This was done to determine how well the sample represented the marketing area. Results showed relatively high (greater than 90 percent) "hit" rates for all locations except New Mexico. As a result, procedures for identifying appropriate ZIP codes in New Mexico were refined and a new sample of ZIP codes was assembled for that state. For the final study, the new ZIP codes in New Mexico were substituted for those used in the pilot test sampling plan, and the updated ZIP code list was used to select the sample of addresses for the final phase of the Glen Canyon Non-Use Values Survey.

Characteristics of pilot test respondents showed them to be significantly different from the population. For example, pilot test results show a disproportionate percentage of males responding to the survey compared to the true percentage of males in the sample frame. It is likely that this result is a factor of the sampling procedures used. For the pilot test, the survey was addressed to the individual named in the sample. Typically, this individual is the head of household who is most frequently male. Several members of the committee expressed concern about the over-representation of males in the pilot test. In turn, the committee decided to implement the final study using procedures that would randomly select survey respondents from among the adult members of the household. Thus, in the final study, random selection of survey participants within a household was accomplished in the following way. If the selected sample point was John Smith, all survey materials were addressed to the "Smith Household, care of John Smith." Survey materials indicated that the adult member of the household whose birthday occurred the latest in the calendar year should complete the survey.

Additional differences were observed between the characteristics of pilot test respondents and the population. Pilot test respondents tended to be older, have higher incomes and higher levels of education than the national population. It was not possible to determine whether this result was a consequence of survey non-responses or whether the sampling frame did not represent the national population. The SSI sampling frame is typically based on telephone directories and is subject to non-coverage to the extent that households do not have telephones or do have unlisted numbers. In an attempt to improve the sampling frame, the sample for the final study was drawn from a sampling frame based on telephone listings augmented by drivers license records where available (23 states).

C.8.9 Monetary Incentive

Given the implementation procedures used in the pilot test, a response rate of 70 percent was expected. This expectation was based upon prior experience in conducting similar types of surveys, as well as a response rate prediction model HBRS had developed (Heberlein and Baumgartner, 1978; 1981). The pilot study mail survey for the marketing area sample met our expectation with a response rate of 76 percent. However, for the national sample, the pilot study mail survey response rate was 60 percent. As a consequence of the lower than expected response rate in the national sample, it was decided to increase the monetary incentive included with the initial survey mailing. A $2 incentive was used in the pilot test. In the final study, a $3 incentive was used.

C.8.10 Telephone Survey

Concerns about the response rate led to a decision to change survey implementation procedures by adding an additional effort to contact potential survey respondents. In the pilot test, potential respondents received an advance letter, an initial survey mailing, a follow-up post card, and up to two additional survey mailings to non-respondents. The final study used these procedures and added a telephone call to non-respondents after the third survey mailing. The purpose of the telephone call was to encourage potential respondents to complete the survey, and to collect a limited set of environmental attitude and socio-demographic data.

APPENDIX D
QUALITY OF SAMPLES

This appendix addresses issues relating to the quality of the samples purchased for this study. Information is first provided about the source of the samples and the selection procedures. Following this, demographic characteristics are repeated for the population, the sample frame, and survey respondents.

D.1 SAMPLE SELECTION

One goal of the sampling plan was to obtain a sample that represents the households in the United States. We refer to this as the "national sample." Because the national sample was designed to represent all households, it included households from the marketing area in proportion to their size in the total population. However, because only a small percentage of households in the U.S. reside in areas served by power produced at Glen Canyon Dam, we expected only a small number of marketing area households to be selected for the national sample. As a result, we selected a second sample that represents those households that reside in the areas of the United States that receive power produced at Glen Canyon Dam and whose electric bills would be directly affected by any changes in dam operations. We refer to this second sample as the "marketing area sample." The marketing area sample of households was selected from addresses in ZIP codes in service territories for utilities with firm power contracts for Salt Lake City Area Integrated Projects (SLCA/IP). Glen Canyon Dam represents about 80 percent of SLCA/IP power.

High-quality general population mail survey samples purchased from reputable vendors, may not accurately represent the national population. One reason is that mail samples are typically selected from white-page telephone directories, thus excluding the sectors of the population without telephones and those with unlisted telephone numbers. Approximately 5.1 percent of households in the continental United States do not have telephones, while an additional 26.1 percent of the households in the continental United States have unlisted telephone numbers. Households with unlisted telephone numbers tend to be more mobile and are more likely to reside in rented, urban multi-family units (Piekarski, 1989). Furthermore, people who have unlisted numbers are more likely to be unmarried, have lower incomes and educational levels, and are more likely to belong to a minority group.

Listed samples tend to overrepresent "retired" householders, whereas unlisted householders are significantly younger.

In an effort to improve the coverage of the mail survey sampling frame, samples were drawn from a database of listed households, supplemented with drivers license records from those states that publish these data. At the time the samples were drawn for this study, driver's license records were available from 23 states.

Both the national and the regional samples for this study were purchased from Survey Sampling Inc. (SSI), an independent firm specializing in national survey databases. Because the percentage of households with no telephones and the percentage of households with listed telephone numbers differs by state and region within states, the mail survey sampling frame does not contain the correct distribution of the number of households by state. To correct this potential source of sampling error, SSI uses census data to estimate the total number of households by state and region within states, and bases the number of households to be selected in each geographic strata on the estimated total number of households in each strata. Based on these factors, we feel that SSI's mail survey sampling frame provides as much coverage of our target populations as any samples that were readily available and practically affordable for this study.

The national sample for this study was drawn from SSI's supplemented database that included all states in the United States. The marketing sample, on the other hand, was restricted to certain geographical areas defined by ZIP codes. Market area ZIP codes were identified by Western Area Power Administration (WAPA) to represent the geographic areas served by utilities that had firm power contracts for SLCA/IP, for the WAPA Salt Lake City office. Like the national sample, the marketing area sample was also drawn from SSI's data base supplemented with driver's license records.

Both samples were submitted to a "deduping" process in which all sample points for the final study were compared to the pilot test sample to ensure there was no overlap of cases. This process is carried out by comparing the telephone numbers of each case. Since a portion of the final study samples did not have listed telephone numbers (i.e., sample points from driver's license records), there was only a very small possibility of overlap between the two samples. However, given the size of SSI's data base and the total number of households in the United States, the likelihood of overlap between the pilot sample and the final sample was remote. No duplicate cases were identified during this procedure for either the national or the marketing area samples.

SSI suggests that researchers using their mail samples can expect a 'deliverable rate' between 85 percent and 87 percent depending on the geography of the survey area. The deliverable rate is impacted by two factors. First, 12 percent to 15 percent of the names included in a mail sample can change due to normal population mobility. Second, 5 percent to 10 percent of records nationwide are rural -- frequently with addresses consisting of only two lines -- and are thus sometimes considered to be undeliverable by local post offices (Survey Sampling, Inc., 1992). Prior to selecting a sample of households, SSI screens all samples to exclude nonresidential addresses.

D.2 COMPARISON OF THE POPULATION, SAMPLE FRAME, AND SURVEY RESPONDENTS

As described above, even if a high-quality sample is purchased, there are likely to be differences between the characteristics of the individuals in the sample frame and those of the population. Such differences are difficult to avoid given the limitations of existing data sources. A comparison of the demographic characteristics of the population with the characteristics of the sample frame can provide some indication of how well the sample represents the population. In turn, comparisons between the characteristics of the sample frame and survey respondents can provide some indication of the characteristics of nonrespondents.

Comparisons between the population, sample frame and survey respondents are shown in Table D-1 for the national sample.[1] The first column reports projected U.S. Census estimates for 1993. U.S. Census projections for 1995 were not available for all the categories shown. All Census projections are based on data collected during the 1990 Census.

The characteristics of the national sample frame were provided by SSI along with the purchased sample. SSI reports that these characteristics of the sample frame were also projected using the 1990 U.S. Census data. SSI estimates of sampling frame characteristics are not based on a random sample from the sampling frame. Consequently, useful conclusions based on comparisons between the population and the sample frame cannot be made.

In Column 3, characteristics were tabulated from the survey results. Results from the mail and telephone surveys were combined to estimate the respondent characteristics. Telephone survey respondents were added in order to mitigate biases that could occur because of nonresponse to the mail survey.

Several caveats should be kept in mind when comparing characteristics reported in the three columns of Table D-1. First, the three estimates were obtained from three different sources, each using a different method of estimation. Population characteristics in Column 1 for instance, are based on 1990 Census data projected to 1993. Sample frame characteristics are also based on 1990 Census data but are projected to 1994 and are calculated by SSI, not the Census Bureau. In contrast, respondent characteristics are based on actual responses to the GCES non-use value mail or telephone survey. One major difference between the sources is the unit of sampling. Population and sample frame characteristics are reported for the population and for households, whereas respondent characteristics are reported for

1 Comparable data for the marketing area sample was not assembled, given the difficulty in obtaining appropriate Census data for locations identified by ZIP codes.

individuals selected within households (different from the population). Age, percent male, and education reported for the population and the sample frame refer to the population or a portion of the population, while those reported for respondents are for a household representative.

Keeping these limitations in mind, Table D-1 compares all three sources on five characteristics. A comparison of the age distribution shows that the sample frame closely resembles the population. In contrast, the age distribution of survey respondents shows them to be significantly older. The next three variables, sex, education, and household size, were not provided by SSI for the sample frame.

Compared to the national population, survey respondents are more likely to be males and to have achieved a higher level of education. Comparison of household income is difficult given the variety of ways in which income is reported. Average household size of survey respondents appears to be about the same as that reported for the population.

The U.S. Census Bureau reports median household income and median family income, making a distinction between the two; SSI reported an average household income for the sample frame; and the survey data provided average and median household income. The Census Bureau defines a "household" as a group of individuals living together and sharing living expenses. In contrast, a "family" is defined as a group of related individuals who live in the same dwelling and share living expenses. Because of these distinctions, comparisons between the population and the sample frame are not possible.

Comparing income for the sample frame and survey respondents across income categories shows that survey respondents have higher household incomes than the sample frame. However, on average, respondents' household income is only slightly higher than the sample frame.

The survey results can also be compared to Census figures for households and families. Recall that the household was the unit of selection for this study. Study results show that the median household income for survey respondents is larger than median household income as projected by the Census. However, the survey respondents' median income appears to be similar to the median family income calculated by the Census. Given the inherent biases in a mail survey sample, we might assume that survey respondents' median household income is much closer to the median family income reported by the U.S. Census.

Table D-1
Characteristics of the Population, Sample Frame, and Survey Respondents

	Population Characteristics[a]	National Sample Frame Characteristics[b]	National Sample Respondent Characteristics[c]
Age:			
18 - 24 Years	13.4%	14.4%	4.1%
25 - 34 Years	22.0	22.0	17.5
35 - 44 Years	21.4	20.7	22.7
45 - 54 Years	15.0	14.5	19.8
55 - 64 Years	11.0	11.3	12.5
65 Years or older	17.2	17.1	23.4
	(190,674,000)	(190,282,531)	(1,913)
Percent Male:	47.9%	NA	52.8%
	(190,674,000)		(1,878)
Education:[d]			
High school graduate or higher	80.2% (165,012,000)	NA	91.6% (1,789)
Bachelors degree or higher[e]	21.9% (165,012,000)	NA	43.8% (1,789)
Average Household Size:	2.6 people (96,391,000)	NA	2.7 people (1,765)
Household Income:			
$0 - $9,999	NA	14.2%	7.1%
$10 - $14,999		8.4	7.2
$15 - $24,999		16.5	15.1
$25 - $34,999		15.3	18.0
$35 - $49,999		17.9	19.4
$50 - $99,999		21.9	26.9
$100,000 or more		5.7	6.3
		(94,705,985)	(1,741)

(continued)

Table D-1
Characteristics of the Population, Sample Frame, and Survey Respondents
(Continued)

Income:[f]			
Average household	NA	$41,911 (94,705,985)	$42,856 (1,741)
Median household	$30,786 (96,391,000)	NA	$37,250 (1,741)
Median family	$36,950 (68,100,000)	NA	NA

[a] U.S. Census projected estimates for 1993.
[b] Information provided by SSI, projected forward from the 1990 U.S. Census.
[c] To more fully represent the portion of the national sample contacted, results are reported for the combined mail and telephone survey data. For cases where respondents might be represented in both data sets, the mail survey data is excluded.
[d] Education is reported for individuals 25 years old or older.
[e] Information reported for national sample respondent characteristics represents respondents who reported being a college or technical school graduate or having completed post graduate work.
[f] Median household income reported for the population is projected for 1992, in 1992 dollars, and the median family income is projected for 1993, in 1993 dollars.
( ) Numbers in parentheses indicate the number of valid cases.
NA Information is not available.

D.3 CONCLUSIONS

If the assumption can be made that the characteristics of the sample frame closely resemble U.S. Census statistics, then some general conclusions about how well the *sample frame* represents the population and how well the *sample respondents* represent the sampling frame can be made. Survey respondents are somewhat older than either the population or the sample frame, are more likely to be male, and have achieved higher levels of education. Survey household size appears to be about the same as the population. Average household income for respondents is roughly similar to that reported for the sample frame, and median household income is similar to median family income reported for the population.

Although these figures are comparatively close, we can not definitively say how well the survey *sample* represents the sample frame or the population, because the characteristics of the sample frame and the population are both based on U.S. Census figures. The mail sample was drawn from a database that, in and of itself, is subject to potential biases. Although an attempt was made to compensate for these biases, there is no way to determine how well this effort at reducing the biases worked since not all individuals in the sample were reached. Thus, it is not possible to distinguish whether differences between survey respondents and the sample frame are due to biases in the sample resulting from the selection procedures or due to nonresponse bias.

APPENDIX E
SURVEY MATERIALS

Mail Survey Materials - National Sample
Mail Survey Materials - Marketing Area Sample
Telephone Survey

Mail Survey Materials -- National Sample

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings,

I am writing to ask you to share your views about an important issue affecting the Colorado River in Grand Canyon National Park. In the next several weeks, you will receive a survey in the mail. The survey is part of a national study of issues concerning the operation of Glen Canyon Dam. Glen Canyon Dam controls the water level in the Colorado River in the bottom of the Grand Canyon and affects the resources in and along the river. The study is a cooperative effort between the Bureau of Reclamation, National Park Service, U.S. Fish and Wildlife Service, Western Area Power Administration, and several Southwest American Indian tribes.

Government officials will soon be making decisions about how the dam is to be operated. The decisions will affect both the river environment at the bottom of the Canyon and the production of electricity. The way that the dam is operated affects the water level in the Colorado River which in turn affects natural and cultural resources in and along the river. The way the dam is operated also determines the value of the electricity produced by the dam. The decision makers need to know how people in households like yours feel about the tradeoffs between natural and cultural resources, such as fish, vegetation, and beaches at the bottom of the Grand Canyon, and the production of electricity from Glen Canyon Dam.

Even if you have never heard of the Glen Canyon Dam, your answers are important to this study. We cannot send this survey to every household in the country. Instead, a random sample of households was drawn. Your household was scientifically selected to receive this survey. In this study, your household represents many other households similar to yours. What U.S. households think about these issues is important for making future decisions on how to operate the Glen Canyon Dam.

The survey will arrive in the next week or so. HBRS, Inc., an independent research firm, has been hired to design and carry out the study. The survey will take about 30 minutes to complete. To ensure a random selection of respondents, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year. The survey package will provide information about Glen Canyon Dam and the natural and cultural resources downstream. You will only be asked to give your opinions and responses to questions about how <u>you</u> feel. The survey does not require any technical knowledge of hydroelectricity or dam operations. A stamped enveloped will be supplied to return the survey to HBRS. If you have any questions about the study, you can call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

We are very interested in hearing from your household so that we get an accurate picture of the range of opinions about the issues related to Glen Canyon Dam and the downstream resources. I hope you will help us out. Thank you, in advance, for your participation.

Thank you,

David L. Wegner

David L. Wegner
Glen Canyon Studies Project Manager

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

E-

IN REPLY REFER TO:

Greetings,

Here is the survey I told you about in my letter last week. This study is about the Glen Canyon Dam, which controls the water level in the Colorado River as it flows through Grand Canyon National Park. Government officials will soon be making decisions about how to operate the dam. Your participation in the study will help them understand how people in households like yours feel about trade-offs between cultural and natural resources, such as fish, vegetation, and beaches, at the bottom of the Grand Canyon and the production of electricity from Glen Canyon Dam. Answers to this survey will affect future decisions about how the dam is operated.

Your response to this survey is very important. We could not send this survey to every household in the nation. Your household is part of a relatively small group of households who have been randomly selected to participate in this survey. Your answers will represent the views of many other households similar to yours and will ensure that all households are represented in decisions about the operation of the Glen Canyon Dam. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Before beginning the survey, please read the colored information sheets included in the package. This background information describes Glen Canyon Dam, the resources below the dam, and how the operation of the dam affects these resources. I realize you may not have heard about Glen Canyon Dam before you received this survey. The background information was designed by scientists studying the dam and the Grand Canyon resources downstream to help you understand the issues. The survey does not require any technical knowledge about hydroelectricity or dam operations. The survey takes about 30 minutes to complete. People who have filled the survey out tell us they found it interesting and informative.

Answers to this survey are confidential; your name will never be revealed. Information from the survey will only be reported in statistical terms. There is an identification number on the back of the survey so that HBRS, Inc., the firm conducting the survey, will know who has already returned the survey and whom to send reminders to.

When the survey is completed, simply return it in the enclosed postage-paid envelope. If you have any questions about the study, we would like to hear from you. You can call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

I appreciate your help in this study. I know your time is valuable and, in recognition, have enclosed a small gift as a token of appreciation. In addition, if you would like to receive a newsletter providing more information about the Glen Canyon Dam and this study, write to the Glen Canyon Studies Office at P.O. Box 22459, Flagstaff, AZ 86002-2459.

Thank you,

David L. Wegner

David L. Wegner
Glen Canyon Studies Project Manager

Remember -- This survey is to be filled out by the adult in your household with the latest birthday in the calendar year.

BACKGROUND INFORMATION ABOUT THIS STUDY
PLEASE READ THESE PAGES BEFORE
YOU COMPLETE THE SURVEY

INFORMATION ABOUT GLEN CANYON DAM AND THE STUDY AREA

Before you fill out the survey, we want to describe the Glen Canyon Dam and the resources downstream from Glen Canyon Dam in the Study Area.

Glen Canyon Dam

- Glen Canyon Dam is located on the Colorado River in Arizona.
  - -- It is just upstream from the Grand Canyon.
  - -- It was built to provide water supplies and hydroelectricity.
  - -- It was completed about 30 years ago.
  - -- It controls the water flow through the Grand Canyon.
  - -- Revenues from the sale of hydroelectricity are used to repay costs.

The Study Area

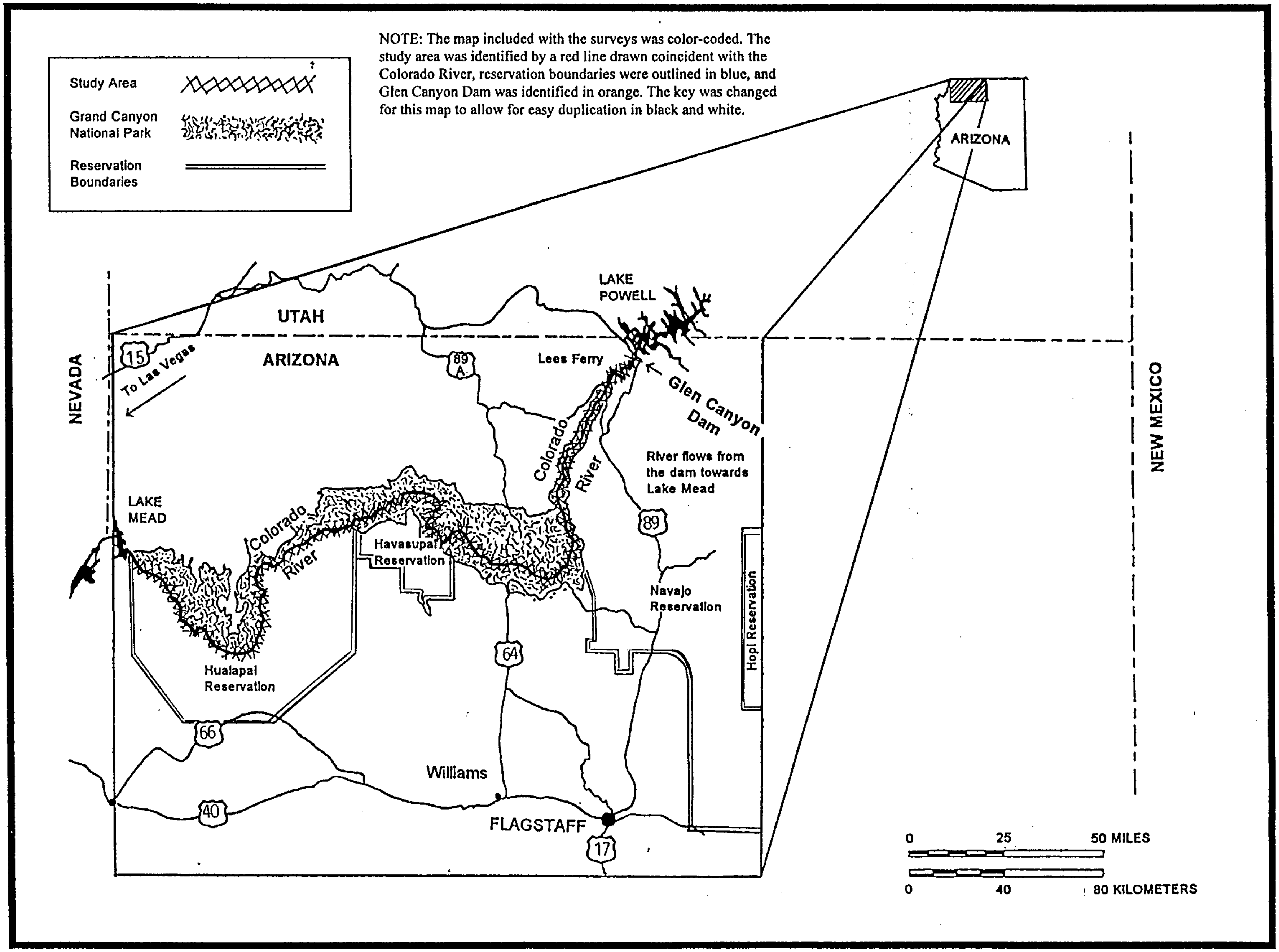
- The Study Area consists only of the area in and along the Colorado River at the bottom of the Grand Canyon.
- The Study Area begins at Glen Canyon Dam.
- The Study Area continues for nearly 300 miles.
- The Study Area ends at Lake Mead near Las Vegas.
- Part of the Study Area is within the Grand Canyon National Park.
- Part of the Study Area is bordered by American Indian reservations.
- The cover of the survey booklet shows one view of the Colorado River in the Study Area.

How Glen Canyon Dam affects the Colorado River in the Study Area

- The amount of electricity produced by Glen Canyon Dam depends on the amount of water released from the dam: the more water released, the more electricity produced.
- More water is released during periods of high demand for electricity and less water is released during periods of low demand for electricity.
  - -- On a seasonal basis, more water is released during the hottest summer months and the coldest winter months.
  - -- On a daily basis, more water is released during the day than at night.
  - -- The amount of water released can vary from hour to hour throughout the day.
- In some places in the Grand Canyon, this can result in the river rising and falling as much as ten feet in a day.

This study deals with the ways Glen Canyon Dam could be operated to benefit natural and cultural resources in the Study Area. A map showing the location of the Dam and the Study Area appears on the next page. A description of the resources in the Study Area is contained on the pages following the map.

NOTE: The map included with the surveys was color-coded. The study area was identified by a red line drawn coincident with the Colorado River, reservation boundaries were outlined in blue, and Glen Canyon Dam was identified in orange. The key was changed for this map to allow for easy duplication in black and white.



NATURAL RESOURCES IN THE STUDY AREA

The natural resources in the Study Area are located in and along the Colorado River below Glen Canyon Dam.

- **Deposits of sand, mud, and gravel, sometimes called beaches, are scattered along the river. The rest of the river bank consists of cliffs and steep slopes covered with rocks, boulders, and desert vegetation.**
  - -- Beaches vary greatly in size. Some are as large as several acres, and others consist of a little sand at the river's edge.
- **Some beaches are covered with vegetation.**
  - -- Beaches with vegetation provide habitat for birds and other small animals.
- **Archeological sites are located along the river.**
  - -- These sites are associated with American Indian cultures that have inhabited or used the Grand Canyon for thousands of years.
  - -- These sites contain evidence of ancient human activity along the river, including pots and tools.
- **Present-day American Indians have sacred sites and traditional-use areas along the river.**
  - -- American Indians gather materials from these sites for use in their everyday life.
- **Native fish species live in the Study Area.**
  - -- Only one of these native species is found outside the Colorado River and its tributaries.
- **Trout also live in the river.**
  - -- Trout are not native to this section of the Colorado River.
  - -- People fish for these trout in the first 15 miles of river downstream from Glen Canyon Dam.
- **Several other non-native fish species, including carp, catfish, and fathead minnows, also live in the Study Area.**
- **Only a small percentage of visitors to the Grand Canyon National Park actually see or use the resources in the Study Area.**
  - -- The only people who see the resources in the Study Area are American Indians using resources in the Study Area, river rafters, backpackers, and people who fish there.

SOME PEOPLE ARE CONCERNED ABOUT THESE RESOURCES

- **Because of erosion, the number and size of beaches along the river are decreasing.**

  -- Between 1973 and 1991, the *number* of beaches decreased from 276 to 258; many of the remaining beaches are *smaller.*

  -- The loss is most severe along the narrow sections of river.

- **27 known archeological sites have been affected by erosion. An unknown number of other sites may be affected.**

- **Resources important to American Indians are also affected by erosion.**

  -- Loss of archeological sites destroys important links to the past.

  -- Sacred sites exist in places that may be damaged by erosion.

  -- Plants, animals, and minerals used by American Indians are affected by erosion.

- **Populations of native fish in the Study Area have declined.**

  -- Eight species of native fish evolved in the Colorado River when the water was warmer than it is today.

  -- Three of the eight native fish species are no longer found in the Study Area.

  -- Two of five remaining native species, the humpback chub and razorback sucker, are in danger of becoming extinct.

  -- Cold water released from Glen Canyon Dam may be the most important factor in the decline of native fish populations.

  -- Competition from non-native fish (trout, carp, catfish, minnow species) may have contributed to the decline of native species.

- **Conditions for trout are affected by daily fluctuations in water level.**

  -- Maintenance of recreational trout fishing requires annual stocking.

  -- Trout eggs dry out and die during low-water periods.

  -- Food for trout is reduced because of exposure during low-water periods.

Scientists have learned that by changing the way water is released from the dam, primarily by reducing the size of daily fluctuations, some of the concerns about the natural resources in the Study Area could be addressed.

- Reducing fluctuations in water released from the dam could affect the following resources in the Study Area:

  -- The number and size of beaches.
  -- Conditions for native fish.
  -- Conditions for trout.
  -- The amount of vegetation available for bird and wildlife habitat.
  -- Archeological sites along the river.

Changing the way water is released from the dam <u>will not reduce</u> the total amount of electricity produced at Glen Canyon Dam.

However, there will be changes in <u>when</u> and <u>where</u> electricity is produced.

- During the day:

  -- Less electricity will be produced at Glen Canyon Dam.
  -- More electricity will be produced from power plants burning gas or oil.

- During the night:

  -- More electricity will be produced at Glen Canyon Dam.
  -- Less electricity will be produced from power plants burning coal.

- Since oil and gas are more expensive fuel sources than coal, the overall cost of meeting electrical demand will increase.

Some households receiving power from Glen Canyon Dam could see their monthly electric bill increase.

- About 4.5 million households live in states surrounding Glen Canyon Dam.

- About 1.5 million of these households receive some, or all, of their electricity from Glen Canyon Dam.

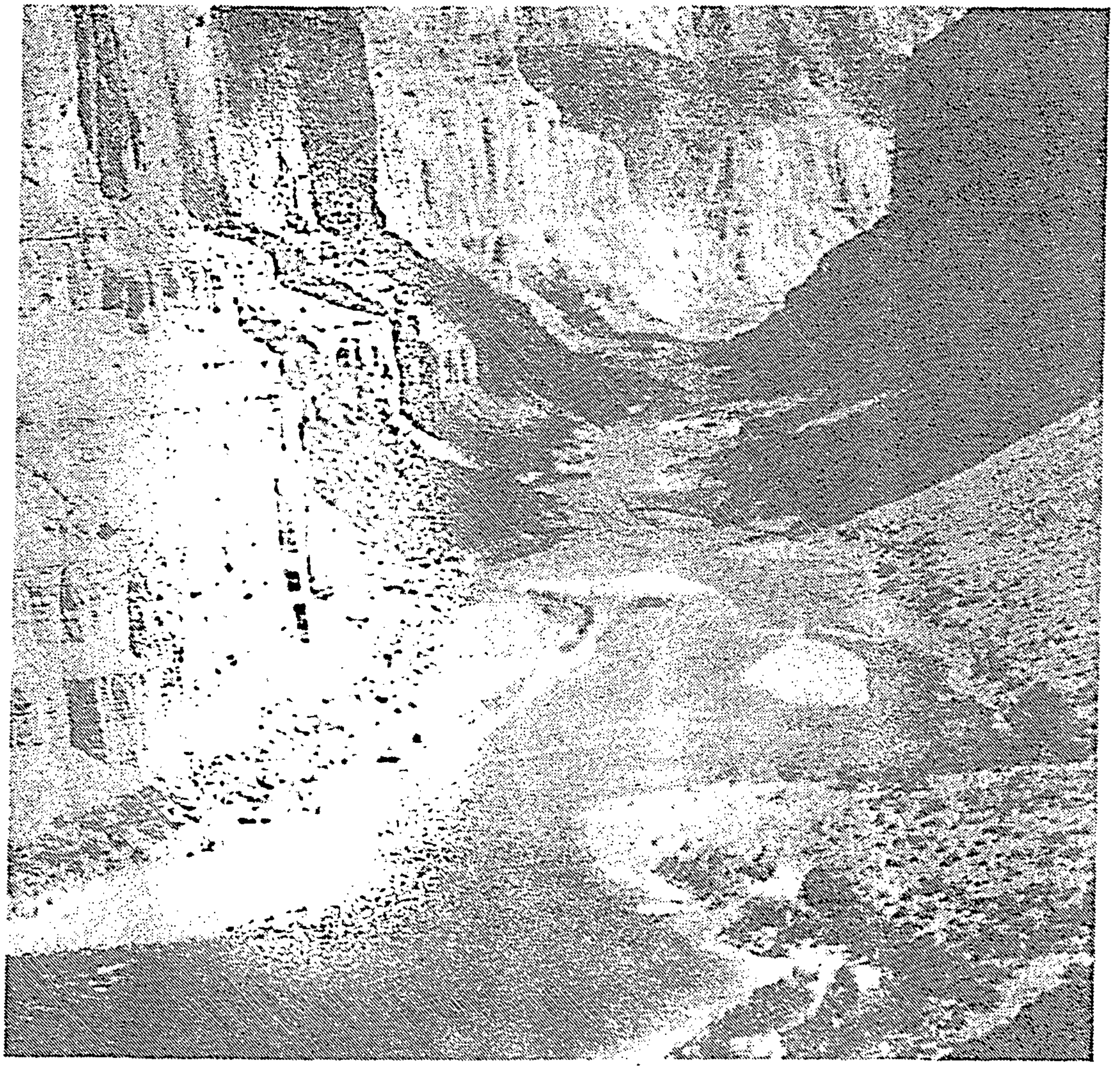
- Most of the 1.5 million households receiving power from Glen Canyon Dam are located in rural areas and smaller towns.

- The amount of increase in a household's electric bill depends on how much of their electricity comes from Glen Canyon Dam.

Some farmers using electricity to pump irrigation water will also be affected.

- Higher costs for pumping irrigation water will reduce some farmers' incomes.

GLEN CANYON SURVEY



View of the Colorado River in the Grand Canyon at Nankoweap.
Photo by Gary Ladd

Privacy Act Statement: Your participation in this survey is voluntary. There are no penalties for not answering some or all of the questions, but since you will represent many others who will not be surveyed, your cooperation is extremely important. The answers you provide are confidential. An identification number on the questionnaire is for mailing purposes only. Our results will be summarized so that the answers you provide cannot be associated with you or anyone in your household. Your name and address will not be given to any other group or used by us beyond the purposes of this study.

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, gathering and monitoring data, and completing and reviewing the form. Send comments regarding the burden estimate or any other aspect of this form to the Chief Publications and Records Management Branch, Code D-7920, Bureau of Reclamation, Denver Federal Center, PO Box 25007, Denver, CO 80225-0007; and the Office of Management and Budget, Paperwork Reduction 1006-0016, Washington, D.C. 20503.

OMB No: 1006-0016
Expiration Date: August 23, 1997

We presented a lot of material in the background information. In this section, we will ask a few questions about the background information to make sure it was clearly presented. Please feel free to refer to the information sheets when answering these questions.

1. For each statement below, please circle the letter "T" if you think the statement is true, or the letter "F" if you think the statement is false.
(CIRCLE ONE LETTER FOR EACH STATEMENT)

	TRUE	FALSE
There are now many **more** beaches along the Colorado River than there were 20 years ago.	T	F
Native fish populations in the Colorado River **have declined**.	T	F
The decrease in the number and size of beaches is most severe along **wide** sections of the river.	T	F
None of the beaches along the river have vegetation.	T	F
There are **American Indian** traditional-use areas and sacred sites located along the Colorado River below Glen Canyon Dam.	T	F
Archeological sites are **not** being affected by erosion.	T	F
Trout are **not native** to the study area.	T	F
All native fish species have disappeared from the Grand Canyon.	T	F
Nearly all visitors to the Grand Canyon National Park use the beaches along the river.	T	F

(CONTINUED)

	TRUE	FALSE
American Indian traditional-use areas **are** affected by erosion.	T	F
Water levels are **constant** throughout the day.	T	F
The Study Area consists **only** of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.	T	F
The shoreline in the study area consists **only** of beaches.	T	F
Vegetation on beaches **provides habitat** for birds and other wildlife.	T	F
Two of the native fish species are in danger of extinction.	T	F
Reducing daily fluctuations in the amount of water released from the dam will **reduce** the total amount of hydroelectricity produced.	T	F

Government Officials Are Deciding How to Operate Glen Canyon Dam in Future Years.

- Their decision on how the dam should be operated could cost you money. For example
  - Changes in operations of the dam could reduce the revenue earned by the dam -- as a result, taxpayers would have to make up the difference.
  - If you live in an area receiving power from Glen Canyon Dam, your utility bill would increase.

INSTRUCTIONS FOR NEXT QUESTION

Government officials will consider many factors when deciding whether or not to change dam operations. One factor they would like to consider is whether various proposals are personally worthwhile to people like you. In the next question, we will describe the effects of a specific proposal to change dam operations. We would like you to tell us if you would vote "YES" or "NO" on this proposal.

Some people might vote "NO" because:

- the cost of the proposal is too high.
- the effects of the proposal are not worth anything (not even 10¢) to them.
- they just can't afford the cost.

Some people might vote "YES" because:

- the cost of the proposal is low enough.
- the effects of the proposal are worth what it would cost them.

At this point in time, it is not certain what the cost would be to any specific individual, so we are asking different people about different amounts. Even if the amount we ask you about seems very low or very high, please answer carefully. This will allow us to determine whether people think the proposal is worthwhile at whatever level the final cost is determined to be. For this study, it is important that you tell us how you would vote, based only on **your personal evaluation** of whether changes in dam operations and their effects, are worth the additional cost **to you**.

Version 1: Moderate Fluctuating Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites, and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish.
- Native fish populations, including those in danger of extinction, would probably continue to decline in numbers.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to maintain the population.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households and a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

   1 No---------->*SKIP TO QUESTION 8*
   2 Yes
   3 I would choose not to vote on this proposal---------->*SKIP TO QUESTION 8*

Version 2: Low Fluctuating Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish.
- It is likely, but not certain, that native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households to a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

   1 No---------->*SKIP TO QUESTION 8*
   2 **Yes**
   3 **I would choose not to vote on this proposal**---------->*SKIP TO QUESTION 8*

Version 3: Seasonally Adjusted Steady Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- The average electric bill would increase by $9 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $21 per month for 3,600 households to a minimum of no increase for 300,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 6%.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

   1 **No**---------->*SKIP TO QUESTION 8*
   2 **Yes**
   3 **I would choose not to vote on this proposal**--------->*SKIP TO QUESTION 8*

Version 4: Seasonally Adjusted Steady Flow with Moderate Fluctuating Flow Price Impacts Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American-traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households to a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

    1 **No**---------->*SKIP TO QUESTION 8*
    2 **Yes**
    3 **I would choose not to vote on this proposal**---------->*SKIP TO QUESTION 8*

The higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal. Taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. Would you vote for this proposal if passage of the proposal would cost your household $ in increased taxes **every year** for the foreseeable future? *(CIRCLE ONE NUMBER)*

   1 **Definitely No - I would definitely vote against the proposal.**
   2 **Probably No - I would probably vote against the proposal.**
   3 **Not Sure - I am not sure if I would vote for the proposal.**
   4 **Probably Yes - I would probably vote for the proposal.**
   5 **Definitely Yes - I would definitely vote for the proposal.**

4. If this proposal passes and you had to pay $ **every year** for the foreseeable future, on what sorts of things would you spend less money in order to pay for the cost of this proposal? *(FILL IN THE BLANK)*

   ____
   ____
   ____

5. Now that you have had an additional chance to think about what you would have to give up if the proposal passes, would you like to change your vote? *(CIRCLE ONE NUMBER)*

   1 **No**------------->*SKIP TO QUESTION 7*
   2 **Yes**

6. Now how would you vote on the proposal? *(CIRCLE ONE NUMBER)*

   1 **Definitely No - I would definitely vote against the proposal.**
   2 **Probably No - I would probably vote against the proposal.**
   3 **Not Sure - I am not sure if I would vote for the proposal.**
   4 **Probably Yes - I would probably vote for the proposal.**
   5 **Definitely Yes - I would definitely vote for the proposal.**

7. Do you believe your taxes will increase if this proposal passes?
(CIRCLE ONE NUMBER)

1 No
2 Yes

8. Do you think public officials will consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future?
(CIRCLE ONE NUMBER)

1 No
2 Yes

9. Do you think public officials <u>should</u> consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future?
(CIRCLE ONE NUMBER)

1 No
2 Yes

10. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

1 No
2 Yes

11. <u>Before</u> receiving this survey had you heard of Glen Canyon Dam?
(CIRCLE ONE NUMBER)

1 No
2 Yes------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*

____

____

____

____

12. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please indicate how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
When humans interfere with nature, it often produces disastrous consequences.	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5
Humans were meant to rule the rest of nature.	1	2	3	4	5
Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
Human ingenuity will ensure that we do not make the earth unlivable.	1	2	3	4	5
Humans are severely abusing the environment.	1	2	3	4	5
The so-called ecological crisis facing humankind has been greatly exaggerated.	1	2	3	4	5
We are approaching the limit of the number of people the earth can support.	1	2	3	4	5
The earth is like a spaceship with very limited room and resources.	1	2	3	4	5
The earth has plenty of natural resources, if we just learn how to develop them.	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5

13. The following statements discuss economic and environmental issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
Economic security and well-being should be considered first; then we can worry about environmental problems.	1	2	3	4	5
It is possible to protect our environment and natural resources and still maintain a healthy economy.	1	2	3	4	5
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market.	1	2	3	4	5
Some pollution is inevitable if we are going to continue to improve our standard of living.	1	2	3	4	5
I would be willing to pay somewhat higher prices (5 to 10 percent higher) for products that would cause less pollution or environmental damage.	1	2	3	4	5
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds	1	2	3	4	5
Some land in the United States should be set aside from human use so it can remain completely untouched, regardless of its economic value.	1	2	3	4	5

14. The following statements discuss American Indian issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
It is our responsibility to protect those areas of historical or religious importance to American Indians.	1	2	3	4	5
We have gone too far in granting American Indians special rights to use public lands and resources, such as fish and wildlife.	1	2	3	4	5
Our society can learn important lessons from studying earlier cultures that inhabited our country.	1	2	3	4	5
We can't afford to let concern for preserving artifacts of earlier American Indian cultures stand in the way of operating hydroelectric dams.	1	2	3	4	5
American Indian concerns should be equally as important as our society's economic needs when deciding how to use land.	1	2	3	4	5

15. The following statements discuss hydroelectricity. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
The benefits of hydroelectric dams on the Colorado River outweigh the impacts to the natural environment and historical places along the river.	1	2	3	4	5
Hydroelectric dams should not be constructed on rivers that flow through national parks.	1	2	3	4	5
Hydroelectric dams have fewer environmental impacts than coal, oil, or gas-burning power plants.	1	2	3	4	5
Hydroelectric dams can have serious impacts on the plants and animals that live in or along the river.	1	2	3	4	5
Hydroelectric dams produce relatively cheap electricity compared to other sources.	1	2	3	4	5
Hydroelectric dams should be developed wherever it is economically feasible, even if it means that some rivers will be changed.	1	2	3	4	5
Rivers without dams are a unique and irreplaceable resource that should be protected from hydroelectric dams.	1	2	3	4	5

In this section, we would like to learn how you feel about national parks in the United States.

16. Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

    1 No
    2 Yes
    3 Don't know

17. We are interested in learning how you feel about national parks in general. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below.
    (CIRCLE ONE NUMBER FOR EACH STATEMENT)

	STRONGLY AGREE				STRONGLY DISAGREE
National parks are a "luxury" we cannot afford in difficult economic times.	1	2	3	4	5
National parks help us to remember that our future is tied to the preservation of nature and natural resources.	1	2	3	4	5
It is important that national parks offer us a chance to see America as the early settlers saw it.	1	2	3	4	5
Americans need places like national parks to "recharge their batteries."	1	2	3	4	5
An important function of the National Park Service is to protect native birds, plants, and animals.	1	2	3	4	5

(CONTINUED)

	STRONGLY AGREE				STRONGLY DISAGREE
National parks are only valuable to the people who visit them.	1	2	3	4	5
Oil and natural gas finds on national park lands should be developed since it is in the national interest.	1	2	3	4	5
The National Park Service places too much emphasis on preservation.	1	2	3	4	5
I am glad there are national parks, even if I don't visit them.	1	2	3	4	5
People can think a place is valuable, even if they do not actually go there themselves.	1	2	3	4	5
The American people should provide greater financial support for the National Park Service to avoid more commercial activities in the national parks.	1	2	3	4	5
If the National Park Service needs more financial support, they should develop more gift shops and commercial activities to raise money.	1	2	3	4	5

In this section, we are interested in learning about trips you may have taken to Grand Canyon National Park.

18. As best you can recall, have you ever flown over Grand Canyon National Park in an aircraft? *(CIRCLE ONE NUMBER)*

    1 **No**------------->*SKIP TO QUESTION 20*
    2 **Yes**

19. Did you fly over Grand Canyon National Park while you were on a commercial airliner, or did you fly over the park as part of a sightseeing air tour that included the park? *(CIRCLE ALL NUMBERS THAT APPLY)*

    1 **I flew over Grand Canyon National Park while on a commercial aircraft**
    2 **I flew over Grand Canyon National Park as part of a sightseeing air tour**
    3 **Other** (please describe: ______________________________)

20. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 **No**------------->*SKIP TO QUESTION 23*
    2 **Yes**

21. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 **No**------------->*SKIP TO QUESTION 23*
    2 **Yes**

22. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 **No**
    2 **Yes**

23. How likely do you think it is that you will visit the Grand Canyon National Park in the future? *(CIRCLE ONE NUMBER)*

    1 **Not at all likely**
    2 **Somewhat unlikely**
    3 **Somewhat likely**
    4 **Very likely**

In this last section, we would like to ask you some questions about your background that will help us compare your answers with those of other people. We stress that all of your responses are strictly confidential.

24. Are you: *(CIRCLE ONE NUMBER)*

    1 Male
    2 Female

25. How old are you? *(FILL IN THE BLANK)*

    ________ **Years old**

26. How many years of schooling have you completed? *(CIRCLE ONE NUMBER)*

    1 Eight years or less
    2 Some high school
    3 High school graduate
    4 Some college or technical school
    5 College or technical school graduate
    6 Post graduate work

27. How many people live in your household? *(FILL IN ALL BLANKS)*

    NUMBER

____ **People 18 years old or older**

____ **People under the age of 18**

____ **Total number of people in the household**

28. Did you or any members in your household have any taxes withheld from a paycheck or other earnings in 1993? *(CIRCLE ONE NUMBER)*

    1 No
    2 Yes

29. Did you or any members of your household file a Federal income tax form for 1993?
(CIRCLE ONE NUMBER)

1 **No**
2 **Yes**

30. Which of the following categories comes closest to your total 1993 household income?
(CIRCLE ONE NUMBER)

1 **Less than $10,000**
2 **$10,000 to $14,999**
3 **$15,000 to $19,999**
4 **$20,000 to $24,999**
5 **$25,000 to $29,999**
6 **$30,000 to $34,999**
7 **$35,000 to $39,999**
8 **$40,000 to $44,999**
9 **$45,000 to $49,999**
10 **$50,000 to $59,999**
11 **$60,000 to $69,999**
12 **$70,000 to $79,999**
13 **$80,000 to $89,999**
14 **$90,000 to $99,999**
15 **Over $100,000**

THANK YOU FOR YOUR HELP!

Comments:

Please feel free to keep the colored background information materials

Please return only this survey booklet in the enclosed, postage-paid envelope to:

Glen Canyon Studies
c/o HBRS, Inc.
University Research Park
455 Science Drive
Madison, WI 53711

Hello,

A few days ago your household received a questionnaire about the tradeoffs between production of electricity at Glen Canyon Dam and the natural and cultural resources along the Colorado River in the Grand Canyon. If the survey has been completed and returned, please consider this a "thank you." Otherwise, I hope you will be able to fill it out and return it soon.

Your household's responses to this survey are very important. We can only survey a small number of households, so your responses will represent many other households like yours, who are not able to participate in this study.

Thank you for you participation.

Sincerely,

David L. Wegner

David Wegner
Glen Canyon Studies Manager

Glen Canyon Studies c/o HBRS. Inc. 455 Science Drive Madison, WI 53711

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings!

About two weeks ago, we sent a questionnaire to your household. The survey asked about your opinions on how the Glen Canyon Dam on the Colorado River should be operated. Hearing from your household is very important. If you have already completed and returned the questionnaire, please accept our sincere thanks. If you have not done so, we would still very much like to hear from your household.

Even if you have never heard about Glen Canyon Dam prior to receiving this survey, your opinions are very important for this study. You don't need to have any special knowledge about hydroelectricity, dam operations, or environmental issues to fill out the survey. The background information sheets enclosed with the survey were prepared to help people understand the relation between the operation of the dam and downstream cultural and natural resources.

Government officials will soon be making decisions about how to operate the dam. Your participation in the study will help them understand how people in households like yours feel about trade-offs between cultural and natural resources, such as fish, vegetation, and beaches, at the bottom of the Grand Canyon and the production of electricity from Glen Canyon Dam. Answers to this survey will affect future decisions about how the dam is operated.

We could not send this survey to every household in the nation. Your household is part of a relatively small group of households who have been randomly selected to participate in this survey. Your answers will represent the views of many other households similar to yours and will ensure that the opinions of all households are represented in decisions about the operation of the Glen Canyon Dam. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Your responses are confidential, and your name will **not** be revealed. Information from the surveys will only be reported in statistical terms, such as "10 percent of all respondents have seen the Colorado River in Grand Canyon National Park."

I have enclosed another copy of the survey in case the first one was lost or misplaced. There is an identification number on the back of the survey so that HBRS, Inc., the firm conducting the survey, will know who has already returned the survey and who to send reminders to.

When the survey is completed, simply return it in the enclosed postage-paid envelope. We hope that you find the survey interesting and enjoyable to fill out. If you have any questions or concerns about this survey or the study, please feel free to call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

I appreciate your help in this study.

Sincerely,

David L. Wegner

David L. Wegner
Glen Canyon Studies Manager

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings!

I am sorry if this certified letter has caused you any inconvenience. This survey is very important and I wanted to make sure it reached your household.

About three weeks ago, I sent a survey concerning the operations of Glen Canyon Dam. Even if you don't live near Glen Canyon Dam or the Grand Canyon, it is still important to hear from you, even if it is only to tell us that you simply don't care how Glen Canyon Dam is operated. Some people have told us that they felt they did not know enough to answer the questionnaire. The background information sheets enclosed with the survey were prepared to help people understand the relation between the operation of the dam and downstream cultural and natural resources. This background information will enable you to participate in this study even if you don't feel that you know very much about the Glen Canyon Dam.

Government officials will soon be making decisions about how the dam is operated. In making these decisions, they would like to know more about how individuals like you feel about the issues that are discussed in the questionnaire. Your household was chosen at random to participate in this study. Since we can't send surveys to every household, your response will represent the opinions of households similar to yours that were not selected to participate in the study. We need to hear from everyone to make sure that we have a representative sample of opinions about this issue.

I am enclosing another copy of the questionnaire and a stamped self-addressed envelope in case you have misplaced the previous ones. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Thank you for your help in this study. Your cooperation in completing this questionnaire will help to make this a successful project.

Sincerely,

David L. Wegner

David L. Wegner
Glen Canyon Studies Manager

P.S. If for some reason, you can't complete the questionnaire, please write a note on the questionnaire booklet and mail it back. It is better for us to hear something from you than nothing at all. Or if you prefer, you can call HBRS collect at 608-232-2800. Ask for Mike Welsh, the Glen Canyon Studies project manager.

Mail Survey Materials -- Marketing Area Sample

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings,

I am writing to ask you to share your views about an important issue affecting the Colorado River in Grand Canyon National Park. In the next several weeks, you will receive a survey in the mail. The survey is part of a national study of issues concerning the operation of Glen Canyon Dam. Glen Canyon Dam controls the water level in the Colorado River in the bottom of the Grand Canyon and affects the resources in and along the river. The study is a cooperative effort between the Bureau of Reclamation, National Park Service, U.S. Fish and Wildlife Service, Western Area Power Administration, and several Southwest American Indian tribes.

Government officials will soon be making decisions about how the dam is to be operated. The decisions will affect both the river environment at the bottom of the Canyon and the production of electricity. The way that the dam is operated affects the water level in the Colorado River which in turn affects natural and cultural resources in and along the river. The way the dam is operated also determines the value of the electricity produced by the dam. The decision makers need to know how people in households like yours feel about the tradeoffs between natural and cultural resources, such as fish, vegetation, and beaches at the bottom of the Grand Canyon, and the production of electricity from Glen Canyon Dam.

Even if you have never heard of the Glen Canyon Dam, your answers are important to this study. We cannot send this survey to every household in the country. Instead, a random sample of households was drawn. Your household was scientifically selected to receive this survey. In this study, your household represents many other households similar to yours. What U.S. households think about these issues is important for making future decisions on how to operate the Glen Canyon Dam.

The survey will arrive in the next week or so. HBRS, Inc., an independent research firm, has been hired to design and carry out the study. The survey will take about 30 minutes to complete. To ensure a random selection of respondents, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year. The survey package will provide information about Glen Canyon Dam and the natural and cultural resources downstream. You will only be asked to give your opinions and responses to questions about how <u>you</u> feel. The survey does not require any technical knowledge of hydroelectricity or dam operations. A stamped enveloped will be supplied to return the survey to HBRS. If you have any questions about the study, you can call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

We are very interested in hearing from your household so that we get an accurate picture of the range of opinions about the issues related to Glen Canyon Dam and the downstream resources. I hope you will help us out. Thank you, in advance, for your participation.

Thank you,

David L. Wegner

David L. Wegner
Glen Canyon Studies Project Manager

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings,

Here is the survey I told you about in my letter last week. This study is about the Glen Canyon Dam, which controls the water level in the Colorado River as it flows through Grand Canyon National Park. Government officials will soon be making decisions about how to operate the dam. Your participation in the study will help them understand how people in households like yours feel about trade-offs between cultural and natural resources, such as fish, vegetation, and beaches, at the bottom of the Grand Canyon and the production of electricity from Glen Canyon Dam. Answers to this survey will affect future decisions about how the dam is operated.

Your response to this survey is very important. We could not send this survey to every household in the nation. Your household is part of a relatively small group of households who have been randomly selected to participate in this survey. Your answers will represent the views of many other households similar to yours and will ensure that all households are represented in decisions about the operation of the Glen Canyon Dam. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Before beginning the survey, please read the colored information sheets included in the package. This background information describes Glen Canyon Dam, the resources below the dam, and how the operation of the dam affects these resources. I realize you may not have heard about Glen Canyon Dam before you received this survey. The background information was designed by scientists studying the dam and the Grand Canyon resources downstream to help you understand the issues. The survey does not require any technical knowledge about hydroelectricity or dam operations. The survey takes about 30 minutes to complete. People who have filled the survey out tell us they found it interesting and informative

Answers to this survey are confidential; your name will never be revealed. Information from the survey will only be reported in statistical terms. There is an identification number on the back of the survey so that HBRS, Inc., the firm conducting the survey, will know who has already returned the survey and whom to send reminders to.

When the survey is completed, simply return it in the enclosed postage-paid envelope. If you have any questions about the study, we would like to hear from you. You can call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

I appreciate your help in this study. I know your time is valuable and, in recognition, have enclosed a small gift as a token of appreciation. In addition, if you would like to receive a newsletter providing more information about the Glen Canyon Dam and this study, write to the Glen Canyon Studies Office at P.O. Box 22459, Flagstaff, AZ 86002-2459.

Thank you,

David L. Wegner

David L. Wegner
Glen Canyon Studies Project Manager

Remember -- This survey is to be filled out by the adult in your household with the <u>latest</u> birthday in the calendar year.

BACKGROUND INFORMATION ABOUT THIS STUDY
PLEASE READ THESE PAGES BEFORE YOU COMPLETE THE SURVEY

INFORMATION ABOUT GLEN CANYON DAM AND THE STUDY AREA

Before you fill out the survey, we want to describe the Glen Canyon Dam and the resources downstream from Glen Canyon Dam in the Study Area.

Glen Canyon Dam

- Glen Canyon Dam is located on the Colorado River in Arizona.
  - It is just upstream from the Grand Canyon.
  - It was built to provide water supplies and hydroelectricity.
  - It was completed about 30 years ago.
  - It controls the water flow through the Grand Canyon.
  - Revenues from the sale of hydroelectricity are used to repay costs.

The Study Area

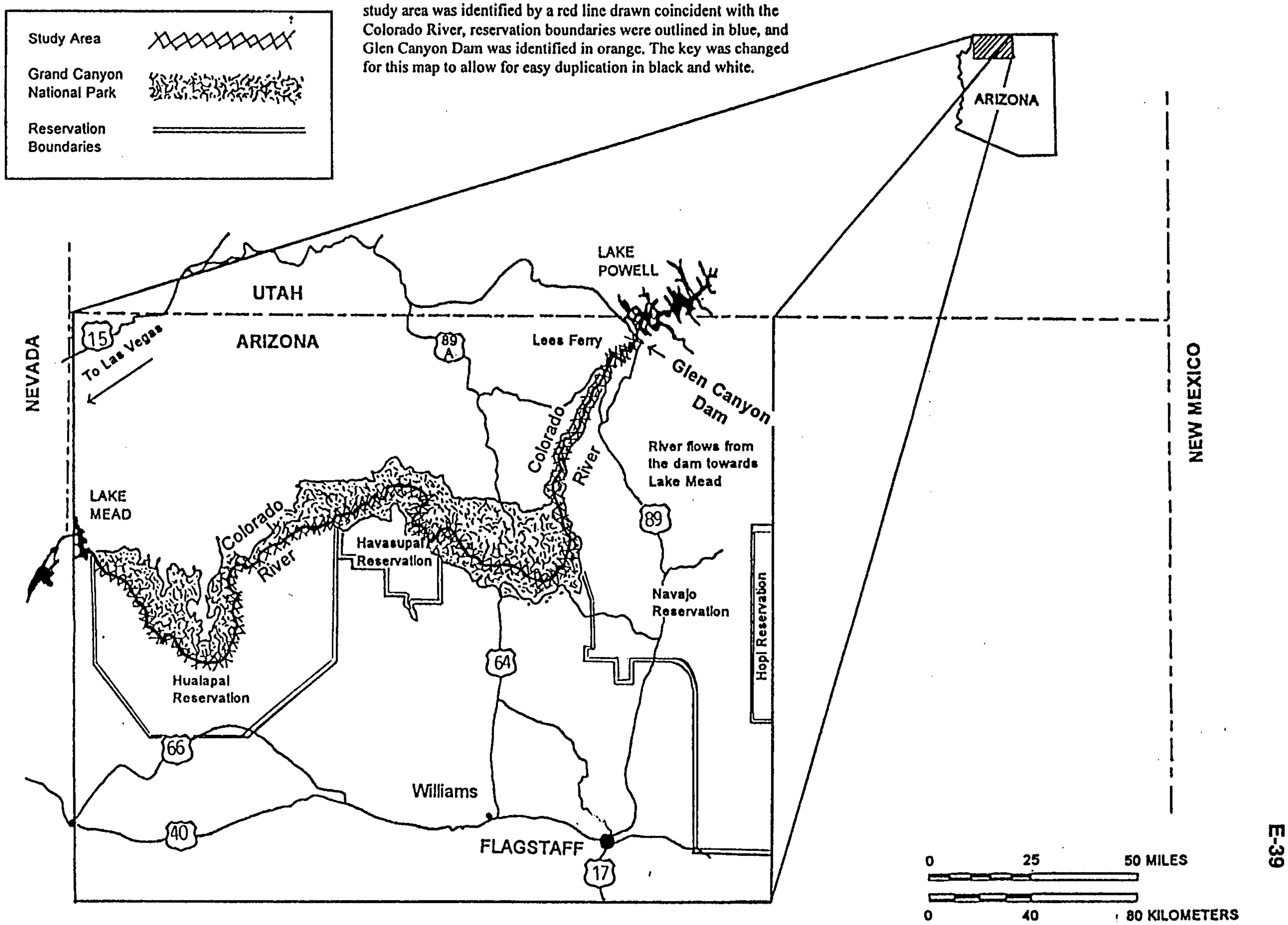
- The Study Area consists only of the area in and along the Colorado River at the bottom of the Grand Canyon.
- The Study Area begins at Glen Canyon Dam.
- The Study Area continues for nearly 300 miles.
- The Study Area ends at Lake Mead near Las Vegas.
- Part of the Study Area is within the Grand Canyon National Park.
- Part of the Study Area is bordered by American Indian reservations.
- The cover of the survey booklet shows one view of the Colorado River in the Study Area.

How Glen Canyon Dam affects the Colorado River in the Study Area

- The amount of electricity produced by Glen Canyon Dam depends on the amount of water released from the dam: the more water released, the more electricity produced.
- More water is released during periods of high demand for electricity and less water is released during periods of low demand for electricity.
  - On a seasonal basis, more water is released during the hottest summer months and the coldest winter months.
  - On a daily basis, more water is released during the day than at night.
  - The amount of water released can vary from hour to hour throughout the day.
- In some places in the Grand Canyon, this can result in the river rising and falling as much as ten feet in a day.

This study deals with the ways Glen Canyon Dam could be operated to benefit natural and cultural resources in the Study Area. A map showing the location of the Dam and the Study Area appears on the next page. A description of the resources in the Study Area is contained on the pages following the map.

NOTE: The map included with the surveys was color-coded. The study area was identified by a red line drawn coincident with the Colorado River, reservation boundaries were outlined in blue, and Glen Canyon Dam was identified in orange. The key was changed for this map to allow for easy duplication in black and white.



NATURAL RESOURCES IN THE STUDY AREA

The natural resources in the Study Area are located in and along the Colorado River below Glen Canyon Dam.

- **Deposits of sand, mud, and gravel, sometimes called beaches, are scattered along the river. The rest of the river bank consists of cliffs and steep slopes covered with rocks, boulders, and desert vegetation.**
  - -- Beaches vary greatly in size. Some are as large as several acres, and others consist of a little sand at the river's edge.
- **Some beaches are covered with vegetation.**
  - -- Beaches with vegetation provide habitat for birds and other small animals.
- **Archeological sites are located along the river.**
  - -- These sites are associated with American Indian cultures that have inhabited or used the Grand Canyon for thousands of years.
  - -- These sites contain evidence of ancient human activity along the river, including pots and tools.
- **Present-day American Indians have sacred sites and traditional-use areas along the river.**
  - -- American Indians gather materials from these sites for use in their everyday life.
- **Native fish species live in the Study Area.**
  - -- Only one of these native species is found outside the Colorado River and its tributaries.
- **Trout also live in the river.**
  - -- Trout are not native to this section of the Colorado River.
  - -- People fish for these trout in the first 15 miles of river downstream from Glen Canyon Dam.
- **Several other non-native fish species, including carp, catfish, and fathead minnows, also live in the Study Area.**
- **Only a small percentage of visitors to the Grand Canyon National Park actually see or use the resources in the Study Area.**
  - -- The only people who see the resources in the Study Area are American Indians using resources in the Study Area, river rafters, backpackers, and people who fish there.

SOME PEOPLE ARE CONCERNED ABOUT THESE RESOURCES

- **Because of erosion, the number and size of beaches along the river are decreasing.**
  - Between 1973 and 1991, the *number* of beaches decreased from 276 to 258; many of the remaining beaches are *smaller.*
  - The loss is most severe along the narrow sections of river.
- **27 known archeological sites have been affected by erosion. An unknown number of other sites may be affected.**
- **Resources important to American Indians are also affected by erosion.**
  - Loss of archeological sites destroys important links to the past.
  - Sacred sites exist in places that may be damaged by erosion.
  - Plants, animals, and minerals used by American Indians are affected by erosion.
- **Populations of native fish in the Study Area have declined.**
  - Eight species of native fish evolved in the Colorado River when the water was warmer than it is today.
  - Three of the eight native fish species are no longer found in the Study Area.
  - Two of five remaining native species, the humpback chub and razorback sucker, are in danger of becoming extinct.
  - Cold water released from Glen Canyon Dam may be the most important factor in the decline of native fish populations.
  - Competition from non-native fish (trout, carp, catfish, minnow species) may have contributed to the decline of native species.
- **Conditions for trout are affected by daily fluctuations in water level.**
  - Maintenance of recreational trout fishing requires annual stocking.
  - Trout eggs dry out and die during low-water periods.
  - Food for trout is reduced because of exposure during low-water periods.

Scientists have learned that by changing the way water is released from the dam, primarily by reducing the size of daily fluctuations, some of the concerns about the natural resources in the Study Area could be addressed.

- Reducing fluctuations in water released from the dam could affect the following resources in the Study Area:

  -- The number and size of beaches.
  -- Conditions for native fish.
  -- Conditions for trout.
  -- The amount of vegetation available for bird and wildlife habitat.
  -- Archeological sites along the river.

Changing the way water is released from the dam <u>will not reduce</u> the total amount of electricity produced at Glen Canyon Dam.

However, there will be changes in <u>when</u> and <u>where</u> electricity is produced.

- During the day:

  -- Less electricity will be produced at Glen Canyon Dam.
  -- More electricity will be produced from power plants burning gas or oil.

- During the night:

  -- More electricity will be produced at Glen Canyon Dam.
  -- Less electricity will be produced from power plants burning coal.

- Since oil and gas are more expensive fuel sources than coal, the overall cost of meeting electrical demand in your area will increase.

GLEN CANYON SURVEY

View of the Colorado River in the Grand Canyon at Nankoweap.
Photo by Gary Ladd

Privacy Act Statement: Your participation in this survey is voluntary. There are no penalties for not answering some or all of the questions, but since you will represent many others who will not be surveyed, your cooperation is extremely important. The answers you provide are confidential. An identification number on the questionnaire is for mailing purposes only. Our results will be summarized so that the answers you provide cannot be associated with you or anyone in your household. Your name and address will not be given to any other group or used by us beyond the purposes of this study.

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, gathering and monitoring data, and completing and reviewing the form. Send comments regarding the burden estimate or any other aspect of this form to the Chief Publications and Records Management Branch, Code D-7920, Bureau of Reclamation, Denver Federal Center, PO Box 25007, Denver, CO 80225-0007; and the Office of Management and Budget, Paperwork Reduction 1006-0016, Washington, D.C. 20503.

OMB No: 1006-0016
Expiration Date: August 23, 1997

We presented a lot of material in the background information. In this section, we will ask a few questions about the background information to make sure it was clearly presented. Please feel free to refer to the information sheets when answering these questions.

1. For each statement below, please circle the letter "T" if you think the statement is true, or the letter "F" if you think the statement is false.
(CIRCLE ONE LETTER FOR EACH STATEMENT)

	TRUE	**FALSE**
There are now many **more** beaches along the Colorado River than there were 20 years ago.	T	F
Native fish populations in the Colorado River **have declined**.	T	F
The decrease in the number and size of beaches is most severe along **wide** sections of the river.	T	F
None of the beaches along the river have vegetation.	T	F
There are **American Indian** traditional-use areas and sacred sites located along the Colorado River below Glen Canyon Dam.	T	F
Archeological sites are **not** being affected by erosion.	T	F
Trout are **not native** to the study area.	T	F
All native fish species have disappeared from the Grand Canyon.	T	F
Nearly all visitors to the Grand Canyon National Park use the beaches along the river.	T	F

(CONTINUED)

	TRUE	FALSE
American Indian traditional-use areas **are** affected by erosion.	T	F
Water levels are **constant** throughout the day.	T	F
The Study Area consists **only** of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.	T	F
The shoreline in the study area consists **only** of beaches.	T	F
Vegetation on beaches **provides habitat** for birds and other wildlife.	T	F
Two of the native fish species are in danger of extinction.	T	F
Reducing daily fluctuations in the amount of water released from the dam will **reduce** the total amount of hydroelectricity produced.	T	F

Government Officials Are Deciding How to Operate Glen Canyon Dam in Future Years.

- Their decision on how the dam should be operated could cost you money.
- Since you live in an area receiving power from Glen Canyon Dam, if operations are changed, your utility bill will increase.

INSTRUCTIONS FOR NEXT QUESTION

Government officials will consider many factors when deciding whether or not to change dam operations. One factor they would like to consider is whether various proposals are personally worthwhile to people like you. In the next question, we will describe the effects of a specific proposal to change dam operations. We would like you to tell us if you would vote "YES" or "NO" on this proposal.

Some people might vote "NO" because:

- the cost of the proposal is too high.
- the effects of the proposal are not worth anything (not even 10¢) to them.
- they just can't afford the cost.

Some people might vote "YES" because:

- the cost of the proposal is low enough.
- the effects of the proposal are worth what it would cost them.

At this point in time, it is not certain how much utility bills would increase in your area if the operation of Glen Canyon Dam is changed so we are asking different people about different amounts. Even if the amount we ask you about seems very low or very high, please answer carefully. This will allow us to determine whether people think the proposal is worthwhile at whatever level the final cost is determined to be. For this study, it is important that you tell us how you would vote, based only on **your personal evaluation** of whether changes in dam operations and their effects, are worth the additional cost **to you**.

Version 5: Moderate Fluctuating Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish.
- Native fish populations, including those in danger of extinction, would probably continue to decline in numbers.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to maintain the population.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

   1 No---------->*SKIP TO QUESTION 8*
   2 Yes
   3 **I would choose not to vote on this proposal**---------->*SKIP TO QUESTION 8*

Version 6: Low Fluctuating Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish.
- It is likely, but not certain, that native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

   1 No---------->*SKIP TO QUESTION 8*
   2 Yes
   3 I would choose not to vote on this proposal---------->*SKIP TO QUESTION 8*

Version 7: Seasonally Adjusted Steady Flow Alternative -- Survey Page 5

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

    1 No---------->*SKIP TO QUESTION 8*
    2 Yes
    3 **I would choose not to vote on this proposal**---------->*SKIP TO QUESTION 8*

How would you vote on this proposal if passage meant your utility bill would increase? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. Would you vote for this proposal if passage meant your utility bill would increase by $ **every year** (that would be about $ per month) for the foreseeable future? *(CIRCLE ONE NUMBER)*

1	**Definitely No**	-	**I would definitely vote against the proposal.**
2	**Probably No**	-	**I would probably vote against the proposal.**
3	**Not Sure**	-	**I am not sure if I would vote for the proposal.**
4	**Probably Yes**	-	**I would probably vote for the proposal.**
5	**Definitely Yes**	-	**I would definitely vote for the proposal.**

4. If this proposal passes and you had to pay $ **every year** for the foreseeable future, on what sorts of things would you spend less money in order to pay for the cost of this proposal? *(FILL IN THE BLANK)*

____

____

____

5. Now that you have had an additional chance to think about what you would have to give up if the proposal passes, would you like to change your vote? *(CIRCLE ONE NUMBER)*

1 **No**------------->*SKIP TO QUESTION 7*
2 **Yes**

6. Now how would you vote on the proposal? *(CIRCLE ONE NUMBER)*

1	**Definitely No**	-	**I would definitely vote against the proposal.**
2	**Probably No**	-	**I would probably vote against the proposal.**
3	**Not Sure**	-	**I am not sure if I would vote for the proposal.**
4	**Probably Yes**	-	**I would probably vote for the proposal.**
5	**Definitely Yes**	-	**I would definitely vote for the proposal.**

7. Do you believe your utility bill will increase if this proposal passes?
(CIRCLE ONE NUMBER)

1 No
2 Yes

8. Do you think public officials will consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future?
(CIRCLE ONE NUMBER)

1 No
2 Yes

9. Do you think public officials <u>should</u> consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future?
(CIRCLE ONE NUMBER)

1 No
2 Yes

10. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

1 No
2 Yes

11. <u>Before</u> receiving this survey had you heard of Glen Canyon Dam?
(CIRCLE ONE NUMBER)

1 No
2 Yes------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*

____
____
____
____

12. People often have different views about environmental issues. On a scale of 1 to 5, with 1

being strongly agree and 5 being strongly disagree, please indicate how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
When humans interfere with nature, it often produces disastrous consequences.	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5
Humans were meant to rule the rest of nature.	1	2	3	4	5
Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
Human ingenuity will ensure that we do not make the earth unlivable.	1	2	3	4	5
Humans are severely abusing the environment.	1	2	3	4	5
The so-called ecological crisis facing humankind has been greatly exaggerated.	1	2	3	4	5
We are approaching the limit of the number of people the earth can support.	1	2	3	4	5
The earth is like a spaceship with very limited room and resources.	1	2	3	4	5
The earth has plenty of natural resources, if we just learn how to develop them.	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5

13. The following statements discuss economic and environmental issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
Economic security and well-being should be considered first; then we can worry about environmental problems.	1	2	3	4	5
It is possible to protect our environment and natural resources and still maintain a healthy economy.	1	2	3	4	5
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market.	1	2	3	4	5
Some pollution is inevitable if we are going to continue to improve our standard of living.	1	2	3	4	5
I would be willing to pay somewhat higher prices (5 to 10 percent higher) for products that would cause less pollution or environmental damage.	1	2	3	4	5
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	1	2	3	4	5
Some land in the United States should be set aside from human use so it can remain completely untouched, regardless of its economic value.	1	2	3	4	5

14. The following statements discuss American Indian issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
It is our responsibility to protect those areas of historical or religious importance to American Indians.	1	2	3	4	5
We have gone too far in granting American Indians special rights to use public lands and resources, such as fish and wildlife.	1	2	3	4	5
Our society can learn important lessons from studying earlier cultures that inhabited our country.	1	2	3	4	5
We can't afford to let concern for preserving artifacts of earlier American Indian cultures stand in the way of operating hydroelectric dams.	1	2	3	4	5
American Indian concerns should be equally as important as our society's economic needs when deciding how to use land.	1	2	3	4	5

15. The following statements discuss hydroelectricity. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE
The benefits of hydroelectric dams on the Colorado River outweigh the impacts to the natural environment and historical places along the river.	1	2	3	4	5
Hydroelectric dams should not be constructed on rivers that flow through national parks.	1	2	3	4	5
Hydroelectric dams have fewer environmental impacts than coal, oil, or gas-burning power plants.	1	2	3	4	5
Hydroelectric dams can have serious impacts on the plants and animals that live in or along the river.	1	2	3	4	5
Hydroelectric dams produce relatively cheap electricity compared to other sources.	1	2	3	4	5
Hydroelectric dams should be developed wherever it is economically feasible, even if it means that some rivers will be changed.	1	2	3	4	5
Rivers without dams are a unique and irreplaceable resource that should be protected from hydroelectric dams.	1	2	3	4	5

In this section, we would like to learn how you feel about national parks in the United States.

16. Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

    1 No
    2 Yes
    3 Don't know

17. We are interested in learning how you feel about national parks in general. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below.
    (CIRCLE ONE NUMBER FOR EACH STATEMENT)

	STRONGLY AGREE				STRONGLY DISAGREE
National parks are a "luxury" we cannot afford in difficult economic times.	1	2	3	4	5
National parks help us to remember that our future is tied to the preservation of nature and natural resources.	1	2	3	4	5
It is important that national parks offer us a chance to see America as the early settlers saw it.	1	2	3	4	5
Americans need places like national parks to "recharge their batteries."	1	2	3	4	5
An important function of the National Park Service is to protect native birds, plants, and animals.	1	2	3	4	5

(CONTINUED)

	STRONGLY AGREE				STRONGLY DISAGREE
National parks are only valuable to the people who visit them.	1	2	3	4	5
Oil and natural gas finds on national park lands should be developed since it is in the national interest.	1	2	3	4	5
The National Park Service places too much emphasis on preservation.	1	2	3	4	5
I am glad there are national parks, even if I don't visit them.	1	2	3	4	5
People can think a place is valuable, even if they do not actually go there themselves.	1	2	3	4	5
The American people should provide greater financial support for the National Park Service to avoid more commercial activities in the national parks.	1	2	3	4	5
If the National Park Service needs more financial support, they should develop more gift shops and commercial activities to raise money.	1	2	3	4	5

In this section, we are interested in learning about trips you may have taken to Grand Canyon National Park.

18. As best you can recall, have you ever flown over Grand Canyon National Park in an aircraft? *(CIRCLE ONE NUMBER)*

    1 No------------->*SKIP TO QUESTION 20*
    2 Yes

19. Did you fly over Grand Canyon National Park while you were on a commercial airliner, or did you fly over the park as part of a sightseeing air tour that included the park? *(CIRCLE ALL NUMBERS THAT APPLY)*

    1 I flew over Grand Canyon National Park while on a commercial aircraft

    2 I flew over Grand Canyon National Park as part of a sightseeing air tour

    3 Other (please describe: ________________________________)

20. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 No------------->*SKIP TO QUESTION 23*
    2 Yes

21. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 No------------->*SKIP TO QUESTION 23*
    2 Yes

22. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

    1 No
    2 Yes

23. How likely do you think it is that you will visit the Grand Canyon National Park in the future? *(CIRCLE ONE NUMBER)*

    1 Not at all likely
    2 Somewhat unlikely
    3 Somewhat likely
    4 Very likely

In this last section, we would like to ask you some questions about your background that will help us compare your answers with those of other people. We stress that all of your responses are strictly confidential.

24. Are you: *(CIRCLE ONE NUMBER)*

 1 Male
 2 Female

25. How old are you? *(FILL IN THE BLANK)*

 ________ **Years old**

26. How many years of schooling have you completed? *(CIRCLE ONE NUMBER)*

 1 Eight years or less
 2 Some high school
 3 High school graduate
 4 Some college or technical school
 5 College or technical school graduate
 6 Post graduate work

27. How many people live in your household? *(FILL IN ALL BLANKS)*

 NUMBER

 ______ **People 18 years old or older**

 ______ **People under the age of 18**

 ______ **Total number of people in the household**

28. Do you, or another member of your household, own or rent this residence? *(CIRCLE ONE NUMBER)*

 1 Own
 2 Rent
 3 Other (please describe: ____)

29. Are you, or another member of your household, responsible for paying the utility bill? *(CIRCLE ONE NUMBER)*

    1 No
    2 Yes

30. Which of the following categories comes closest to your total 1993 household income? *(CIRCLE ONE NUMBER)*

1	**Less than $10,000**	**9**	**$45,000 to $49,999**
2	**$10,000 to $14,999**	**10**	**$50,000 to $59,999**
3	**$15,000 to $19,999**	**11**	**$60,000 to $69,999**
4	**$20,000 to $24,999**	**12**	**$70,000 to $79,999**
5	**$25,000 to $29,999**	**13**	**$80,000 to $89,999**
6	**$30,000 to $34,999**	**14**	**$90,000 to $99,999**
7	**$35,000 to $39,999**	**15**	**Over $100,000**
8	**$40,000 to $44,999**		

THANK YOU FOR YOUR HELP!

Comments:

Please feel free to keep the colored background information materials

Please return only this survey booklet in the enclosed, postage-paid envelope to:

Glen Canyon Studies
c/o HBRS, Inc.
University Research Park
455 Science Drive
Madison, WI 53711

Hello,

A few days ago your household received a questionnaire about the tradeoffs between production of electricity at Glen Canyon Dam and the natural and cultural resources along the Colorado River in the Grand Canyon. If the survey has been completed and returned, please consider this a "thank you." Otherwise, I hope you will be able to fill it out and return it soon.

Your household's responses to this survey are very important. We can only survey a small number of households, so your responses will represent many other households like yours, who are not able to participate in this study.

Thank you for you participation.

Sincerely,

David L. Wegner

David Wegner
Glen Canyon Studies Manager

Glen Canyon Studies c/o HBRS. Inc. 455 Science Drive Madison, WI 53711

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

E-64

IN REPLY REFER TO:

Greetings!

About two weeks ago, we sent a questionnaire to your household. The survey asked about your opinions on how the Glen Canyon Dam on the Colorado River should be operated. Hearing from your household is very important. If you have already completed and returned the questionnaire, please accept our sincere thanks. If you have not done so, we would still very much like to hear from your household.

Even if you have never heard about Glen Canyon Dam prior to receiving this survey, your opinions are very important for this study. You don't need to have any special knowledge about hydroelectricity, dam operations, or environmental issues to fill out the survey. The background information sheets enclosed with the survey were prepared to help people understand the relation between the operation of the dam and downstream cultural and natural resources.

Government officials will soon be making decisions about how to operate the dam. Your participation in the study will help them understand how people in households like yours feel about trade-offs between cultural and natural resources, such as fish, vegetation, and beaches, at the bottom of the Grand Canyon and the production of electricity from Glen Canyon Dam. Answers to this survey will affect future decisions about how the dam is operated.

We could not send this survey to every household in the nation. Your household is part of a relatively small group of households who have been randomly selected to participate in this survey. Your answers will represent the views of many other households similar to yours and will ensure that the opinions of all households are represented in decisions about the operation of the Glen Canyon Dam. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Your responses are confidential, and your name will **not** be revealed. Information from the surveys will only be reported in statistical terms, such as "10 percent of all respondents have seen the Colorado River in Grand Canyon National Park."

I have enclosed another copy of the survey in case the first one was lost or misplaced. There is an identification number on the back of the survey so that HBRS, Inc., the firm conducting the survey, will know who has already returned the survey and who to send reminders to.

When the survey is completed, simply return it in the enclosed postage-paid envelope. We hope that you find the survey interesting and enjoyable to fill out. If you have any questions or concerns about this survey or the study, please feel free to call Mike Welsh, the HBRS survey project manager, collect at 0-608-232-2800.

I appreciate your help in this study.

Sincerely,

David L. Wegner

David L. Wegner
Glen Canyon Studies Manager

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Glen Canyon Environmental Studies
P.O. Box 22459
Flagstaff, Arizona 86002-2459

IN REPLY REFER TO:

Greetings!

I am sorry if this certified letter has caused you any inconvenience. This survey is very important and I wanted to make sure it reached your household.

About three weeks ago, I sent a survey concerning the operations of Glen Canyon Dam. Even if you don't live near Glen Canyon Dam or the Grand Canyon, it is still important to hear from you, even if it is only to tell us that you simply don't care how Glen Canyon Dam is operated. Some people have told us that they felt they did not know enough to answer the questionnaire. The background information sheets enclosed with the survey were prepared to help people understand the relation between the operation of the dam and downstream cultural and natural resources. This background information will enable you to participate in this study even if you don't feel that you know very much about the Glen Canyon Dam.

Government officials will soon be making decisions about how the dam is operated. In making these decisions, they would like to know more about how individuals like you feel about the issues that are discussed in the questionnaire. Your household was chosen at random to participate in this study. Since we can't send surveys to every household, your response will represent the opinions of households similar to yours that were not selected to participate in the study. We need to hear from everyone to make sure that we have a representative sample of opinions about this issue.

I am enclosing another copy of the questionnaire and a stamped self-addressed envelope in case you have misplaced the previous ones. To ensure a random selection of respondents within a household, we are asking that the survey be filled out by the adult member of your household with the **latest birthday** in the calendar year.

Thank you for your help in this study. Your cooperation in completing this questionnaire will help to make this a successful project.

Sincerely,

David L. Wegner

David L. Wegner
Glen Canyon Studies Manager

P.S. If for some reason, you can't complete the questionnaire, please write a note on the questionnaire booklet and mail it back. It is better for us to hear something from you than nothing at all. Or if you prefer, you can call HBRS collect at 608-232-2800. Ask for Mike Welsh, the Glen Canyon Studies project manager.

Telephone Survey

OMB No: 1006-0016
Expiration Date: August 23, 1997

Hi, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. I'm trying to reach the **(Name)** household at **(Phone Number)**. Do I have the right number? *(CIRCLE ONE NUMBER)*

1 **No**------------>*(THANK AND TERMINATE)*

2 **Yes**

3 **Hung up**

Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam. To help us understand the survey results we need to understand the reasons people have for not participating in the study.

1. We asked that the adult in your household with the latest birthday in the calendar year read and complete the survey. Are you the adult in your household who had the latest birthday in the calendar year? *(CIRCLE ONE NUMBER)*

   1 **No**------>May I please speak to (him/her)? *(CIRCLE ONE NUMBER)*

   1 **No/not available**-------->When would be a good time for me to reach (him/her)? Who should we ask for when we call back? *(FILL IN BLANK AND GET FIRST NAME)*

   ____

   2 **Yes**------>Hello, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam.

   9 **Refusal**

   2 **Yes**

   9 **Refusal**

To help us understand the survey results we need to understand the reasons people have for not participating in the study.

2. Do you remember receiving the questionnaire in the mail? *(CIRCLE ONE NUMBER)*

   1 No------------->*(PROBE:* It was a (color) booklet that came in a package with several other sheets of paper. There was also an envelope for you to return the questionnaire in. Do you remember that (color) booklet, it had a picture of the Colorado River on the cover? *(CIRCLE ONE NUMBER)*

      1 No--------->I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

      First name: ______________________

      Last name: ______________________

      Street address: ______________________

      City: ______________________

      State: ______________________

      ZIP Code: ______________________

      (SKIP TO QUESTION 8)

      2 **Yes**

      9 **Refusal**

   2 **Yes**

   9 **Refusal**------------->*(SKIP TO QUESTION 8)*

3. Did you look through the package of materials and the questionnaire? *(CIRCLE ONE NUMBER)*

   1 No------------>Why not? *(FILL IN BLANK)* ______________________

   ____

   2 **Yes**

   9 **Refusal**------------->*(SKIP TO QUESTION 5)*

4. Did you read the background information that described the study and the situation with the Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

   1 No------------>Why not? *(FILL IN BLANK)* ______________________

   ____

   2 **Yes**

   9 **Refusal**

5. Did you start to fill out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

    1 No------------>Why not? *(FILL IN BLANK)* ____

    ____

    2 Yes

    9 Refusal------------>*(SKIP TO QUESTION 7)*

6. Did you finish filling out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

    1 No------------>Why not? *(FILL IN BLANK)* ____

    ____

    2 Yes

    9 Refusal

7. Do you still have the questionnaire booklet? *(CIRCLE ONE NUMBER)*

    1 No/Don't know-------->Why not? *(FILL IN BLANK)* ________________________________

    ____

    2 Yes

    9 Refusal

> Another reason I'm calling you is that we need to find out a little bit about the people who didn't return the questionnaire booklet, so we can learn whether the results might have been different if we had heard from everyone.

8. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

    1 No

    2 Yes

    8 Don't recall

    9 Refusal

9. <u>Before</u> receiving this survey had you heard of Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

    1 No

    2 Yes------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*

    ____

    ____

    ____

    ____

    9 Refusal

10. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

- 1 **No/Don't recall------------->**Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*
  - 1 **No**
  - 2 **Yes**
  - 3 **Don't know**
  - 9 **Refusal**

  (SKIP TO QUESTION 13)
- 2 **Yes**
- 9 **Refusal------------->***(SKIP TO QUESTION 13)*

11. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

- 1 **No/Don't recall------------->***(SKIP TO QUESTION 13)*
- 2 **Yes**
- 9 **Refusal**

12. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

- 1 **No**
- 2 **Yes**
- 3 **Don't recall**
- 9 **Refusal**

13. How likely do you think it is that you will visit the Grand Canyon National Park in the future? Are you not at all likely, somewhat unlikely, somewhat likely, or very likely to visit the Grand Canyon in the future? *(CIRCLE ONE NUMBER)*

- 1 **Not at all likely**
- 2 **Somewhat unlikely**
- 3 **Somewhat likely**
- 4 **Very likely**
- 8 **Don't know**
- 9 **Refusal**

Next, I'm going to read you some statements and ask you whether you agree or disagree with each statement. There are no right or wrong answers, we just want to know your opinion

14. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE	REFUSAL
a. When humans interfere with nature, it often produces disastrous consequences.	1	2	3	4	5	9

On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

b. Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5	9
c. The balance of nature is very delicate and easily upset.	1	2	3	4	5	9
d. Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5	9
e. If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5	9

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

f. Humans were meant to rule the rest of nature.	1	2	3	4	5	9
g. Despite our special abilities, humans are still subject to the laws of nature.	1	2	3	4	5	9
h. Plants and animals have as much right as humans to exist.	1	2	3	4	5	9
i. Human ingenuity will ensure that we do not make the earth unlivable.	1	2	3	4	5	9
j. Humans are severely abusing the environment.	1	2	3	4	5	9

(Continued)

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	STRONGLY AGREE				STRONGLY DISAGREE	REFUSAL
k. The so-called ecological crisis facing humankind has been greatly exaggerated.	1	2	3	4	5	9
l. We are approaching the limit of the number of people the earth can support.	1	2	3	4	5	9
m. The earth is like a spaceship with very limited room and resources.	1	2	3	4	5	9
n. The earth has plenty of natural resources, if we just learn how to develop them.	1	2	3	4	5	9
o. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5	9

15. OK, the last few statements I am going to read to you discuss economic and environmental issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE	REFUSAL
a. Economic security and well-being should be considered first, then we can worry about environmental problems	1	2	3	4	5	9
b. If business if forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market	1	2	3	4	5	9
c. Some pollution is inevitable if we are going to continue to improve our standard of living.	1	2	3	4	5	9
d. The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	1	2	3	4	5	9

The last few questions I have are about your background. These questions will help us compare your answers with those of other people. All of your responses are <u>strictly confidential</u>.

16. How old are you? *(FILL IN THE BLANK)*

______ Years old

999 Refusal

17. How many years of schooling have you completed? *(READ LIST; CIRCLE ONE NUMBER)*

1 Eight years or less
2 Some high school
3 High school graduate
4 Some college or technical school
5 College or technical school graduate
6 Post graduate work
9 Refusal

18. Including yourself, how many people live in your household? How many of these people are less than 18 years old? *(FILL IN ALL BLANKS)*

NUMBER
______ **People under the age of 18**
______ **People 18 years old or older**
______ **Total number of people in the household**
99 Refusal

19. Which of the following categories comes closest to your total **1993 household** income? *(READ LIST; CIRCLE ONE NUMBER)*

1 Less than $10,000
2 $10,000 to less than $15,000
3 $15,000 to less than $20,000
4 $20,000 to less than $25,000
5 $25,000 to less than $30,000
6 $30,000 to less than $35,000
7 $35,000 to less than $40,000
8 $40,000 to less than $45,000
9 $45,000 to less than $50,000
10 $50,000 to less than $60,000
11 $60,000 to less than $70,000
12 $70,000 to less than $80,000
13 $80,000 to less than $90,000
14 $90,000 to less than $100,000
15 Over $100,000
98 Don't know
99 Refusal

[CHECK RESPONSE TO QUESTION 7. IF NO LONGER HAS SURVEY, SKIP TO QUESTION 19b.]

19a. Earlier, you said that you still have a copy of the questionnaire booklet. It would really help me out if you could spend a few minutes reading the background information materials and completing at least the first 9 questions in the survey booklet and mail it back to us in the envelope. Do you think you would be able to do that in the next few days? *(CIRCLE ONE NUMBER)*

1 No------------> OK, Thanks for your help.

2 Yes----------> I would really appreciate it if you could fill out at least the first 9 questions of the survey and put it in the mail in the next few days.

9 Refusal

19b. Earlier, you said you may not have a copy of the survey booklet. If we mailed you another copy, could you spend a few minutes reading the background information and completing at least the first 9 questions of the survey booklet? If would really help me out. *(CIRCLE ONE NUMBER)*

1 **No**------------->OK, thanks for your help.

2 **Yes**----------->OK, I will mail you another copy of the survey. *(VERIFY ADDRESS IF NOT ALREADY DONE)*

I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

First name: ______________________

Last name: ______________________

Street address: ______________________

City: ______________________

State: ______________________

ZIP Code: ______________________

9 **Refusal**

Thank you for your time. I'd really like to encourage you to return your survey. Do you have any questions are comments? *(FILL IN BLANK)*

000 No comments

____

____

____

____

____

(INTERVIEWER -- IS RESPONDENT . . . ?) (CIRCLE ONE NUMBER)

1 **Male**

2 **Female**

8 **Unsure**

APPENDIX F
GLEN CANYON NON-USE VALUE SURVEY FREQUENCIES

Mail Survey	**-National Sample**
Mail Survey	**-Marketing Area Sample**
Telephone Survey	**-National Sample**
Telephone Survey	**-Marketing Area Sample**

Mail Survey Frequencies -- National Sample

The frequencies presented in this section are based on 1,696 mail surveys that were completed and returned from national sample respondents in time to be included in the electronic dataset. Percentages shown for each question are based on the total number of cases with valid responses. The number of valid responses is shown in parentheses for each question. Invalid responses (item nonresponse) can be calculated by subtracting the number of valid responses from the total number that should have responded to the question. For example, all respondents were asked to answer the first true/false item in Question 1. Of the total number of respondents who should have answered the question, 1,673 actually answered it (valid responses), and 23 did not (invalid responses). When calculating item nonresponse, keep in mind that not all survey respondents were required to answer all questions: some respondents were asked to skip some questions, depending on their answers to previous questions.

Survey Version

24.6%	**National Sample: Moderate Fluctuating Flow**
24.8	**National Sample: Low Fluctuating Flow**
25.3	**National Sample: Seasonally Adjusted Steady Flow**
25.2	**National Sample: Seasonally Adjusted Steady Flow with Moderate Fluctuating Flow Price Impacts**
(1,696)	

We presented a lot of material in the background information. In this section, we will ask a few questions about the background information to make sure it was clearly presented. Please feel free to refer to the information sheets when answering these questions.

1. For each statement below, please circle the letter "T" if you think the statement is true, or the letter "F" if you think the statement is false. *(CIRCLE ONE LETTER FOR EACH STATEMENT)*

	TRUE	FALSE	
There are now many **more** beaches along the Colorado River than there were 20 years ago.	8.1%	91.9%	(1,673)
Native fish populations in the Colorado River **have declined.**	96.0	4.0	(1,670)
The decrease in the number and size of beaches is most severe along **wide** sections of the river.	14.1	85.9	(1,649)
None of the beaches along the river have vegetation.	4.0	96.0	(1,660)
There are **American Indian** traditional-use areas and sacred sites located along the Colorado River below Glen Canyon Dam.	97.9	2.1	(1,652)
Archeological sites are **not** being affected by erosion.	5.0	95.0	(1,662)
Trout are **not native** to the study area.	85.4	14.6	(1,662)
All native fish species have disappeared from the Grand Canyon.	4.5	95.5	(1,664)
Nearly all visitors to the Grand Canyon National Park use the beaches along the river.	9.9	90.1	(1,654)
American Indian traditional-use areas **are** affected by erosion.	94.7	5.3	(1,634)
Water levels are **constant** throughout the day.	7.1	92.9	(1,631)
The Study Area consists **only** of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.	88.0	12.0	(1,612)
The shoreline in the study area consists **only** of beaches.	4.0	96.0	(1,605)
Vegetation on beaches **provides habitat** for birds and other wildlife.	98.5	1.5	(1,634)
Two of the native fish species are in danger of extinction.	89.4	10.6	(1,630)
Reducing daily fluctuations in the amount of water released from the dam will **reduce** the total amount of hydroelectricity produced.	31.9	68.1	(1,619)

Government Officials Are Deciding How to Operate Glen Canyon Dam in Future Years.

- Their decision on how the dam should be operated could cost you money. For example:
  - Changes in operations of the dam could reduce the revenue earned by the dam -- as a result, taxpayers would have to make up the difference.
  - If you live in an area receiving power from Glen Canyon Dam, your utility bill would increase.

INSTRUCTIONS FOR NEXT QUESTION

Government officials will consider many factors when deciding whether or not to change dam operations. One factor they would like to consider is whether various proposals are personally worthwhile to people like you. In the next question, we will describe the effects of a specific proposal to change dam operations. We would like you to tell us if you would vote "YES" or "NO" on this proposal.

Some people might vote "NO" because:

- the cost of the proposal is too high.
- the effects of the proposal are not worth anything (not even 10¢) to them.
- they just can't afford the cost.

Some people might vote "YES" because:

- the cost of the proposal is low enough.
- the effects of the proposal are worth what it would cost them.

At this point in time, it is not certain what the cost would be to any specific individual, so we are asking different people about different amounts. Even if the amount we ask you about seems very low or very high, please answer carefully. This will allow us to determine whether people think the proposal is worthwhile at whatever level the final cost is determined to be. For this study, it is important that you tell us how you would vote, based only on **your personal evaluation** of whether changes in dam operations and their effects, are worth the additional cost **to you**.

Version 1

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites, and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish.
- Native fish populations, including those in danger of extinction, would probably continue to decline in numbers.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to maintain the population.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households and a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

Version 2

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish.
- It is likely, but not certain, that native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households to a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

Version 3

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- The average electric bill would increase by $9 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $21 per month for 3,600 households to a minimum of no increase for 300,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 6%.

Version 4

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.
- The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households to a minimum of no increase for 800,000 households.
- On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

11.8%	**No---------->***SKIP TO QUESTION 8*
78.2	**Yes**
10.0	**I would choose not to vote on this proposal---------->***SKIP TO QUESTION 8*
(1,635)	

The higher electric rates described earlier cannot make up for all the revenue lost as a result of this proposal. Taxpayers would have to make up the difference. How would you, as a taxpayer, vote on this proposal? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. Would you vote for this proposal if passage of the proposal would cost your household $______ in increased taxes **every year** for the foreseeable future? *(CIRCLE ONE NUMBER)*

Annual cost of proposal

12.9%	**$5**
13.3	**$15**
12.7	**$30**
11.9	**$60**
11.8	**$90**
12.6	**$120**
13.0	**$150**
11.9	**$200**
(1,696)	

12.0%	**Definitely No**	**- I would definitely vote against the proposal.**
17.1	**Probably No**	**- I would probably vote against the proposal.**
16.6	**Not Sure**	**- I am not sure if I would vote for the proposal.**
35.5	**Probably Yes**	**- I would probably vote for the proposal.**
18.8	**Definitely Yes**	**- I would definitely vote for the proposal.**
(1,266)		

4. If this proposal passes and you had to pay $______ **every year** for the foreseeable future, on what sorts of things would you spend less money in order to pay for the cost of this proposal? *(FILL IN THE BLANK)*

Category	**Percent of Responses[1]**	**Percent of Cases[2]**
Vacation	**4.0%**	**6.2%**
Travel/trips	**3.6**	**5.5**
Food/drink	**19.2**	**29.6**
Recreation/hobbies	**8.2**	**12.6**
Clothing	**8.0**	**12.4**
Entertainment	**18.5**	**28.5**
Needless items	**7.5**	**11.7**
No effect	**8.2**	**12.7**
Gifts/toys	**1.4**	**2.2**
Irrigation	**.1**	**.1**
Newspaper	**1.9**	**2.9**
Phone	**.2**	**.4**
Can't afford	**.5**	**.7**
Donations	**3.3**	**5.1**
Savings	**2.7**	**4.2**
Vehicle expenses	**2.2**	**3.4**
Utility usage	**2.1**	**3.3**
Living expenses	**2.4**	**3.7**
Government programs	**.1**	**.2**
Computer/electronics	**.2**	**.3**
Housing improvements	**.4**	**.6**
Tobacco	**1.3**	**2.0**
Other	**3.4**	**5.2**
Health care	**.1**	**.2**
Education	**.2**	**.3**
Insurance	**.2**	**.3**
Bills	**.1**	**.2**
	100.0%	**154.5%**
		(1,107)

1 Respondents were allowed to record multiple responses. This column reflects percentage of the total number of responses recorded.

2 This column reflects percentage of the total number of respondents citing each item listed. Since respondents were allowed to record multiple responses, the column does not sum to 100 percent.

5. Now that you have had an additional chance to think about what you would have to give up if the proposal passes, would you like to change your vote? *(CIRCLE ONE NUMBER)*

94.2% No------------->*SKIP TO QUESTION 7*
5.8 Yes
(1,262)

6. Now how would you vote on the proposal? *(CIRCLE ONE NUMBER)*

8.6%	**Definitely No**	**- I would definitely vote against the proposal.**
12.9	**Probably No**	**- I would probably vote against the proposal.**
30.0	**Not Sure**	**- I am not sure if I would vote for the proposal.**
42.9	**Probably Yes**	**- I would probably vote for the proposal.**
5.7	**Definitely Yes**	**- I would definitely vote for the proposal.**
(70)		

7. Do you believe your taxes will increase if this proposal passes? *(CIRCLE ONE NUMBER)*

28.4% No
71.6 Yes
(1,255)

8. Do you think public officials will consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future? *(CIRCLE ONE NUMBER)*

39.2% No
60.8 Yes
(1,633)

9. Do you think public officials should consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future? *(CIRCLE ONE NUMBER)*

4.9% No
95.1 Yes
(1,646)

10. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

89.0% No
11.0 Yes
(1,661)

11. Before receiving this survey had you heard of Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

70.9% No
29.1% Yes------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*
(1,652)

0.2%	**Heard about this study**
8.7	**Heard about environmental impacts of dam operations**
91.1	**Heard other things about Glen Canyon Dam**
(426)	

12. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please indicate how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
When humans interfere with nature, it often produces disastrous consequences.	38.0%	28.2%	24.6%	6.1%	3.1%	(1,654)
Humans will eventually learn enough about how nature works to be able to control it.	7.4	14.9	25.1	26.5	26.2	(1,655)
The balance of nature is very delicate and easily upset.	47.3	28.9	14.0	6.9	3.0	(1,648)
Humans have the right to modify the natural environment to suit their needs.	6.5	10.5	28.1	24.9	30.0	(1,652)
If things continue on their present course, we will soon experience a major ecological catastrophe.	25.2	26.1	25.1	13.2	10.4	(1,649)
Humans were meant to rule the rest of nature.	8.3	8.1	14.6	22.5	46.5	(1,650)
Despite our special abilities, humans are still subject to the laws of nature.	60.2	27.6	8.1	2.0	2.1	(1,639)
Plants and animals have as much right as humans to exist.	46.4	21.7	16.4	9.4	6.1	(1,652)
Human ingenuity will ensure that we do not make the earth unlivable.	12.1	19.6	33.8	22.3	12.1	(1,649)
Humans are severely abusing the environment.	40.6	27.5	18.5	8.2	5.2	(1,656)
The so-called ecological crisis facing humankind has been greatly exaggerated.	8.8	13.9	26.7	28.3	22.4	(1,641)
We are approaching the limit of the number of people the earth can support.	22.2	21.8	28.6	15.7	11.7	(1,650)
The earth is like a spaceship with very limited room and resources.	25.3	25.4	24.2	14.0	11.1	(1,646)
The earth has plenty of natural resources, if we just learn how to develop them.	28.6	31.3	21.9	12.2	6.0	(1,659)
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	5.5	9.9	22.2	33.4	29.0	(1,654)

13. The following statements discuss economic and environmental issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
Economic security and well-being should be considered first; then we can worry about environmental problems.	**6.0%**	**10.8%**	**25.4%**	**31.3%**	**26.6%**	**(1,656)**
It is possible to protect our environment and natural resources and still maintain a healthy economy.	**45.7**	**39.5**	**11.2**	**2.3**	**1.3**	**(1,664)**
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market.	**7.4**	**13.6**	**25.6**	**32.1**	**21.2**	**(1,658)**
Some pollution is inevitable if we are going to continue to improve our standard of living.	**14.2**	**30.8**	**25.6**	**20.0**	**9.3**	**(1,657)**
I would be willing to pay somewhat higher prices (5 to 10 percent higher) for products that would cause less pollution or environmental damage.	**32.0**	**37.2**	**19.5**	**6.9**	**4.5**	**(1,658)**
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	**4.2**	**7.5**	**24.4**	**33.0**	**30.9**	**(1,653)**
Some land in the United States should be set aside from human use so it can remain completely untouched, regardless of its economic value.	**55.5**	**20.6**	**12.1**	**6.9**	**5.0**	**(1,664)**

14. The following statements discuss American Indian issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
It is our responsibility to protect those areas of historical or religious importance to American Indians.	**49.5%**	**27.8%**	**15.7%**	**4.3%**	**2.6%**	**(1,664)**
We have gone too far in granting American Indians special rights to use public lands and resources, such as fish and wildlife.	**7.7**	**11.2**	**19.3**	**24.7**	**37.1**	**(1,665)**
Our society can learn important lessons from studying earlier cultures that inhabited our country.	**46.7**	**31.7**	**15.5**	**4.1**	**2.0**	**(1,665)**
We can't afford to let concern for preserving artifacts of earlier American Indian cultures stand in the way of operating hydroelectric dams.	**5.8**	**9.0**	**19.7**	**29.0**	**36.5**	**(1,661)**
American Indian concerns should be equally as important as our society's economic needs when deciding how to use land.	**36.7**	**26.0**	**23.3**	**9.7**	**4.3**	**(1,663)**

15. The following statements discuss hydroelectricity. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE	
	1	2	3	4	5	
The benefits of hydroelectric dams on the Colorado River outweigh the impacts to the natural environment and historical places along the river.	6.8%	11.8%	29.8%	30.2%	21.4%	(1,614)
Hydroelectric dams should not be constructed on rivers that flow through national parks.	18.0	15.7	31.9	23.3	11.1	(1,613)
Hydroelectric dams have fewer environmental impacts than coal, oil, or gas-burning power plants.	23.6	32.9	28.8	9.7	5.1	(1,593)
Hydroelectric dams can have serious impacts on the plants and animals that live in or along the river.	32.9	36.4	20.4	6.8	3.4	(1,609)
Hydroelectric dams produce relatively cheap electricity compared to other sources.	29.5	40.0	24.0	3.3	3.2	(1,601)
Hydroelectric dams should be developed wherever it is economically feasible, even if it means that some rivers will be changed.	8.5	15.4	31.9	26.5	17.7	(1,609)
Rivers without dams are a unique and irreplaceable resource that should be protected from hydroelectric dams.	20.0	19.1	38.4	15.3	7.2	(1,604)

In this section, we would like to learn how you feel about national parks in the United States.

16. Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

15.9%	No
82.5	Yes
1.7	Don't know
(1,619)	

17. We are interested in learning how you feel about national parks in general. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

		STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
1	National parks are a "luxury" we cannot afford in difficult economic times.	4.2%	3.2%	8.7%	22.8%	61.1%	(1,633)
	National parks help us to remember that our future is tied to the preservation of nature and natural resources.	61.2	26.3	8.1	2.4	2.1	(1,636)
	It is important that national parks offer us a chance to see America as the early settlers saw it.	50.1	30.4	14.7	3.2	1.6	(1,634)
	Americans need places like national parks to "recharge their batteries."	49.6	28.2	15.5	3.9	2.9	(1,631)
	An important function of the National Park Service is to protect native birds, plants, and animals.	66.1	23.8	7.2	1.6	1.3	(1,636)
	National parks are only valuable to the people who visit them.	5.9	5.1	7.4	29.9	51.8	(1,640)
	Oil and natural gas finds on national park lands should be developed since it is in the national interest.	6.7	9.8	28.7	23.1	31.6	(1,635)
	The National Park Service places too much emphasis on preservation.	4.0	5.2	18.0	29.7	43.1	(1,637)
	I am glad there are national parks, even if I don't visit them.	76.6	17.2	5.1	0.4	0.7	(1,623)
	People can think a place is valuable, even if they do not actually go there themselves.	75.6	18.7	4.5	0.7	0.6	(1,639)
	The American people should provide greater financial support for the National Park Service to avoid more commercial activities in the national parks.	37.3	26.1	25.0	7.2	4.3	(1,637)
	If the National Park Service needs more financial support, they should develop more gift shops and commercial activities to raise money.	9.8	16.7	30.1	22.0	21.4	(1,638)

In this section, we are interested in learning about trips you may have taken to Grand Canyon National Park.

18. As best you can recall, have you ever flown over Grand Canyon National Park in an aircraft? *(CIRCLE ONE NUMBER)*

60.9%	**No**------------->*SKIP TO QUESTION 20*
39.1	**Yes**
(1,635)	

19. Did you fly over Grand Canyon National Park while you were on a commercial airliner, or did you fly over the park as part of a sightseeing air tour that included the park? *(CIRCLE ALL NUMBERS THAT APPLY)*

94.2% (637)	**flew over Grand Canyon National Park while on a commercial aircraft**
5.3% (637)	**flew over Grand Canyon National Park as part of a sightseeing air tour**

flew over Grand Canyon National Park as part of a:

53.6%	**Military flight**
32.1	**Private plane**
3.6	**Corporate plane**
3.6	**Charter flight**
3.6	**Medical evacuation**
3.6	**Testing navigation**
(28)	

20. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

65.9%	**No**------------->*SKIP TO QUESTION 23*
34.1	**Yes**
(1,638)	

21. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

8.3%	**No**------------->*SKIP TO QUESTION 23*
91.7	**Yes**
(553)	

22. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

80.6%	**No**
19.4	**Yes**
(510)	

23. How likely do you think it is that you will visit the Grand Canyon National Park in the future? *(CIRCLE ONE NUMBER)*

16.4%	**Not at all likely**
14.7	**Somewhat unlikely**
35.0	**Somewhat likely**
33.9	**Very likely**
(1,635)	

In this last section, we would like to ask you some questions about your background that will help us compare your answers with those of other people. We stress that all of your responses are strictly confidential.

24. Are you: *(CIRCLE ONE NUMBER)*

54.1% Male
45.9 Female
(1,647)

25. How old are you? *(FILL IN THE BLANK)*

AVERAGE AGE
49.0 Years old
(1,630)

26. How many years of schooling have you completed? *(CIRCLE ONE NUMBER)*

2.3% Eight years or less
5.5 Some high school
19.9 High school graduate
27.2 Some college or technical school
26.7 College or technical school graduate
18.5 Post graduate work
(1,642)

27. How many people live in your household? *(FILL IN ALL BLANKS)*

AVERAGE NUMBER
2.00 People 18 years old or older
(1,517)
0.73 People under the age of 18
(1,394)
2.69 Total number of people in the household
(1,535)

28. Did you or any members in your household have any taxes withheld from a paycheck or other earnings in 1993? *(CIRCLE ONE NUMBER)*

17.1% No
82.9 Yes
(1,619)

29. Did you or any members of your household file a Federal income tax form for 1993? *(CIRCLE ONE NUMBER)*

7.2% No
92.8 Yes
(1,620)

30. Which of the following categories comes closest to your total 1993 household income? *(CIRCLE ONE NUMBER)*

6.9%	Less than $10,000	6.2%	$45,000 to $49,999
7.1	$10,000 to $14,999	10.0	$50,000 to $59,999
5.9	$15,000 to $19,999	6.6	$60,000 to $69,999
8.4	$20,000 to $24,999	5.6	$70,000 to $79,999
9.2	$25,000 to $29,999	3.7	$80,000 to $89,999
8.2	$30,000 to $34,999	2.3	$90,000 to $99,999
6.8	$35,000 to $39,999	6.2	Over $100,000
6.9	$40,000 to $44,999	(1,540)	

Mail Survey Frequencies -- Marketing Area Sample

The frequencies presented in this section are based on 1,392 mail surveys that were completed and returned from marketing area sample respondents in time to be included in the electronic dataset. Percentages shown for each question are based on the total number of cases with valid responses. The number of valid responses is shown in parentheses for each question. Invalid responses (item nonresponse) can be calculated by subtracting the number of valid responses from the total number that should have responded to the question. For example, all respondents were asked to answer the first true/false item in Question 1. Of the total number of respondents who should have answered the question, 1,362 actually answered it (valid responses), and 30 did not (invalid responses). When calculating item nonresponse, keep in mind that not all survey respondents were required to answer all questions: some respondents were asked to skip some questions, depending on their answers to previous questions.

Survey Version

33.0%	**Marketing Area Sample: Moderate Fluctuating Flow**
32.4	**Marketing Area Sample: Low Fluctuating Flow**
34.6	**Marketing Area Sample: Seasonally Adjusted Steady Flow**
(1,392)	

We presented a lot of material in the background information. In this section, we will ask a few questions about the background information to make sure it was clearly presented. Please feel free to refer to the information sheets when answering these questions.

1. For each statement below, please circle the letter "T" if you think the statement is true, or the letter "F" if you think the statement is false.
(CIRCLE ONE LETTER FOR EACH STATEMENT)

	TRUE	FALSE	
There are now many **more** beaches along the Colorado River than there were 20 years ago.	9.8%	90.2%	(1,362)
Native fish populations in the Colorado River **have declined.**	94.9	5.1	(1,364)
The decrease in the number and size of beaches is most severe along **wide** sections of the river.	14.3	85.7	(1,336)
None of the beaches along the river have vegetation.	2.4	97.6	(1,357)
There are **American Indian** traditional-use areas and sacred sites located along the Colorado River below Glen Canyon Dam.	98.8	1.2	(1,365)
Archeological sites are **not** being affected by erosion.	4.3	95.7	(1,359)
Trout are **not native** to the study area.	86.1	13.9	(1,356)
All native fish species have disappeared from the Grand Canyon.	3.2	96.8	(1,358)
Nearly all visitors to the Grand Canyon National Park use the beaches along the river.	8.4	91.6	(1,365)
American Indian traditional-use areas **are** affected by erosion.	95.9	4.1	(1,324)
Water levels are **constant** throughout the day.	5.2	94.8	(1,327)
The Study Area consists **only** of the area in and along the Colorado River between Glen Canyon Dam and Lake Mead.	88.7	11.3	(1,317)
The shoreline in the study area consists **only** of beaches.	3.6	96.4	(1,321)
Vegetation on beaches **provides habitat** for birds and other wildlife.	98.9	1.1	(1,336)
Two of the native fish species are in danger of extinction.	90.6	9.4	(1,325)
Reducing daily fluctuations in the amount of water released from the dam will **reduce** the total amount of hydroelectricity produced.	28.6	71.4	(1,318)

Government Officials Are Deciding How to Operate Glen Canyon Dam in Future Years.

- Their decision on how the dam should be operated could cost you money.
- Since you live in an area receiving power from Glen Canyon Dam, if operations are changed, your utility bill will increase.

INSTRUCTIONS FOR NEXT QUESTION

Government officials will consider many factors when deciding whether or not to change dam operations. One factor they would like to consider is whether various proposals are personally worthwhile to people like you. In the next question, we will describe the effects of a specific proposal to change dam operations. We would like you to tell us if you would vote "YES" or "NO" on this proposal.

Some people might vote "NO" because:

- the cost of the proposal is too high.
- the effects of the proposal are not worth anything (not even 10¢) to them.
- they just can't afford the cost.

Some people might vote "YES" because:

- the cost of the proposal is low enough.
- the effects of the proposal are worth what it would cost them.

At this point in time, it is not certain how much utility bills would increase in your area if the operation of Glen Canyon Dam is changed so we are asking different people about different amounts. Even if the amount we ask you about seems very low or very high, please answer carefully. This will allow us to determine whether people think the proposal is worthwhile at whatever level the final cost is determined to be. For this study, it is important that you tell us how you would vote, based only on **your personal evaluation** of whether changes in dam operations and their effects, are worth the additional cost **to you**.

Version 5

A PROPOSAL

Under this proposal, there would be a moderate reduction in the daily fluctuations in the river level. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a small improvement in conditions for native fish.
- Native fish populations, including those in danger of extinction, would probably continue to decline in numbers.
- There would be a small improvement in conditions for trout, but stocking of trout would still be required to maintain the population.

Version 6

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be greatly reduced. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10%, so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a moderate improvement in conditions for native fish.
- It is likely, but not certain, that native fish populations, including those in danger of extinction, would increase.
- There would be a moderate improvement in conditions for trout. The trout population could increase and it would require less annual stocking.

Version 7

A PROPOSAL

Under this proposal, daily fluctuations in the river level would be eliminated. Seasonal releases would also be changed so that releases would be highest during the spring, just like before the dam was built. However, the highest spring releases would still be lower than the average springtime flow prior to the dam. If this proposal is selected, it will result in the following conditions along the Colorado River in the Grand Canyon:

- In the long-term, the number and size of beaches would remain at present levels.
- The risk of erosion to Native American traditional-use areas, sacred sites and archeological sites would decrease substantially.
- The area available for vegetation would increase by about 10% so that the area available for birds and other forms of wildlife would increase by about 10%.
- There would be a major improvement in conditions for fish.
- Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations.
- There would be a major improvement in conditions for trout. The size and number of trout would increase. Maintenance of the trout population would no longer require any annual stocking.

2. Think about a situation in which you had an opportunity to vote on this proposal. If passage of this proposal would not cost you anything would you support this proposal? *(CIRCLE ONE NUMBER)*

11.4%	**No**---------->*SKIP TO QUESTION 8*
82.1	**Yes**
6.6	**I would choose not to vote on this proposal**---------->*SKIP TO QUESTION 8*
(1,338)	

How would you vote on this proposal if passage meant your utility bill would increase? As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses or to spend on other environmental issues.

3. Would you vote for this proposal if passage meant your utility bill would increase by $________ **every year** for the foreseeable future? *(CIRCLE ONE NUMBER)*

Annual cost of proposal

12.9%	**$5**
13.5	**$15**
11.7	**$30**
12.1	**$60**
12.5	**$90**
12.4	**$120**
12.1	**$150**
12.7	**$200**
(1,392)	

14.4%	**Definitely No** -	**I would definitely vote against the proposal.**
16.1	**Probably No** -	**I would probably vote against the proposal.**
13.3	**Not Sure** -	**I am not sure if I would vote for the proposal.**
34.7	**Probably Yes** -	**I would probably vote for the proposal.**
21.5	**Definitely Yes**	**-I would definitely vote for the proposal.**
(1,084)		

4. If this proposal passes and you had to pay $________ **every year** for the foreseeable future, on what sorts of things would you spend less money in order to pay for the cost of this proposal? *(FILL IN THE BLANK)*

Category	Percent of Responses[1]	Percent of Respondents[2]
Vacation	2.5%	3.7%
Travel/trips	3.8	5.8
Food/drink	20.4	31.1
Recreation/hobbies	8.8	13.3
Clothing	7.6	11.5
Entertainment	16.9	25.8
Needless items	4.8	7.2
No effect	8.2	12.5
Gifts/toys	.9	1.4
Newspaper	1.8	2.8
Phone	.8	1.3
Can't afford	.8	1.3
Donations	1.5	2.3
Savings	2.4	3.6
Vehicle expenses	4.2	6.4
Utility usage	4.0	6.1
Living expenses	4.8	7.3
Government programs	.1	.1
Housing improvements	.5	.7
Tobacco	.6	.9
Other	3.5	5.3
Health care	.5	.7
Education	.1	.2
Insurance	.4	.5
Taxes	.1	.2
	100.0%	152.1%
		(939)

1 Respondents were allowed to record multiple responses. This column reflects percentage of the total number of responses recorded.

2 This column reflects percentage of the total number of respondents citing each item listed. Since respondents were allowed to record multiple responses, the column does not sum to 100 percent.

5. Now that you have had an additional chance to think about what you would have to give up if the proposal passes, would you like to change your vote? *(CIRCLE ONE NUMBER)*

94.6%	**No**------------->*SKIP TO QUESTION 7*
5.4	**Yes**
(1,072)	

6. Now how would you vote on the proposal? *(CIRCLE ONE NUMBER)*

12.7%	**Definitely No -**	**I would definitely vote against the proposal.**
27.3	**Probably No -**	**I would probably vote against the proposal.**
20.0	**Not Sure -**	**I am not sure if I would vote for the proposal.**
29.1	**Probably Yes -**	**I would probably vote for the proposal.**
10.9	**Definitely Yes**	**-I would definitely vote for the proposal.**
(55)		

7. Do you believe your utility bill will increase if this proposal passes? *(CIRCLE ONE NUMBER)*

16.8%	**No**
83.2	**Yes**
(1,076)	

8. Do you think public officials will consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future? *(CIRCLE ONE NUMBER)*

41.9%	**No**
58.1	**Yes**
(1,331)	

9. Do you think public officials should consider the results of this study, along with other evidence, in deciding how Glen Canyon Dam should be operated in the future? *(CIRCLE ONE NUMBER)*

5.0%	**No**
95.0	**Yes**
(1,337)	

10. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

54.7%	**No**
45.3	**Yes**
(1,351)	

11. Before receiving this survey had you heard of Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

28.1%	**No**
71.9	**Yes**------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*
(1,351)	

0.0%	**Heard through media specifically about the study**
8.5	**Heard about environmental effects of the dam or dam operations on downriver resources**
0.0	**Both of the above**
91.5	**Other**
0.0	**Don't know**
(838)	

12. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly

agree and 5 being strongly disagree, please indicate how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
When humans interfere with nature, it often produces disastrous consequences.	37.8%	22.6%	26.3%	8.0%	5.3%	(1,356)
Humans will eventually learn enough about how nature works to be able to control it.	7.0	12.9	24.1	27.1	28.8	(1,352)
The balance of nature is very delicate and easily upset.	44.5	26.5	17.6	7.7	3.7	(1,352)
Humans have the right to modify the natural environment to suit their needs.	7.8	14.5	25.7	22.9	29.1	(1,352)
If things continue on their present course, we will soon experience a major ecological catastrophe.	25.8	20.3	25.3	15.6	13.0	(1,350)
Humans were meant to rule the rest of nature.	9.9	9.9	17.3	18.6	44.2	(1,348)
Despite our special abilities, humans are still subject to the laws of nature.	62.9	25.4	7.5	2.0	2.2	(1,343)
Plants and animals have as much right as humans to exist.	44.4	20.0	17.3	8.8	9.6	(1,348)
Human ingenuity will ensure that we do not make the earth unlivable.	12.0	19.3	32.0	21.3	15.5	(1,338)
Humans are severely abusing the environment.	39.7	23.7	20.8	9.4	6.4	(1,349)
The so-called ecological crisis facing humankind has been greatly exaggerated.	13.2	17.3	26.5	22.0	21.2	(1,338)
We are approaching the limit of the number of people the earth can support.	25.5	18.2	25.2	15.1	16.0	(1,350)
The earth is like a spaceship with very limited room and resources.	27.3	22.5	23.0	13.8	13.5	(1,345)
The earth has plenty of natural resources, if we just learn how to develop them.	30.8	28.9	21.7	11.8	6.7	(1,352)
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	6.2	8.8	22.9	33.7	28.3	(1,348)

13. The following statements discuss economic and environmental issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE				STRONGLY DISAGREE	
	1	2	3	4	5	
Economic security and well-being should be considered first; then we can worry about environmental problems.	7.9%	10.5%	29.9%	28.6%	23.1%	(1,372)
It is possible to protect our environment and natural resources and still maintain a healthy economy.	45.1	40.0	11.2	2.0	1.6	(1,374)
If business is forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market.	9.5	16.7	28.3	25.4	20.1	(1,360)
Some pollution is inevitable if we are going to continue to improve our standard of living.	15.0%	29.4%	27.4%	16.8%	11.4%	(1,367)
I would be willing to pay somewhat higher prices (5 to 10 percent higher) for products that would cause less pollution or environmental damage.	31.2	32.6	23.5	8.1	4.6	(1,364)
The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	5.6	8.4	27.4	30.4	28.2	(1,363)
Some land in the United States should be set aside from human use so it can remain completely untouched, regardless of its economic value.	46.0	21.5	13.3	9.1	10.2	(1,369)

14. The following statements discuss American Indian issues. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
It is our responsibility to protect those areas of historical or religious importance to American Indians.	40.8%	29.9%	17.8%	6.8%	4.6%	(1,374)
We have gone too far in granting American Indians special rights to use public lands and resources, such as fish and wildlife.	13.9	14.3	21.8	21.2	28.2	(1,370)
Our society can learn important lessons from studying earlier cultures that inhabited our country.	44.9	30.4	17.7	4.7	2.3	(1,373)
We can't afford to let concern for preserving artifacts of earlier American Indian cultures stand in the way of operating hydroelectric dams.	6.9	11.0	23.0	26.7	32.4	(1,372)
American Indian concerns should be equally as important as our society's economic needs when deciding how to use land.	33.9	24.6	25.7	9.7	6.1	(1,372)

15. The following statements discuss hydroelectricity. We would like to understand how you feel about these issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
The benefits of hydroelectric dams on the Colorado River outweigh the impacts to the natural environment and historical places along the river.	9.8%	14.6%	33.2%	23.9%	18.5%	(1,333)
Hydroelectric dams should not be constructed on rivers that flow through national parks.	16.7	13.2	29.9	25.1	15.1	(1,336)
Hydroelectric dams have fewer environmental impacts than coal, oil, or gas-burning power plants.	29.7	31.3	25.7	8.3	5.1	(1,324)
Hydroelectric dams can have serious impacts on the plants and animals that live in or along the river.	30.7	34.2	23.0	7.2	4.8	(1,341)
Hydroelectric dams produce relatively cheap electricity compared to other sources.	33.7	38.5	21.5	3.3	3.0	(1,328)
Hydroelectric dams should be developed wherever it is economically feasible, even if it means that some rivers will be changed.	12.6	17.3	29.1	22.4	18.6	(1,340)
Rivers without dams are a unique and irreplaceable resource that should be protected from hydroelectric dams.	19.9	16.1	34.3	20.6	9.1	(1,335)

In this section, we would like to learn how you feel about national parks in the United States.

16. Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

4.4%	**No**
94.9	**Yes**
0.7	**Don't know**
(1,349)	

17. We are interested in learning how you feel about national parks in general. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell us how you feel about each statement written below. *(CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
National parks are a "luxury" we cannot afford in difficult economic times.	4.3%	3.8%	9.0%	24.1%	58.8%	(1,351)
National parks help us to remember that our future is tied to the preservation of nature and natural resources.	57.0	27.8	9.9	3.2	2.1	(1,350)
It is important that national parks offer us a chance to see America as the early settlers saw it.	49.2	29.3	14.9	4.0	2.7	(1,355)
Americans need places like national parks to "recharge their batteries."	48.6	28.3	15.8	3.2	4.1	(1,352)
An important function of the National Park Service is to protect native birds, plants, and animals.	58.8	27.5	9.5	1.7	2.5	(1,351)
National parks are only valuable to the people who visit them.	4.9	5.9	8.8	29.1	51.2	(1,345)
Oil and natural gas finds on national park lands should be developed since it is in the national interest.	8.4	10.6	26.6	23.4	31.0	(1,337)
The National Park Service places too much emphasis on preservation.	4.8	9.1	19.5	28.6	38.0	(1,341)
I am glad there are national parks, even if I don't visit them.	72.8	18.9	6.3	0.8	1.2	(1,332)
People can think a place is valuable, even if they do not actually go there themselves.	72.6	21.5	4.0	0.8	1.0	(1,345)
The American people should provide greater financial support for the National Park Service to avoid more commercial activities in the national parks.	38.8	22.7	24.0	8.1	6.3	(1,341)
If the National Park Service needs more financial support, they should develop more gift shops and commercial activities to raise money.	10.3	11.6	28.4	24.4	25.3	(1,339)

In this section, we are interested in learning about trips you may have taken to Grand Canyon National Park.

18. As best you can recall, have you ever flown over Grand Canyon National Park in an aircraft? *(CIRCLE ONE NUMBER)*

57.1%	**No------------->** *SKIP TO QUESTION 20*
42.9	**Yes**
(1,341)	

19. Did you fly over Grand Canyon National Park while you were on a commercial airliner, or did you fly over the park as part of a sightseeing air tour that included the park? *(CIRCLE ALL NUMBERS THAT APPLY)*

91.5%	**flew over Grand Canyon National Park while on a commercial aircraft**
(564)	
6.4%	**flew over Grand Canyon National Park as part of a sightseeing air tour**
(564)	

flew over Grand Canyon National Park as part of a:

20.0%	**Military flight**
63.1	**Private plane**
4.6	**Charter flight**
1.5	**Medical evacuation**
6.2	**Helicopter**
1.5	**Fire fighter**
1.5	**Mail plane**
1.5	**Small craft**
(65)	

20. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

33.9%	**No------------->** *SKIP TO QUESTION 23*
66.1	**Yes**
(1,354)	

21. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

7.9%	**No------------->** *SKIP TO QUESTION 23*
92.1	**Yes**
(884)	

22. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

77.8%	**No**
22.2	**Yes**
(819)	

23. How likely do you think it is that you will visit the Grand Canyon National Park in the future? *(CIRCLE ONE NUMBER)*

8.7%	**Not at all likely**
11.2	**Somewhat unlikely**
34.4	**Somewhat likely**
45.6	**Very likely**
(1,353)	

In this last section, we would like to ask you some questions about your background that will help us compare your answers with those of other people. We stress that all of your responses are strictly confidential.

24. Are you: *(CIRCLE ONE NUMBER)*

56.9%	**Male**
43.1	**Female**
(1,361)	

25. How old are you? *(FILL IN THE BLANK)*

AVERAGE AGE	
51.6	**Years old**
(1,353)	

26. How many years of schooling have you completed? *(CIRCLE ONE NUMBER)*

2.8%	**Eight years or less**
4.3	**Some high school**
18.5	**High school graduate**
32.3	**Some college or technical school**
25.4	**College or technical school graduate**
16.8	**Post graduate work**
(1,353)	

27. How many people live in your household? *(FILL IN ALL BLANKS)*

AVERAGE NUMBER	
2.00	**People 18 years old or older**
(1,228)	
0.90	**People under the age of 18**
(1,137)	
2.80	**Total number of people in the household**
(1,258)	

28. Do you, or another member of your household, own or rent this residence? *(CIRCLE ONE NUMBER)*

84.6%	**Own**
13.9	**Rent**
1.5	**Other**
(1,354)	

29. Are you, or another member of your household, responsible for paying the utility bill? *(CIRCLE ONE NUMBER)*

2.4%	**No**
97.6	**Yes**
(1,357)	

30. Which of the following categories comes closest to your total 1993 household income? *(CIRCLE ONE NUMBER)*

6.9%	**Less than $10,000**	**7.2**	**$45,000 to $49,999**
8.0	**$10,000 to $14,999**	**7.7**	**$50,000 to $59,999**
9.8	**$15,000 to $19,999**	**6.9**	**$60,000 to $69,999**
9.4	**$20,000 to $24,999**	**4.3**	**$70,000 to $79,999**
9.0	**$25,000 to $29,999**	**2.1**	**$80,000 to $89,999**
8.6	**$30,000 to $34,999**	**1.5**	**$90,000 to $99,999**
7.1	**$35,000 to $39,999**	**4.2**	**Over $100,000**
7.4	**$40,000 to $44,999**	**(1,292)**	

Telephone Survey Frequencies -- National Sample

The frequencies presented in this section are based on 248 telephone interviews that were completed with nonrespondents to the mail survey for the national sample. Percentages shown for each question are based on the total number of cases with valid responses. The number of valid responses is shown in parentheses for each question. Invalid responses (item nonresponse) can be calculated by subtracting the number of valid responses from the total number that should have responded to the question. For example, all respondents were asked to answer Question 8. Of the total number of respondents who should have answered the question, 246 actually answered it (valid responses), and 2 refused (invalid responses). When calculating item nonresponse, keep in mind that not all survey respondents were required to answer all questions: some respondents were asked to skip some questions, depending on their answers to previous questions.

Survey Version

25.8%	**National Sample: Moderate Fluctuating Flow**
21.4	**National Sample: Low Fluctuating Flow**
27.8	**National Sample: Seasonally Adjusted Steady Flow**
25.0	**National Sample: Seasonally Adjusted Steady Flow with Moderate Fluctuating Flow Price Impacts**
(248)	

Hi, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. I'm trying to reach the **(Name)** household at **(Phone Number)**. Do I have the right number? *(CIRCLE ONE NUMBER)*

1 **No**------------->*(THANK AND TERMINATE)*
2 **Yes**
3 **Hung up**

Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam. To help us understand the survey results we need to understand the reasons people have for not participating in the study.

1. We asked that the adult in your household with the latest birthday in the calendar year read and complete the survey. Are you the adult in your household who had the latest birthday in the calendar year? *(CIRCLE ONE NUMBER)*

   1 **No**------>May I please speak to (him/her)? *(CIRCLE ONE NUMBER)*

   1 **No/not available**-------->When would be a good time for me to reach (him/her)? Who should we ask for when we call back? *(FILL IN BLANK AND GET FIRST NAME)*

   ____

   2 **Yes**------>Hello, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam.

   2 **Yes**

To help us understand the survey results we need to understand the reasons people have for not participating in the study.

2. Do you remember receiving the questionnaire in the mail? *(CIRCLE ONE NUMBER)*

31.3% **No**------------->*(PROBE:* It was a (color) booklet that came in a package with several other sheets of paper. There was also an envelope for you to return the questionnaire in. Do you remember that (color) booklet, it had a picture of the Colorado River on the cover? *(CIRCLE ONE NUMBER)*

87.0% **No**--------->I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

First name: ____________________
Last name: ____________________
Street address: ____________________
City: ____________________
State: ____________________
ZIP Code: ____________________
(SKIP TO QUESTION 8)

13.0 **Yes**
(77)

68.7 **Yes**
(246)

3. Did you look through the package of materials and the questionnaire? *(CIRCLE ONE NUMBER)*

30.2% **No**------------->Why not? *(FILL IN BLANK)*

52.2%	**No time/ too busy**
13.0	**Not interested/ not important**
2.2	**Lost booklet**
6.5	**Threw away/gave away**
4.3	**Vision impaired/couldn't read**
2.2	**Didn't understand/too hard**
4.3	**In process of moving**
2.2	**Confusion about proper respondent**
4.3	**Thought it was junk**
2.2	**Out of town, country**
2.2	**Don't do surveys**
4.3	**Don't know**
(46)	

69.8 **Yes**
(179)

4. Did you read the background information that described the study and the situation with the Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

32.0% No------------->Why not? *(FILL IN BLANK)*

42.1%	**No time/too busy**
7.9	**Not interested/not important**
2.6	**Lost booklet**
2.6	**Not enough information to answer**
7.9	**Vision impaired/couldn't read**
2.6	**Just didn't/no reason**
10.5	**Didn't understand/too hard**
2.6	**Just looked at it**
5.3	**Too long, wordy, detailed**
2.6	**Put it off/forgot about it**
2.6	**Confusion about proper respondent**
5.3	**Thought it was junk**
5.3	**Don't know**
(38)	

68.0 Yes
(125)

5. Did you start to fill out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

75.8% No------------->Why not? *(FILL IN BLANK)*

43.7%	**No time/too busy**
10.9	**Not interested/not important**
0.8	**Threw away/gave away**
3.4	**Not enough information to answer**
4.2	**Vision impaired/couldn't read**
0.8	**How information will be used**
1.7	**Just didn't/no reason**
9.2	**Didn't understand/too hard**
0.8	**Never been there (Glen Canyon Dam/Colorado River)**
0.8	**Just looked at it**
1.7	**My opinion not important**
4.2	**Too long, wordy, detailed**
1.7	**Put it off/forgot about it**
1.7	**In process of moving**
5.9	**Confusion about prop**
4.2	**Thought it was junk**
0.8	**Didn't think it was**
0.8	**Don't do surveys**
2.5	**Don't know**
(119)	

24.2 Yes
(178)

6. Did you finish filling out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

74.4% **No**------------->Why not? *(FILL IN BLANK)*

55.6%	**No time/too busy**
3.7	**Lost booklet**
14.8	**Not enough information to answer**
3.7	**Had questions**
3.7	**Too far away**
3.7	**Just didn't/no reason**
3.7	**Put it off/forgot about it**
3.7	**Did not mail it yet**
3.7	**Out of town, country**
3.7	**Don't know what it is**
(27)	

25.6 **Yes**
(43)

7. Do you still have the questionnaire booklet? *(CIRCLE ONE NUMBER)*

57.9% **No/Don't know**-------->Why not? *(FILL IN BLANK)*

1.1%	**No time/too busy**
4.5	**Not interested/not important**
13.6	**Lost booklet**
50.0	**Threw away/gave away**
1.1	**Vision impaired/couldn't read**
5.7	**Mailed it back**
1.1	**Just didn't/no reason**
1.1	**In process of moving**
1.1	**Confusion about prop**
1.1	**Did not mail it yet**
2.3	**Thought it was junk**
17.0	**Don't know**
(88)	

42.1 **Yes**
(178)

Another reason I'm calling you is that we need to find out a little bit about the people who didn't return the questionnaire booklet, so we can learn whether the results might have been different if we had heard from everyone.

8. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

91.9% **No**
6.9 **Yes**
1.2 **Don't recall**
(246)

9. Before receiving this survey had you heard of Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

74.8% **No**
25.2 **Yes**------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*
(246)

0.0% **Heard through media specifically about the study**
5.3 **Heard about the environmental effects of the dam or dam operations on downriver resources**
0.0 **Both of the above**
82.5 **Other comments**
12.3 **Don't know**
(57)

10. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

81.7% **No/Don't recall**------>Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

52.2% **No**
45.3 **Yes**
2.5 **Don't know**
(201)

(SKIP TO QUESTION 13)

18.3 **Yes**
(246)

11. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

20.0% **No/Don't recall**------------->*(SKIP TO QUESTION 13)*
80.0 **Yes**
(45)

12. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

86.1%	**No**
13.9	**Yes**
0.0	**Don't recall**
(36)	

13. How likely do you think it is that you will visit the Grand Canyon National Park in the future? Are you not at all likely, somewhat unlikely, somewhat likely, or very likely to visit the Grand Canyon in the future? *(CIRCLE ONE NUMBER)*

33.6%	**Not at all likely**
13.4	**Somewhat unlikely**
35.6	**Somewhat likely**
16.2	**Very likely**
1.2	**Don't know**
(247)	**Refusal**

Next, I'm going to read you some statements and ask you whether you agree or disagree with each statement. There are no right or wrong answers, we just want to know your opinion

14. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
a. When humans interfere with nature, it often produces disastrous consequences.	**44.4%**	**18.8%**	**23.0%**	**6.7%**	**7.1%**	**(239)**

On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	1	2	3	4	5	
b. Humans will eventually learn enough about how nature works to be able to control it.	**17.2**	**13.1**	**20.9**	**18.9**	**29.9**	**(244)**
c. The balance of nature is very delicate and easily upset.	**55.7**	**19.4**	**13.1**	**5.9**	**5.9**	**(237)**
d. Humans have the right to modify the natural environment to suit their needs.	**13.5**	**11.0**	**26.6**	**16.9**	**32.1**	**(237)**
e. If things continue on their present course, we will soon experience a major ecological catastrophe.	**43.0**	**14.5**	**20.0**	**9.8**	**12.8**	**(235)**

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	1	2	3	4	5	
f. Humans were meant to rule the rest of nature.	**13.6**	**7.4**	**13.2**	**18.6**	**47.1**	**(242)**
g. Despite our special abilities, humans are still subject to the laws of nature.	**61.1**	**22.1**	**11.5**	**2.5**	**2.9**	**(244)**
h. Plants and animals have as much right as humans to exist.	**63.8**	**14.4**	**9.9**	**4.1**	**7.8**	**(243)**
i. Human ingenuity will ensure that we do not make the earth unlivable.	**18.7**	**17.9**	**31.5**	**17.0**	**14.9**	**(235)**
j. Humans are severely abusing the environment.	**50.0**	**18.2**	**16.5**	**9.9**	**5.4**	**(242)**

(Continued)

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
k. The so-called ecological crisis facing humankind has been greatly exaggerated.	**11.3%**	**11.8%**	**28.2%**	**24.4%**	**24.4%**	**(238)**
l. We are approaching the limit of the number of people the earth can support.	**26.7**	**19.8**	**27.2**	**13.8**	**12.5**	**(232)**
m. The earth is like a spaceship with very limited room and resources.	**29.5**	**21.1**	**22.8**	**12.2**	**14.3**	**(237)**
n. The earth has plenty of natural resources, if we just learn how to develop them.	**49.0**	**21.8**	**16.3**	**7.9**	**5.0**	**(239)**
o. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	**14.2**	**12.1**	**25.4**	**19.0**	**29.3**	**(232)**

15. OK, the last few statements I am going to read to you discuss economic and environmental issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
a. Economic security and well-being should be considered first; then we can worry about environmental problems.	**12.1%**	**11.6%**	**24.5%**	**22.8%**	**28.6%**	**(241)**
b. If business if forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market	**11.3**	**20.0**	**31.3**	**21.3**	**16.1**	**(230)**
c. Some pollution is inevitable if we are going to continue to improve our standard of living.	**20.3**	**36.7**	**19.8**	**12.7**	**10.5**	**(237)**
d. The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	**9.1**	**9.5**	**26.7**	**26.7**	**28.0**	**(232)**

The last few questions I have are about your background. These questions will help us compare your answers with those of other people. All of your responses are strictly confidential.

16. How old are you? *(FILL IN THE BLANK)*

AVERAGE AGE

46.2	**Years old**
(243)	

17. How many years of schooling have you completed? *(READ LIST; CIRCLE ONE NUMBER)*

6.2%	**Eight years or less**
9.1	**Some high school**
26.7	**High school graduate**
25.9	**Some college or technical school**
19.8	**College or technical school graduate**
12.3	**Post graduate work**
(243)	

18. Including yourself, how many people live in your household? How many of these people are less than 18 years old? *(FILL IN ALL BLANKS)*

AVERAGE NUMBER

0.85	**People under the age of 18**
(245)	
1.89	**People 18 years old or older**
(245)	
2.74	**Total number of people in the household**
(245)	

19. Which of the following categories comes closest to your total **1993 household** income? *(READ LIST; CIRCLE ONE NUMBER)*

8.3%	**Less than $10,000**
7.4	**$10,000 to less than $15,000**
6.9	**$15,000 to less than $20,000**
13.8	**$20,000 to less than $25,000**
12.9	**$25,000 to less than $30,000**
10.6	**$30,000 to less than $35,000**
4.1	**$35,000 to less than $40,000**
6.0	**$40,000 to less than $45,000**
5.5%	**$45,000 to less than $50,000**
6.0	**$50,000 to less than $60,000**
4.6	**$60,000 to less than $70,000**
3.7	**$70,000 to less than $80,000**
2.3	**$80,000 to less than $90,000**
1.4	**$90,000 to less than $100,000**
6.5	**Over $100,000**
(217)	

[CHECK RESPONSE TO QUESTION 7. IF NO LONGER HAS SURVEY, SKIP TO QUESTION 19b.]

19a. Earlier, you said that you still have a copy of the questionnaire booklet. It would really help me out if you could spend a few minutes reading the background information materials and completing at least the first 9 questions in the survey booklet and mail it back to us in the envelope. Do you think you would be able to do that in the next few days? *(CIRCLE ONE NUMBER)*

6.7% **No**------------> OK, Thanks for your help.

93.3 **Yes**----------> I would really appreciate it if you could fill out at least the first 9 questions of the survey and put it in the mail in the next few days.

(75)

19b. Earlier, you said you may not have a copy of the survey booklet. If we mailed you another copy, could you spend a few minutes reading the background information and completing at least the first 9 questions of the survey booklet? If would really help me out. *(CIRCLE ONE NUMBER)*

24.0% **No**------------>OK, thanks for your help.
76.0 **Yes**----------->OK, I will mail you another copy of the survey. *(VERIFY ADDRESS IF NOT ALREADY DONE)*
(167)

I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

First name: ______________________
Last name: ______________________
Street address: ______________________
City: ______________________
State: ______________________
ZIP Code: ______________________

Thank you for your time. I'd really like to encourage you to return your survey. Do you have any questions or comments? *(FILL IN BLANK)*

____
____
____
____
____

(INTERVIEWER -- IS RESPONDENT. . . ?) (CIRCLE ONE NUMBER)

44.1% **Male**
55.9 **Female**
(247)

Telephone Survey Frequencies -- Marketing Area Sample

The frequencies presented in this section are based on 193 telephone interviews that were completed with nonrespondents to the mail survey for the marketing area sample. Percentages shown for each question are based on the total number of cases with valid responses. The number of valid responses is shown in parentheses for each question. Invalid responses (item nonresponse) can be calculated by subtracting the number of valid responses from the total number that should have responded to the question. For example, all respondents were asked to answer Question 8. Of the total number of respondents who should have answered the question, 192 actually answered it (valid responses), and one refused (invalid response). When calculating item nonresponse, keep in mind that not all survey respondents were required to answer all questions: some respondents were asked to skip some questions, depending on their answers to previous questions.

Survey Version

32.1%	**Marketing Area Sample: Moderate Fluctuating Flow**
30.1	**Marketing Area Sample: Low Fluctuating Flow**
37.8	**Marketing Area Sample: Seasonally Adjusted Steady Flow**
(193)	

Hi, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. I'm trying to reach the **(Name)** household at **(Phone Number)**. Do I have the right number? *(CIRCLE ONE NUMBER)*

1 **No**------------->*(THANK AND TERMINATE)*
2 **Yes**
3 **Hung up**

Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam. To help us understand the survey results we need to understand the reasons people have for not participating in the study.

1. We asked that the adult in your household with the latest birthday in the calendar year read and complete the survey. Are you the adult in your household who had the latest birthday in the calendar year? *(CIRCLE ONE NUMBER)*

   1 **No**------>May I please speak to (him/her)? *(CIRCLE ONE NUMBER)*

   1 **No/not available**-------->When would be a good time for me to reach (him/her)? Who should we ask for when we call back? *(FILL IN BLANK AND GET FIRST NAME)*

   ____

   2 **Yes**------>Hello, my name is ______________________. I'm with HBRS, a research firm that's working with the Bureau of Reclamation on the Glen Canyon Studies. Late last year we sent your household a questionnaire asking about issues related to the operation of the Glen Canyon Dam.

   2 **Yes**

To help us understand the survey results we need to understand the reasons people have for not participating in the study.

2. Do you remember receiving the questionnaire in the mail? *(CIRCLE ONE NUMBER)*

25.9% **No**------------->*(PROBE:* It was a (color) booklet that came in a package with several other sheets of paper. There was also an envelope for you to return the questionnaire in. Do you remember that (color) booklet, it had a picture of the Colorado River on the cover? *(CIRCLE ONE NUMBER)*

100.0% **No**--------->I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

First name: ____________________
Last name: ____________________
Street address: ____________________
City: ____________________
State: ____________________
ZIP Code: ____________________
(SKIP TO QUESTION 8)

0.0 **Yes**
(50)

74.1 **Yes**
(193)

3. Did you look through the package of materials and the questionnaire? *(CIRCLE ONE NUMBER)*

25.2% **No**------------->Why not? *(FILL IN BLANK)*

47.1%	**No time/ too busy**
11.8	**Not interested/ not important**
2.9	**Threw away/ gave away**
2.9	**Vision impaired/couldn't read**
5.9	**Put it off/forgot about it**
2.9	**In process of moving**
5.9	**Confusion about proper respondent**
2.9	**Thought it was junk**
2.9	**My opinion won't count**
2.9	**Never opened it**
2.9	**Didn't receive background**
2.9	**Don't know what it is**
2.9	**Questions phrased poorly**
2.9	**Don't know**
(34)	

74.8 **Yes**
(143)

4. Did you read the background information that described the study and the situation with the Glen Canyon Dam? *(CIRCLE ONE NUMBER)*

38.3% **No------------>**Why not? *(FILL IN BLANK)*

60.0%	**No time/too busy**
7.5	**Not interested/not important**
2.5	**Threw away/gave away**
7.5	**Not enough information to answer**
2.5	**Vision impaired/couldn't read**
7.5	**Didn't understand/too hard**
2.5	**Too long, wordy, detailed**
5.0	**Put it off/forgot about it**
2.5	**Never received survey**
2.5	**Don't know**
(40)	

61.7 **Yes**
(107)

5. Did you start to fill out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

77.6% **No------------>**Why not? *(FILL IN BLANK)*

45.4%	**No time/too busy**
12.4	**Not interested/not important**
1.0	**Lost booklet**
2.1	**Threw away/gave away**
6.2	**Not enough information to answer**
1.0	**Vision impaired/couldn't read**
1.0	**Too far away**
2.1	**Just didn't/no reason**
9.3	**Didn't understand/too hard**
1.0	**Never been there (Glen Canyon Dam/Colorado River)**
1.0	**My opinion not important**
1.0	**Too long, wordy, detailed**
4.1	**Put it off/forgot it**
1.0	**In process of moving**
2.1	**Confusion about proper respondent**
3.1	**Out of town, country**
1.0	**Never opened it**
1.0	**Had trouble with last one**
1.0	**Don't know what it is**
1.0	**Never received survey**
1.0	**Questions phrased poorly**
1.0	**Don't know**
(97)	

22.4 **Yes**
(143)

6. Did you finish filling out the questionnaire booklet? *(CIRCLE ONE NUMBER)*

78.1% **No**------------->Why not? *(FILL IN BLANK)*

45.5%	**No time/too busy**
9.1	**Not interested/not important**
9.1	**Lost booklet**
13.6	**Not enough information to answer**
4.5	**Vision impaired/couldn't read**
4.5	**Didn't understand/too hard**
4.5	**Too long, wordy, detailed**
4.5	**Questions phrased poorly**
4.5	**Don't know**
(22)	

21.9 **Yes**
(32)

7. Do you still have the questionnaire booklet? *(CIRCLE ONE NUMBER)*

58.5% **No/Don't know**-------->Why not? *(FILL IN BLANK)*

5.6%	**No time/too busy**
2.8	**Not interested/not important**
13.9	**Lost booklet**
48.6	**Threw away/gave away**
2.8	**Not enough information to answer**
1.4	**Vision impaired/couldn't read**
4.2	**Mailed it back**
1.4	**Didn't understand/too hard**
1.4	**In process of moving**
1.4	**Never opened it**
2.8	**Don't know what it is**
1.4	**Never received survey**
12.5	**Don't know**
(72)	

41.5 **Yes**
(142)

Another reason I'm calling you is that we need to find out a little bit about the people who didn't return the questionnaire booklet, so we can learn whether the results might have been different if we had heard from everyone.

8. Have you ever been to Glen Canyon Dam in Arizona? *(CIRCLE ONE NUMBER)*

76.6%	**No**
22.9	**Yes**
0.5	**Don't recall**
(192)	

9. Before receiving this survey had you heard of Glen Canyon Dam?
(CIRCLE ONE NUMBER)

45.8%	**No**	
54.2	**Yes**------------>What had you heard about Glen Canyon Dam before receiving this survey? *(FILL IN THE BLANK)*	
(192)		

0.0%	**Heard through media specifically about the study**
2.0	**Heard about the environmental effects of the dam or dam operations on downriver resources**
0.0	**Both of the above**
89.8	**Other comments**
8.2	**Don't know**
(98)	

10. Have you ever visited Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

59.4% **No/Don't recall**------>Have you ever visited any national parks in the United States? *(CIRCLE ONE NUMBER)*

17.5%	**No**
79.8	**Yes**
2.6	**Don't know**
(114)	

(SKIP TO QUESTION 13)

40.6 **Yes**
(192)

11. Did you see the Colorado River while you were in Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

7.7%	**No/Don't recall**------------>*(SKIP TO QUESTION 13)*
92.3	**Yes**
(78)	

12. Did you go down to the Colorado River while you were at the Grand Canyon National Park? *(CIRCLE ONE NUMBER)*

86.1%	**No**
12.5	**Yes**
1.4	**Don't recall**
(72)	

13. How likely do you think it is that you will visit the Grand Canyon National Park in the future? Are you not at all likely, somewhat unlikely, somewhat likely, or very likely to visit the Grand Canyon in the future? *(CIRCLE ONE NUMBER)*

28.6%	**Not at all likely**
9.4	**Somewhat unlikely**
32.8	**Somewhat likely**
27.6	**Very likely**
1.6	**Don't know**
(192)	

Next, I'm going to read you some statements and ask you whether you agree or disagree with each statement. There are no right or wrong answers, we just want to know your opinion

14. People often have different views about environmental issues. On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
a. When humans interfere with nature, it often produces disastrous consequences.	**39.6%**	**18.2%**	**28.9%**	**5.9%**	**7.5%**	**(187)**

On a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	1	2	3	4	5	
b. Humans will eventually learn enough about how nature works to be able to control it.	**18.6**	**12.8**	**22.9**	**20.7**	**25.0**	**(188)**
c. The balance of nature is very delicate and easily upset.	**55.6**	**17.5**	**15.9**	**7.4**	**3.7**	**(189)**
d. Humans have the right to modify the natural environment to suit their needs.	**15.4**	**13.3**	**24.5**	**15.4**	**31.4**	**(188)**
e. If things continue on their present course, we will soon experience a major ecological catastrophe.	**37.6**	**20.4**	**16.1**	**14.0**	**11.8**	**(186)**

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	1	2	3	4	5	
f. Humans were meant to rule the rest of nature.	**12.9**	**9.7**	**11.8**	**19.4**	**46.2**	**(186)**
g. Despite our special abilities, humans are still subject to the laws of nature.	**62.1**	**23.2**	**9.5**	**2.1**	**3.2**	**(190)**
h. Plants and animals have as much right as humans to exist.	**53.4**	**16.9**	**13.8**	**8.5**	**7.4**	**(189)**
i. Human ingenuity will ensure that we do not make the earth unlivable.	**24.7**	**23.1**	**27.4**	**14.0**	**10.8**	**(186)**
j. Humans are severely abusing the environment.	**42.6**	**18.6**	**25.0**	**9.6**	**4.3**	**(188)**

(Continued)

Again, on a scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, please tell me how you feel about the following statement:

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
k. The so-called ecological crisis facing humankind has been greatly exaggerated.	**12.0%**	**23.5%**	**27.9%**	**20.2%**	**16.4%**	**(183)**
l. We are approaching the limit of the number of people the earth can support.	**30.8**	**23.8**	**14.6**	**15.1**	**15.7**	**(185)**
m. The earth is like a spaceship with very limited room and resources.	**32.4**	**24.3**	**26.5**	**7.0**	**9.7**	**(185)**
n. The earth has plenty of natural resources, if we just learn how to develop them.	**45.7**	**27.1**	**17.0**	**6.4**	**3.7**	**(188)**
o. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	**9.1**	**15.5**	**27.3**	**20.9**	**27.3**	**(187)**

15. OK, the last few statements I am going to read to you discuss economic and environmental issues. On a scale of 1 to 5, where 1 means strongly agree and 5 means strongly disagree, please tell me how you feel about each statement I read. *(READ STATEMENT; CIRCLE ONE NUMBER FOR EACH STATEMENT)*

	STRONGLY AGREE 1	2	3	4	STRONGLY DISAGREE 5	
a. Economic security and well-being should be considered first; then we can worry about environmental problems.	**12.8%**	**13.4%**	**23.0%**	**21.4%**	**29.4%**	**(187)**
b. If business if forced to spend a lot of money on environmental protection, it won't be able to invest in research and development to keep us competitive in the international market	**12.2**	**18.1**	**26.6**	**26.1**	**17.0**	**(188)**
c. Some pollution is inevitable if we are going to continue to improve our standard of living.	**20.4**	**30.6**	**23.1**	**13.4**	**12.4**	**(186)**
d. The decision to develop resources should be based mostly on economic grounds rather than environmental or archeological grounds.	**10.8**	**7.5**	**34.4**	**21.5**	**25.8**	**(186)**

The last few questions I have are about your background. These questions will help us compare your answers with those of other people. All of your responses are strictly confidential.

16. How old are you? *(FILL IN THE BLANK)*

AVERAGE AGE
48.8 Years old
(189)

17. How many years of schooling have you completed? *(READ LIST; CIRCLE ONE NUMBER)*

4.2%	**Eight years or less**
5.2	**Some high school**
28.3	**High school graduate**
30.9	**Some college or technical school**
18.3	**College or technical school graduate**
13.1	**Post graduate work**
(191)	

18. Including yourself, how many people live in your household? How many of these people are less than 18 years old? *(FILL IN ALL BLANKS)*

AVERAGE NUMBER

0.98	**People under the age of 18**
(192)	
1.93	**People 18 years or older**
(192)	
2.94	**Total number of people in the household**
(193)	

19. Which of the following categories comes closest to your total **1993 household** income? *(READ LIST; CIRCLE ONE NUMBER)*

10.2%	**Less than $10,000**	**2.8%**	**$45,000 to less than $50,000**
10.2	**$10,000 to less than $15,000**	**9.7**	**$50,000 to less than $60,000**
8.5	**$15,000 to less than $20,000**	**6.8**	**$60,000 to less than $70,000**
10.8	**$20,000 to less than $25,000**	**2.3**	**$70,000 to less than $80,000**
10.8	**$25,000 to less than $30,000**	**2.3**	**$80,000 to less than $90,000**
8.5	**$30,000 to less than $35,000**	**0.6**	**$90,000 to less than $100,000**
7.4	**$35,000 to less than $40,000**	**2.8**	**Over $100,000**
6.3	**$40,000 to less than $45,000**	**(176)**	

[CHECK RESPONSE TO QUESTION 7. IF NO LONGER HAS SURVEY, SKIP TO QUESTION 19b.]

19a. Earlier, you said that you still have a copy of the questionnaire booklet. It would really help me out if you could spend a few minutes reading the background information materials and completing at least the first 9 questions in the survey booklet and mail it back to us in the envelope. Do you think you would be able to do that in the next few days? *(CIRCLE ONE NUMBER)*

1.8% **No**------------> OK, Thanks for your help.

98.2 **Yes**----------> I would really appreciate it if you could fill out at least the first 9 questions of the survey and put it in the mail in the next few days.

(57)

19b. Earlier, you said you may <u>not</u> have a copy of the survey booklet. If we mailed you another copy, could you spend a few minutes reading the background information and completing at least the first 9 questions of the survey booklet? If would really help me out. *(CIRCLE ONE NUMBER)*

21.8% **No**---------->OK, thanks for your help.
78.2 **Yes**-------->OK, I will mail you another copy of the survey. *(VERIFY ADDRESS IF NOT ALREADY DONE)*
(133)

I'd like to verify your name and mailing address. *(FILL IN BLANKS; VERIFY SPELLING)*

First name: ____________________
Last name: ____________________
Street address: ____________________
City: ____________________
State: ____________________
ZIP Code: ____________________

Thank you for your time. I'd really like to encourage you to return your survey. Do you have any questions or comments? *(FILL IN BLANK)*

____
____
____
____
____

(INTERVIEWER -- IS RESPONDENT . . . ?) (CIRCLE ONE NUMBER)

53.4% **Male**
46.6 **Female**
(193)

APPENDIX G
NONRESPONDENT SUPPORT OF A CHANGE IN DAM OPERATIONS

The calculation of population average willingness-to-pay required an estimate of the percentage of nonrespondents who would support a change in dam operations at zero cost ($0). This was accomplished by estimating separate logistic regression models for national and marketing area samples. Data from mail survey respondents was used to develop the models, where support was the dependent variable. Potential independent variables included the environmental attitude factor scores used in the logit models used to predict willingness-to-pay, income, and education (Reported and defined in Table 5-21). Tables G-1 and G-2 show the estimated parameters of the logit models for the national and marketing area samples, respectively. Variable definitions are shown in Table G-3.

These models predicted the percent of survey *respondents* who would support a change in dam operations. To predict the percent of *nonrespondents* who would support a change, the models were evaluated using the a using the average values for independent variables from the telephone survey of nonrespondents. Average values used for national and marketing area models are reported in Table G-4, and the percent of nonrespondents predicted to support a change in dam operations is reported in Table G-5 for each survey version.

Table G-1
Estimated Logistic Regression Model Parameters for the National Sample to Predict Support for a Change in Dam Operations at Zero Cost[a]

Variable	Parameters
constant	-0.6774 (0.2774) P=0.015
factor1	-0.2877 (0.0732) P=0.000
factor2	0.5175 (0.0747) P=0.000
factor4	0.1470 (0.0716) P=0.040
school	0.3359 (0.0668) P=0.000
income	0.000006 (0.000003) P=0.080
D2	0.7372 (0.2020) P=0.000
D3	0.4862 (0.1933) P=0.012
D4	0.7876 (0.2002) P=0.000
-2* Log Likelihood	1,231.1486
Chi-squared	150.29 P=0.000
Number of observations	1,387

[a] Standard errors are reported in parenthesis. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Table G-2
Estimated Logistic Regression Model Parameters for the Marketing Area Sample to Predict Support for a Change in Dam Operations at Zero Cost[a]

Variable	Parameters
constant	-0.1424 (0.3289) P=0.665
factor1	-0.3630 (0.0793) P=0.000
factor2	0.4604 (0.0860) P=0.000
school	0.2460 (0.0779) P=0.002
income	0.00001 (0.000004) P=0.003
D6	0.5774 (0.2040) P=0.005
D7	0.6114 (0.1995) P=0.002
-2* Log Likelihood	936.8278
Chi-squared	97.97 P=0.000
Number of observations	1,143

[a] Standard errors are reported in parenthesis. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Table G-3
Definition of Variables Used in Models to Predict Support of a Change in Dam Operations

Variable	Definition
constant	constant = 1
factor1	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 12 (nep scale), items 1,3,5,8, and 10. Labeled "Impacts of human intervention on nature." Expected sign: -
factor2	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 13 (economic/environmental issues), items 1,3,4, and 6. Labeled "Economic security." Expected sign: +
factor4	Factor score created from combined mail and telephone survey data. Heavy loading items include: question 12 (nep scale), items 2 and 9. Labeled "Human ingenuity will ensure balance." Expected sign: +
school	Question 26 in the mail survey and question 17 in the telephone survey. Respondent education, coded in categories where 1 = eight years or less and 6 = post graduate work.
income	Question 30 in the mail survey and question 19 in the telephone survey. House hold income. Recoded from categories to midpoint values.
D2	Dummy variable for national survey version. 1 = low fluctuating flow (Version 2), 0 = other
D3	Dummy variable for national survey version 1 = seasonally adjusted steady flow (Version 3), 0 = other
D4	Dummy variable for national survey version. 1 = seasonally adjusted steady flow with moderate flow price impacts (Version 4), 0 = other
D6	Dummy variable for marketing survey version. 1 = low fluctuating flow (Version 6), 0 = other
D7	Dummy variable for marketing survey version. 1 = seasonally adjusted steady flow (Version 7), 0 = other

Table G-4
Average Values of Independent Variables Used to Estimate Nonrespondent Support for a Change in Dam Operations at Zero Cost[a]

Variable	National Sample	Marketing Area Sample
factor1	-0.311 (208)	-0.162 (173)
factor2	-0.587 (208)	-0.531 (173)
factor4	-0.171 (208)	--[b] --
school	3.811 (243)	3.932 (191)
income	$41,797 (217)	$36,918 (176)

a Average values are reported for the data collected from the telephone survey of non-respondents.
b Factor 4 was not included in this model.
() Numbers in parenthesis indicate the number of valid cases.

Table G-5
Predicted Support for a Change in Dam Operations at Zero Cost for Mail Survey Nonrespondents

Water Release Alternative	Percent Who Would Favor a Change
National Sample	
Moderate Fluctuating Flow	65%
Low Fluctuating Flow	79%
Seasonally Adjusted Steady Flow	75%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	80%
Marketing Area Sample	
Moderate Fluctuating Flow	75%
Low Fluctuating Flow	84%
Seasonally Adjusted Steady Flow	85%

APPENDIX H
ADDITIONAL ANALYSES

The information presented in Chapter 5 represents what were considered to be the most important findings from the analysis performed. Additional analyses were performed to address issues raised by GCES Non-Use Value Committee members and by the peer reviewers. These issues include estimating econometric models using interaction terms, using the Turnbull estimation technique to calculate willingness-to-pay, and examining the data for outliers and influential data points. Each of these issues is addressed in this appendix.

H.1 MODELS WITH INTERACTION TERMS

Two sets of models were estimated to address concerns regarding possible interactions between key variables used in the logistic regression models reported in Chapter 5 (Tables 5-19 and 5-20). The two variables of concern are the "belief" variable (belief that taxes, taxincrease, or utility bills, utilityincrease, would increase with passage of the proposal) and the dollar amount used in the contingent valuation (CV) question. These additional models are discussed in order below.

H.1.1 Belief that Respondents Would Pay if the Proposal Passed

After completing the valuation question, survey respondents were asked if they believed they would experience higher taxes (in the national sample) or higher utility bills (in the marketing area sample) if the proposal they voted on actually passed. In the national sample, logistic regression models indicated that, all else equal, respondents who did not believe their taxes would increase were more likely to vote in favor of the proposal. A similar effect was observed in one of the market area logistic regressions. The analysis reported in Chapter 5 adjusted for this effect by evaluating models with this variable set at a level that indicated respondents believed they would have to pay if the proposal passed.

Concern was expressed during the review process about this adjustment. If significant interactions existed between respondents' belief they would have to pay and other factors in the logistic regression, the adjustment discussed above would not be appropriate. To assess this issue, logistic regression models were estimated in which the set of explanatory variables included variables to reflect interactions between each of the variables reported in Tables 5-19 and 5-20 and the belief that either taxes or utility bills would actually increase if the proposal passed. Interactive variables used in the national sample models were calculated by multiplying the variable "taxincrease" by each of the independent variables in the base model reported in Table 5-19. Interactive variables used in the market area sample models were calculated by multiplying the variable "utilityincrease" by each of the independent variables in the base model reported in Table 5-20. An interactive model was not estimated for the

"Definitely Yes" model in the marketing area, because "utilityincrease" was not a significant predictor in that model. Results are reported in Tables H-1 and H-2.

Table H-1
Estimated Logistic Regression Model Parameters for the National Sample with Interactive Variables[a]

Variable	Definitely Yes Model	Definitely / Probably Yes Model
constant	-4.6226	-1.4923
	(1.9339)	(1.2476)
	P=0.017	P=0.232
score	3.0848	2.2465
	(1.9631)	(1.1581)
	P=0.116	P=0.052
taxincrease	0.62167	-1.8647
	(2.2330)	(1.5209)
	P=0.781	P=0.220
useresults	-[b]	0.0061
	-	(0.2791)
	-	P=0.983
futuregc	0.0579	0.1127
	(0.1540)	(0.1381)
	P=0.707	P=0.414
factor1	-0.2653	-0.4143
	(0.2047)	(0.1673)
	P=0.195	P=0.013
factor2	0.7097	0.4405
	(0.1912)	(0.1622)
	P=0.000	P=0.007
factor3	-0.2336	-0.0619
	(0.1573)	(0.1384)
	P=0.137	P=0.655
factor4	0.1752	-
	(0.1710)	-
	P=0.305	-

(continued)

Table H-1
Estimated Logistic Regression Model Parameters for the National Sample with Interactive Variables (*Continued*)

Variable	Definitely Yes Model	Definitely / Probably Yes Model
school	0.1277 (0.1381) P=0.355	- - -
income	- - -	0.00001 (0.000005) P=0.031
D2	0.3047 0.4235 P=0.472	-0.3686 (0.3968) P=0.353
D3	-0.3210 (0.4450) P=0.471	-0.2828 (0.3910) P=0.480
D4	0.2635 (0.4271) P=0.537	0.0429 (0.4081) P=0.916
annbid1	-0.0086 (0.0025) P=0.001	-0.0107 (0.0021) P=0.000
scoreint	-2.2844 (2.2502) P=0.310	0.4944 (1.4327) P=0.730
useresultsint	- - -	0.3215 (0.3286) P=0.328
futuregcint	0.1855 (0.1977) P=0.348	0.0646 (0.1664) P=0.698
factor1int	-0.0487 (0.2430) P=0.841	0.0744 (0.1928) P=0.700
factor2int	-0.0146 (0.2379) P=0.951	0.0791 (0.1918) P=0.680
factor3int	0.0979 (0.1932) P=0.612	-0.0731 (0.1650) P=0.658

(*continued*)

Table H-1
Estimated Logistic Regression Model Parameters for the National Sample with Interactive Variables (*Continued*)

Variable	Definitely Yes Model	Definitely / Probably Yes Model
factor4int	0.0310	-
	(0.2078)	-
	P=0.881	-
schoolint	0.0950	-
	(0.1720)	-
	P=0.581	-
incomeint	-	0.000004
	-	(0.000006)
	-	P=0.482
D2int	-0.1222	0.9501
	(0.5276)	(0.4639)
	P=0.817	P=0.041
D3int	0.9748	0.6954
	(0.5375)	(0.4662)
	P=0.070	P=0.136
D4int	0.2688	0.4406
	(0.5219)	(0.4709)
	P=0.607	P=0.349
annbid1int	-0.0024	-0.0006
	(0.0031)	(0.0025)
	P=0.435	P=0.801
-2 * Log likelihood	910.7486	1196.2988
Chi-squared	8.8595	7.1703
	P=0.635	P=
Number of observations	1,094	1,039

[a] Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

[b] Dashes indicate that the variable was not included in the model.

Table H-2
Estimated Logistic Regression Model Parameters for the Marketing Area Sample with Interactive Variables[a]

Variable	Definitely / Probably Yes Model
constant	-0.9827 (2.3372) P=0.674
score	0.4351 (2.0874) P=0.835
utilityincrease	-2.4375 (2.5014) P=0.330
useresults	-0.2365 (0.4618) P=0.609
futuregc	0.9234 (0.2807) P=0.001
factor1	-0.2813 (0.2396) P=0.240
factor2	0.4294 (0.2656) P=0.106
factor3	-0.4721 (0.2183) P=0.031
factor4	0.2600 (0.2302) P=0.259
D6	0.9154 (0.5523) P=0.097
D7	1.1136 (0.5441) P=0.041
annbid1	-0.0218 (0.0040) P=0.000
scoreint	1.6668 (2.2464) P=0.458

(*continued*)

Table H-2
Estimated Logistic Regression Model Parameters for the Marketing Area Sample with Interactive Variables (*Continued*)

Variable	Definitely / Probably Yes Model
useresultsint	0.9750 (0.4951) P=0.049
futuregcint	-0.4386 (0.2985) P=0.142
factor1int	-0.0862 (0.2579) P=0.738
factor2int	0.1944 (0.2831) P=0.492
factor3int	0.1793 (0.2345) P=0.444
factor4int	-0.1013 (0.2506) P=0.686
D6int	-0.5094 (0.5945) P=0.392
D7int	-0.8915 (0.5827) P=0.126
annbid1int	0.0064 (0.0043) P=0.132
-2 * Log likelihood	950.0402
Chi-squared	12.2052 P=0.212
Number of observations	948

[a] Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Like the models reported in Chapter 5, the models reported in Tables H-1 and H-2 estimate the probability that a respondent would vote in favor of a proposal, as a function of several explanatory variables. Explanatory variables include those originally included in the base models reported in Chapter 5, plus a set of interactive variables. Interactive variables are identified by the "int" extension to the variable names. A statistical test of the joint significance of the interaction terms was carried out using a log-likelihood ratio test. This test statistic, which has a chi-square distribution, is used to test the hypothesis that the interaction variables significantly improved the fit of the model. The chi-squared statistics reported Tables H-1 and H-2 are the test statistics for the hypothesis that the interaction terms represent a significant improvement relative to the appropriate base model as reported in Chapter 5. The values of the test do not allow rejection of the hypothesis that the interaction terms jointly improve the fit of the model.

H.1.2 Interaction Models Allowing Shifts in Coefficient on the Dollar Amount

The analysis reported in Chapter 5 constructs estimates of willingness-to-pay by evaluating logistic regression models at average values and setting the dummy variables that reflect each alternative (D2 through D7) at the appropriate level. This procedure allows only for a shift in the constant term. Some concern was expressed during the review process that significant interactions could exist between the dummy variable reflecting the alternative and the dollar amount. Thus, additional models explored the significance of interaction variables that allowed for changes in the coefficient on the dollar amount used in the CV question depending on the scenario being evaluated. To do this, interactive variables were created by multiplying the dollar amount (variable "annbid1") by the dummy variables identifying alternative survey versions (D2, D3, and D4 for the national sample, and D6 and D7 for the marketing area). Again, the analysis presented here is based on the models reported in Chapter 5 -- the "base" models; interactive variables are identified by the "int" extension. Results are reported in Tables H-3 and H-4 for the national sample and marketing area sample "Definitely Yes" models, respectively. The chi-squared statistic at the bottom of each table tests the joint significance of the interaction terms. The reported test statistics do not allow rejection of the hypothesis that the interaction terms significantly increase the explanatory power of the logistic regression models.

Table H-3
Estimated Logistic Regression Model Parameters for the National Sample with Slope Interaction Variables[a]

Variable	Definitely Yes Model
constant	-3.4912 (1.0393) P=0.001
score	1.5099 (0.9553) P=0.114
taxincrease	-0.3829 (0.1765) P=0.030
futuregc	0.1769 (0.0950) P=0.063
factor1	-0.2996 (0.1096) P=0.006
factor2	0.6955 (0.1128) P=0.000
factor3	-0.1501 (0.0903) P=0.097
factor4	0.1871 (0.0968) P=0.053
school	0.1998 (0.0818) P=0.015
D2	0.1104 (0.3739) P=0.768
D3	0.5241 (0.3686) P=0.155
D4	0.2567 (0.3616) P=0.478

(*continued*)

Table H-3
Estimated Logistic Regression Model Parameters for the National Sample with Slope Interaction Variables [a] *(Continued)*

Variable	Definitely Yes Model
annbid1	-0.0108 (0.0033) P=0.001
D2bid	0.0019 (0.0043) P=0.657
D3bid	-0.0034 (0.0047) P=0.464
D4bid	0.0031 (0.0042) P=0.460
-2* Log likelihood	916.854
Chi Squared	2.7541 P=0.431
Number of observations	1,094

a Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

Table H-4
Estimated Logistic Regression Model Parameters for the Marketing Area Sample with Slope Interaction Variables[a]

Variable	Definitely Yes Model
constant	-4.2050 (1.0169) P=0.000
score	1.3759 (0.9247) P=0.137
useresults	0.6834 (0.1922) P=0.000

(continued)

Table H-4
Estimated Logistic Regression Model Parameters for the Marketing Area Sample with Slope Interaction Variables [a] (*Continued*)

Variable	Definitely Yes Model
futuregc	0.2574 (0.1212) P=0.034
factor1	-0.5599 (0.1146) P=0.000
factor2	0.5227 (0.1081) P=0.000
factor3	-0.2862 (0.0889) P=0.001
factor4	0.3946 (0.1038) P=0.000
income	0.000009 (0.000004) P=0.031
D6	0.1086 (0.3376) P=0.748
D7	0.3847 (0.3252) P=0.237
annbid1	-0.0135 (0.0030) P=0.000
D6bid	-0.0052 (0.0045) P=0.248
D7bid	-0.0032 (0.0040) P=0.422
-2* Log likelihood	764.457
Chi-Squared	1.3977 P=0.497
Number of observations	908

[a] Standard errors are reported in parentheses. Reported probabilities are associated with a 2-tailed test. Appropriate probabilities for a 1-tailed test are calculated by dividing reported probabilities by 2.

H.2 TURNBULL ESTIMATION OF WILLINGNESS-TO-PAY

Results presented in Chapter 5 were developed using a willingness-to-pay model estimated using logistic regression procedures. In recent years, several economists (Kristrom, 1990, Carson et al., 1994, and Haab and McConnell, 1995) have proposed modifications of nonparametric techniques traditionally used in the estimation of hazard functions as an alternative to logistic regression analysis. The process of using nonparametric methods to estimate a cumulative density function for willingness-to-pay is known as Turnbull estimation.

Several members of the peer review panel who were familiar with Turnbull nonparametric estimation suggested that it would be useful to explore whether the results reported in Chapter 5 would be changed if estimates of mean willingness-to-pay were constructed using the Turnbull technique. The Turnbull estimation technique offers several potential advantages to parametric techniques such as logistic regression. First, the Turnbull estimation technique does not require any assumptions about the functional form of the underlying distribution of willingness-to-pay. Second, estimates of average willingness-to-pay can be constructed from the Turnbull estimated cumulative density function in a way that provides lower bound estimates of willingness-to-pay. One drawback of this procedure is that it is only readily applied to univariate models, and is difficult to apply to multivariate models.

The next section provides an overview of the Turnbull estimation procedure. The following section compares estimates of average willingness-to-pay based on the Turnbull procedure to the estimates derived using logistic regression.

H.2.1 Overview of Turnbull Estimation Procedures

Discrete choice contingent valuation questions are questions in which survey respondents are asked if they would agree to some environmental intervention if the intervention would cost them a specified amount of money. All analysis of discrete choice contingent valuation data centers around the process of constructing estimates of the cumulative density function (cdf) for willingness-to-pay and then recovering estimates of mean willingness-to-pay from it. In a parametric analysis, a functional form is assumed for the cdf and the observed data are used to estimate the parameters of the assumed functional form. In nonparametric methods, no assumptions are made about the form of the underlying cdf. Instead, an empirical cdf is constructed using the observed proportion of "No" responses to each of the dollar amounts. For example, Turnbull estimation produces a step function that represents the estimated cdf.

The Turnbull method only requires that the estimated cdf satisfies a monotonicity assumption. This assumption simply reflects the fact that a cdf must be non-decreasing. In the context of contingent valuation, the monotonicity requirement means that the proportion of "No" responses must not decrease as the amount of the bid increases. In any particular data set, however, this assumption may be violated. For example, suppose that the CV study design included a total of m distinct dollar amounts, (in this study m would be 8). For each dollar amount, B_i, the proportion of respondents indicating they would not support the intervention at that amount is represented as $P_i=Z_i/N_i$, where Z_i is the number of respondents indicating they would not support the intervention at a cost of B_i, and N_i represents the number of respondents asked about B_i. The monotonicity requirement requires that $P_i < P_{i+1}$. If this condition is not satisfied for a particular pair of bids, the two dollar amounts are grouped and compared to the next highest bid. For example, if $P_i > P_{i+1}$, the Turnbull estimator would combine the responses to B_i and B_{i+1} and then compare $(Z_i+Z_{i+1})/(N_i+N_{i+1})$ to Z_{i+2}/N_{i+2}. If $(Z_i+Z_{i+1})/(N_i+N_{i+1}) > Z_{i+2}/N_{i+2}$, the process is continued until a monotonic increasing step function is obtained. This step function is a discrete approximation to the underlying cdf for willingness-to-pay. Estimates of mean willingness-to-pay can be constructed from the step function by recalling that for a discrete random variable, the expected value is simply the sum of the products of the possible values times the probability of the value. The Turnbull nonparametric lower bound estimate of mean willingness-to-pay is constructed by choosing the lower end of each step when constructing estimates of mean willingness-to-pay.

The Turnbull process can be illustrated using a simple example. Suppose that the experimental design for a contingent valuation study consisted of three dollar amounts $5, $10, and $15 and that 10 percent of respondents voted "No" to $5, 50 percent voted "No" to $10, and 80 percent voted "No" at $15. The three probabilities 0.1, 0.5, and 0.8 would provide estimates of the height of the step function approximation of the underlying cdf for willingness-to-pay.

A respondent is expected to vote "No" if their actual willingness-to-pay is less than the dollar amount they were asked about: since 10 percent of respondents voted "No" at $5, it could be estimated that 10 percent of the population had a willingness-to-pay of less than $5. Likewise, since 50 percent of respondents voted "No" at $10, it could also be inferred that 50 percent of the population had a willingness-to-pay of less than $10. These two facts allow us to estimate that 40 percent of the population had willingness-to-pay greater than $5 but less than $10. Following this logic, one can estimate the probability that willingness-to-pay falls within four distinct intervals: $0 to $5, $5 to $10, $10 to $15, and above $15 (Table H-5).

Given that the expected value of a discrete random variable can be written as the sum of the products of each possible outcome times the probability of the outcome, the results in Table H-5 can be used to calculate an estimate of mean willingness-to-pay. Table H-5 shows the four possible outcomes and the probabilities associated with each. Construction of an expected value requires picking a value of the discrete random variables for each of the four possible outcomes. In constructing a Turnbull lower bound estimate of mean willingness-to-pay, the probability associated with each interval is multiplied by the dollar value associated with the *lower* end of the interval. For example, Table H-5 shows 10 percent of willingness-to-pay estimates fall between $0 and $5. The Turnbull lower bound estimate assumes that all values in this step less than $5 are equal to zero ($0). Following this rule, the estimated mean willingness-to-pay would be $0*0.1 + $5*0.4 + $10*0.3 +$15*0.2 = $8.

Table H-5
Illustration of Nonparametric Estimation Techniques

Raw Data	
Dollar Amount	Percent Voted No
$5	10%
$10	50%
$15	80%
Inferred Probability of Willingness-to-Pay:	Probability
less than $5	.10
less than $10	.50
less than $15	.80
Inferred Probability of Willingness-to-Pay Falling Between:	Probability
$0 to $5	.10
$5 to $10	.40
$10 to $15	.30
Greater than $15	.20

H.2.2 Application to GCES Non-Use Value Final Study Data

The Turnbull procedure was applied to the observations used to develop the logistic regression models reported in Chapter 5. However, as noted above, the Turnbull procedure is not easily extended to permit a multivariate analysis. As a result, Turnbull nonparametric lower bound estimates of mean willingness-to-pay were calculated on a version-by-version basis. Furthermore, the Turnbull estimates can not be easily adjusted to reflect potential differences in characteristics of respondents to each version or belief that the respondent would really have to pay. Consequently, the Turnbull estimates can not be directly compared to the estimated mean willingness-to-pay reported in Chapter 5.

To provide a comparable set of estimates, the logistic models reported in Chapter 5 were used to produce an alternate set of mean willingness-to-pay estimates. For each survey version, mean willingness-to-pay was re-calculated from the logistic regression model by inserting average values of survey respondents to that version for all variables. Turnbull lower bound estimates and the alternate set of parametric estimates for the "Definitely Yes" models are presented in Table H-6. In the national sample, the Turnbull estimates tend to be less than the parametric estimates. In the marketing area sample, the Turnbull estimates are higher than the parametric estimates for two of the three versions. Differences between the Turnbull estimates and the parametric estimates would be unlikely to substantially alter the results presented in the body of the report.

Table H-6
Comparison of Turnbull Lower Bound and Parametric Estimates of Willingness-to-Pay

	Turnbull mean[a]	Sample size	Parametric mean[b]
National Sample			
Version 1	$24.08	246	$27.15
Version 2	$31.85	282	$33.49
Version 3	$26.04	273	$34.22
Version 4	$34.14	293	$37.75
Marketing Area Sample			
Version 5	$33.37	282	$31.48
Version 6	$31.65	297	$27.86
Version 7	$33.02	329	$34.97

a The data set used to carry out the Turnbull analysis consisted of the same observations used to construct the logistic regression models reported in Tables 5-19 and 5-20.
b Parametric estimates were calculated using the models reported in Tables 5-19 and 5-20. All variables were set equal to the average value observed for respondents to that version.

H.3 INFLUENTIAL DATA POINTS

The presence of influential data points was explored by examining the effect that the removal of each observation would have on the parameters of the "Definitely Yes" models reported in Tables 5-19 and 5-20. Three decision rules were followed to identify influential observations. Under the first decision rule, observations were identified as influential if deletion of the observation resulted in a change of 30 percent or more in any estimated parameter. Under this first decision rule, no observations in either the national or marketing areas samples were identified as influential. Under the second rule, observations were defined as influential if deletion of the observation changed any model parameter by more than 20 percent. A total of four observations were identified under this rule, two in the national sample and two in the marketing area sample. All four observations were identified because deletion of the observation would have resulted in a change of more than 20 percent in the value of the parameter associated with the quiz score. Deletion of any of these increased the value of the parameter associated with the quiz score variable. Consequently, deletion of these observations would have resulted in slightly higher estimates of mean willingness-to-pay. Finally, under the third rule, observations were determined to be influential if deletion of the observation would change any parameter value by 10 percent or more. This third rule identified 45 observations in the national sample and 61 observations in the marketing area sample. The relatively large number of observations identified under this rule (4 percent of the national sample data, and 7 percent of the marketing area data) and the relatively small impact any one of these observations would have on parameters, raised concern about using a 10 percent criteria to identify influential observations. The results of this analysis suggest to us that the logistic regression parameters reported in Chapter 5 are not dramatically affected by the presence of a small number of highly influential data points.

H.4 TRENDS IN PERCENTAGE OF "YES" VOTES IN DEFINITELY YES MODELS

An identical set of dollar amounts was used in the contingent valuation questions for each of the seven survey versions implemented. While respondents in the national sample evaluated four alternatives and respondents in the marketing area sample evaluated three alternatives, it was expected that the overall percentage of "Yes" responses would decrease with increases in the dollar amount that would have to be paid if the proposal passed. This expected relationship is generally exhibited over the range from $5 to $120 (Table H-7). An apparent anomaly to this pattern is observed in both the national and marketing area sample for the dollar amounts of $150 and $200. Disaggregation by the gender of the respondent reveals that this anomaly is very striking for females. For male respondents in the national sample, the percentage of "Yes" responses decreases from 43.2 percent at $5 to 27.5 percent at $30 and then remains in the 12 to 15 percent range for the remaining dollar amounts. For female respondents in the national sample, the percentage of "Yes" responses decreases from 33.9 percent at $5 to 13.1 percent at $120, drops to 1.4 percent at $150 and then increases to 13.5 percent at $200. A very similar pattern is observed in the marketing area. Given prior expectations, it seems clear that the percentage of "Yes" responses by female respondents at either $150 or $200 dollars presents an anomaly. If the response at $120 is accepted as valid, then the percent of females voting "Yes" at $200 appears too high. On the other hand, if the response at $200 is accepted as valid, then the percentage of females voting "Yes" at $150 appears to be too low.

In an attempt to further examine this anomaly, data from female respondents was disaggregated by survey version (Table H-8). When disaggregated to this level, sample sizes per dollar amount are very small (10 to 15 observations per dollar amount per version), however, the relative lack of "Yes" responses at $150 is still quite noticeable.

In the absence of further data it is difficult, if not impossible, to determine whether the response, the $150 amount, or the $200 amount represents the anomaly.

Table H-7
Overall Percentage "Yes" in Definitely Yes Models[a]

	National Sample			Marketing Area Sample		
Dollar Amount	Overall	Males	Females	Overall	Males	Females
$5	39.1%	43.2%	33.9%	50.8%	45.8%	58.0%
$15	30.2	31.8	27.5	37.3	34.4	40.7
$30	24.1	27.5	21.1	25.7	31.1	14.3
$60	15.3	12.5	18.5	22.3	26.2	17.6
$90	13.3	13.5	13.0	17.1	15.2	20.0
$120	14.5	15.5	13.1	12.6	9.4	17.0
$150	6.3	11.4	1.4	5.4	8.3	1.9
$200	12.9	12.5	13.5	9.7	4.7	16.3
	(1,094)	(611)	(483)	(908)	(525)	(383)

[a] The percentage of "Yes" responses is aggregated across all versions in the national sample and across all versions in the marketing area sample to illustrate the general trend of "Yes" and "No" responses.

( ) Number in parentheses indicate the number of valid cases.

Table H-8
Percentage of "Yes" Votes in Definitely Yes Models,
Female Respondents Disaggregated by Survey Version

Dollar Amount	Version 1	Version 2	Version 3	Version 4	Version 5	Version 6	Version 7
$5	31.3%	21.4%	46.2%	37.5%	58.3%	66.7%	50.0%
$15	15.4	27.3	35.7	30.8	50.0	41.2	31.6
$30	36.8	18.2	15.0	13.3	10.0	16.7	15.4
$60	16.7	29.4	17.6	10.5	15.0	17.6	21.4
$90	14.3	9.1	8.3	22.2	16.7	33.3	11.1
$120	7.1	33.3	7.1	5.6	21.4	17.6	12.5
$150	0.0	0.0	5.9	0.0	5.6	0.0	0.0
$200	0.0	15.0	27.3	11.1	13.3	6.7	26.3
	(113)	(128)	(118)	(124)	(119)	(123)	(141)

( ) Number in parentheses indicates number of valid cases.

APPENDIX I
SENSITIVITY ANALYSIS

The results presented in Chapter 5 represent point estimates of average willingness-to-pay for alternative dam operations. These point estimates are subject to several sources of variability. Statistical variability arises from the procedure used to estimate the parameters reported in Tables 5-19 and 5-20. Statistical uncertainty about these parameters results in statistical uncertainty about the estimates of mean willingness-to-pay. This, in turn, is reflected in the range of value estimates reported in Tables 5-31 and 5-32.

A second source of uncertainty arises from the assumptions that were used in the calculation of population average willingness-to-pay. Changes in assumptions would result in changes in estimated willingness-to-pay. This appendix presents the results of sensitivity analyses performed to determine how estimates of willingness-to-pay would change as a result of changes in the key assumptions on which the results in Chapter 5 are based. Each of the following sections examines a key assumption and presents estimates of mean willingness-to-pay if that assumption were changed.

I.1 TREATMENT OF NONRESPONDENTS

The results in Chapter 5 are based on the assumption that at least some of the nonrespondents to the mail survey would have expressed positive values if they had completed and returned the mail survey. Values for nonrespondents were imputed by first estimating the *proportion* of nonrespondents that would have supported the proposal at zero cost. This was accomplished using the logistic regression model discussed in Appendix G. The logistic regression model reported in Tables 5-19 and 5-20 was then used to impute average willingness-to-pay values for the nonrespondents, by using data collected on nonrespondents during the telephone survey.

An alternative assumption would have been to assume that *all* nonrespondents to the mail survey had a zero value for changes in dam operations. Making this assumption decreases population-weighted average willingness-to-pay by about 20 percent for alternatives in the national sample, and by about 17 percent in the market area versions (Table I-1).

I.2 USE OF A "DEFINITELY YES" MODEL

Recent research suggests that data from respondents with a high degree of certainty in their contingent valuation responses may have a higher degree of criterion validity compared with data from less certain respondents. However, the use of discrete choice models based on polychotomous choice response categories (used in the final study) is not widespread. Results from the pilot test suggested that at least a portion of the respondents who voted yes in a dichotomous choice CV question would have chosen the "Probably Yes" response category if polychotomous response categories had been available. Furthermore, in the pilot test, WTP estimates calculated using a "Definitely or Probably Yes" model were substantially closer to (but still lower than) results that were based on a standard dichotomous choice question (see Appendix C for a discussion of pilot test results). Therefore, it is likely that the valuation results based on the "Definitely Yes" models reported in Chapter 5 are substantially lower than the results that would have been obtained if the study had used a more traditional dichotomous choice format categories for the contingent valuation question.

An indication of the possible magnitude the consequence of using polychotomous response categories and basing the results on a "Definitely Yes" model is obtained by comparing the results of the "Definitely Yes" models to the results obtained from the "Definitely/Probably Yes" models (Table I-2). In the national sample, use of a "Definitely/Probably Yes" model increases the estimates of mean willingness-to-pay by 300 percent to 400 percent depending on the alternative evaluated. In the marketing area sample, use of a "Definitely/Probably Yes" model increases mean willingness-to-pay by about 200 percent for the moderate fluctuating and seasonally adjusted steady flow alternatives and about 350 percent for the low fluctuating flow alternative. Given that the "Definitely/Probably Yes" model produced values lower than the dichotomous choice model estimated in the pilot test (pilot test survey Version 7), the results reported in Table I-2 are likely to underestimate the actual impact of having used a "Definitely Yes" model as opposed to a traditional, dichotomous choice model.

I.3 TREATMENT OF OUT-OF-SCOPE SAMPLE POINTS

Some concerns were expressed about the procedures used for calculating population average willingness-to-pay. Recall that survey response rates were calculated as a percentage of deliverable questionnaires. This method of calculation effectively reduces the total valid sample size used to calculate the response rate, by subtracting cases classified as "out-of-scope." Sample points categorized as out-of-scope represent cases for which the respondent could not be reached at the listed address. Examples of out-of-scope sample points include sample points for which:

- Surveys are returned with an indication that the respondent had moved and no forwarding address was available;
- Surveys returned with an indication that no such address existed; and
- Surveys returned with an indication that the recipient had died.

Thus, response rates reflect the percent of survey respondents (those who return completed questionnaires) and nonrespondents (those for whom we had no indication that the address was invalid but had not returned a questionnaires). These two percentages sum to 100 percent. When population average willingness-to-pay estimates were calculated, the weights were calculated so the survey data represented the proportion of these two groups in the sample. (See Tables 5-25 and 5-26 for the "Definitely Yes" models, and Tables 5-27 and 5-

28 for the "Definitely/Probably Yes" models in Section 5.9). This procedure is equivalent to the assumption that the respondents and nonrespondents to the mail survey present an accurate representation of the out-of-scope sample points. This treatment seems to be a rather standard practice in contingent valuation studies. However, some members of the GCES Non-Use Value Committee suggested that out-of-scope sample points might systematically differ from the mail and telephone survey respondents. To assess the potential magnitude of this issue, population-weighted average willingness-to-pay was calculated under the alternative assumption that all out-of-scope sample points had a willingness-to-pay of zero (Table I-3). Under this assumption, population-weighted average willingness-to-pay decreased by 22 to 23 percent in the national sample, and by 23 to 27 percent in the marketing area sample, depending on the survey version.

Table I-1
Percent Change in Mean Willingness-to-Pay between Definitely Yes Models with Values Imputed for Nonrespondents and Models with Zero Values Assumed for Nonrespondents

	Values Imputed for Nonrespondents	Zero Values Assumed for Nonrespondents	Percent Change from Base
National Sample			
Moderate Fluctuating Flow	$13.65	$10.95	-19.78%
Low Fluctuating Flow	$20.15	$16.26	-19.30%
Seasonally Adjusted Steady Flow	$20.55	$16.60	-19.22%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	$23.79	$18.83	-20.85%
Market Area Sample			
Moderate Fluctuating Flow	$22.06	$18.24	-17.27%
Low Fluctuating Flow	$21.45	$17.90	-16.41%
Seasonally Adjusted Steady Flow	$28.87	$24.04	-16.73%

Table I-2
Percent Change in Mean Willingness-to-Pay between Definitely Yes and Definitely/Probably Yes Models with Values Imputed for Nonrespondents

	Definitely Yes	Definitely/ Probably Yes	Percent Change from Base
National Sample			
Moderate Fluctuating Flow	$13.65	$67.56	+394.94%
Low Fluctuating Flow	$20.15	$97.33	+383.03%
Seasonally Adjusted Steady Flow	$20.55	$86.18	+319.37%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	$23.79	$98.77	+315.17%
Market Area Sample			
Moderate Fluctuating Flow	$22.06	$69.49	+215.00%
Low Fluctuating Flow	$21.45	$98.29	+358.23%
Seasonally Adjusted Steady Flow	$28.87	$90.91	+214.89%

Table I-3
Percent Change in Mean Willingness-to-Pay between Definitely Yes Models with Values Imputed for Nonrespondents and Models with Zero Values Assumed for Out-of-Scope Sample Points

	Values Imputed for Nonrespondents	Zero Values Assumed for Out-of-Scope	Percent Change from Base
National Sample			
Moderate Fluctuating Flow	$13.65	$10.63	-22.12%
Low Fluctuating Flow	$20.15	$15.36	-23.77%
Seasonally Adjusted Steady Flow	$20.55	$15.81	-23.07%
Seasonally Adjusted Steady Flow with Moderate Flow Price Impacts	$23.79	$18.47	-22.36%
Market Area Sample			
Moderate Fluctuating Flow	$22.06	$16.37	-25.79%
Low Fluctuating Flow	$21.45	$15.75	-26.57%
Seasonally Adjusted Steady Flow	$28.87	$22.08	-23.52%

MISSION STATEMENTS

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering wise use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

U.S. DEPARTMENT OF COMMERCE
Technology Administration
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Springfield, VA 22161 (703) 487-4650

ATTACHMENT 4.

GAO Final Audit Report.

United States General Accounting Office

GAO

Report to Congressional Committees

October 1996

BUREAU OF RECLAMATION

An Assessment of the Environmental Impact Statement on the Operations of the Glen Canyon Dam

GAO/RCED-97-12

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-272927

October 2, 1996

The Honorable Frank Murkowski
Chairman
The Honorable J. Bennett Johnston
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

The Honorable Don Young
Chairman
The Honorable George Miller
Ranking Minority Member
Committee on Resources
House of Representatives

This report responds to subsection 1804(b) of the Grand Canyon Protection Act of 1992 (title XVIII of P.L. 102-575), which required GAO to audit the Bureau of Reclamation's final environmental impact statement on the operations of the Glen Canyon Dam. The report discusses (1) whether Reclamation's determination of the impact of various dam-operating alternatives on selected resources was reasonable and (2) what, if any, concerns still exist on the part of key interested parties about the final impact statement.

We are providing a copy of this report to the Secretary of the Interior, the Assistant Secretary for Water and Power, and the Commissioner of the Bureau of Reclamation. We will also make copies available to others upon request.

This report was prepared under the direction of Victor S. Rezendes, Director, Energy, Resources, and Science Issues, who can be reached at (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix XIII.

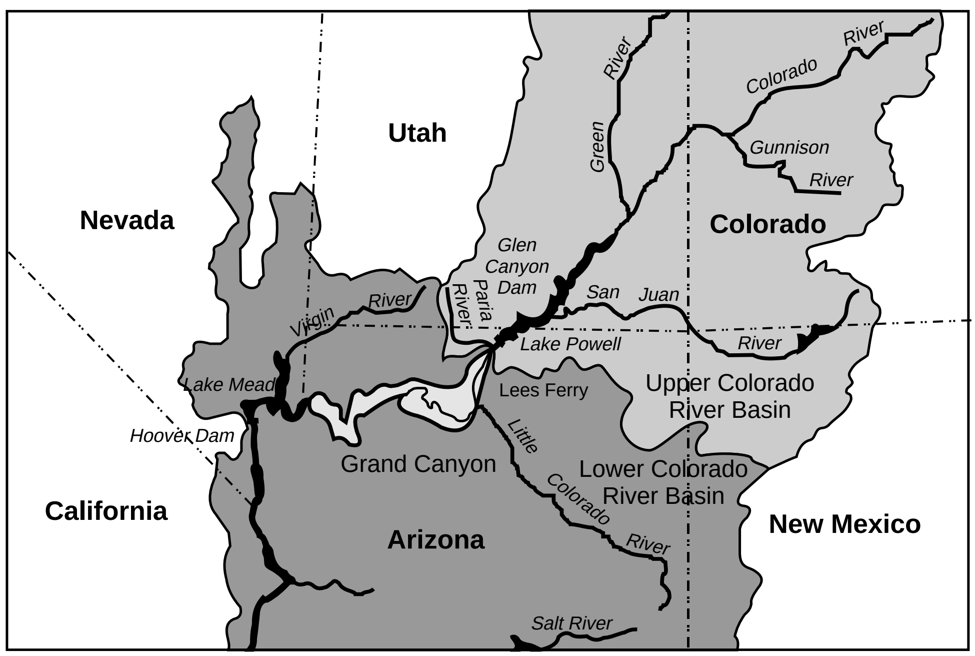
Keith O. Fultz
Assistant Comptroller General

Executive Summary

Purpose

Since the Glen Canyon Dam, located in Page, Arizona, was completed by the Bureau of Reclamation in 1963, it has been used to generate power during periods of high demand, commonly known as peaking power. The fluctuating releases of water associated with the dam's peaking power operations have caused concerns about the detrimental effects such flows have on downstream resources, particularly those located in the Grand Canyon. In response to these concerns, the Secretary of the Interior, in July 1989, directed the Bureau of Reclamation to prepare an environmental impact statement that would reevaluate the Glen Canyon Dam's operations. The purpose of the reevaluation was to determine specific options for operating the dam that could minimize the adverse impacts on the downstream environmental and recreational resources, as well as on Native American interests in the Glen and Grand canyons, while still producing hydropower.

Figure 1: Location of the Glen Canyon Dam



Source: Bureau of Reclamation.

In October 1992, the Congress enacted the Grand Canyon Protection Act of 1992 (title XVIII of P.L. 102-575), which required the Secretary of the Interior to complete the environmental impact statement by October 30, 1994. The act also required that GAO audit the costs and benefits of the various operating alternatives identified in the final environmental impact statement. In preparing the statement, Reclamation studied the potential impact of various flow alternatives on selected resources. Reclamation reported the results of these studies in the final environmental impact statement on March 21, 1995. As discussed with the responsible congressional committees, for the purpose of this audit, GAO examined (1) whether Reclamation's impact determinations were reasonable and (2) what, if any, concerns still exist about the Glen Canyon Dam's final environmental impact statement. The act also requires that on the basis of the findings, conclusions, and recommendations made in the environmental impact statement and the GAO audit report, the Secretary is to adopt criteria and operating plans for the dam.

Background

Before the construction of the Glen Canyon Dam, the Colorado River's sediment-laden flows fluctuated dramatically during different seasons of the year. Annual daily flows of greater than 80,000 cubic feet per second were common during the spring runoff. In contrast, flows of less than 3,000 cubic feet per second were typical throughout the late summer, fall, and winter. Water temperatures ranged from near freezing in the winter to more than 80 degrees Fahrenheit in the summer. The construction of the Glen Canyon Dam altered the natural dynamics of the Colorado River corridor through the Glen and Grand canyons. The dam replaced the dramatic seasonal flow variations with significant daily fluctuations, greatly reduced the amount of sediment in the water, and resulted in nearly constant water release temperatures of about 46 degrees Fahrenheit.

As early as 1982, the Secretary of the Interior initiated the Glen Canyon Environmental Studies of the effects of the dam. These studies were led by Reclamation and conducted by a number of different agencies. In 1989, the Secretary designated Reclamation as the lead agency in preparing an environmental impact statement. Other agencies and individuals participated in these efforts, including federal and state resource agencies, Indian tribes, private consultants, universities, and river guides. To protect the downstream resources until the completion of the impact statement and the adoption of a new operating plan for the dam, in November 1991 Reclamation implemented interim operating criteria. The interim operating criteria reduced the maximum peak releases and daily fluctuations. With the passage of the Grand Canyon Protection Act of 1992, the Congress required that the Glen Canyon Dam be operated to protect and restore the downstream resources of the Grand Canyon National Park and the Glen Canyon National Recreational Area.

The National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) requires that a detailed environmental impact statement be prepared for every major federal action that may significantly affect the quality of the human environment. The act and its implementing regulations set forth the requirements for preparing an impact statement. Among other things, a statement must (1) address the purpose of and need for the action, (2) describe the environment that will be affected, (3) identify alternatives to the proposed action, (4) present the environmental impacts of the proposed action (including the direct, indirect, and cumulative impacts), and (5) identify the agency's preferred alternative. The act does not require, and Reclamation did not perform, a cost and benefit analysis of the proposed action.

In preparing the environmental impact statement for the operation of the Glen Canyon Dam, Reclamation identified 11 resources affected by the dam's operations to be analyzed in detail: water, sediment, fish, vegetation, wildlife and habitat, endangered and other special-status species, cultural resources, air quality, recreation, hydropower, and non-use value. (Non-use values have been defined as those values that people may receive from the knowledge that such things as rare plants and unspoiled natural environments exist, even if people do not consume or use these goods directly.)

In addition, the impact statement identified nine alternative operational scenarios to be studied in detail. These alternatives can be divided into three descriptive categories: unrestricted fluctuating flows (two alternatives, including the no-action alternative); restricted fluctuating flows (four alternatives); and steady flows (three alternatives).

In the final impact statement, Reclamation recommended the Modified Low Fluctuating Flow as the preferred alternative. This alternative was developed to reduce daily flow fluctuations well below the dam's previous operating levels and to provide periodic high, steady releases of short duration; the goal of this alternative was to protect or enhance downstream resources while allowing limited flexibility for power operations.

Results in Brief

In general, Reclamation used appropriate methodologies and the best available information in determining the potential impact of the dam's various flow alternatives on selected resources. GAO identified some shortcomings and controversy in Reclamation's application of certain methodologies, and some of the data that Reclamation used in making its impact determinations were dated, preliminary, or incomplete. These limitations, combined with the inherent uncertainty associated with making forecasts, reduces the precision of the impacts contained in the statement, and some uncertainty, such as the impact of steady flows on fish resources, remains. Nonetheless, according to GAO's analysis and the opinions of experts, these limitations are not significant enough to alter the relative ranking of the flow alternatives nor render the final environmental impact statement unusable as a decision-making document. Furthermore, Reclamation recognizes that uncertainties still exist. To address these concerns, Reclamation intends to initiate a process of "adaptive management" that would provide for long-term monitoring and research to measure the actual effects of the selected alternative. The results of this effort would form the basis for possible future modifications of the dam's operations.

Many of the key interested parties affected by the Glen Canyon Dam's environmental impact statement support the process used by Reclamation to develop the impact statement as well as the implementation of the preferred alternative. However, while expressing their support, some interested parties raised specific concerns that still exist about the final environmental impact statement, including (1) the manner in which compliance with the Endangered Species Act will be achieved, (2) the economic impact of reducing the Glen Canyon Dam's hydroelectric power capacity, (3) the consideration of other possible causes of adverse downstream impacts, (4) the difficulties in measuring the impact of changes in the dam's operations, (5) the adequacy of the measures for reducing the frequency of unscheduled floods, (6) the need for installing multilevel water intake structures (selective withdrawal structures) on the dam to raise the downstream water temperature, and (7) the implementation of the Adaptive Management Program.

Principal Findings

Impact Determinations Are Usable for Decision-Making

In preparing the environmental impact statement, Reclamation used a variety of methodologies and data sources to study the impact of the various dam flow alternatives on hydropower, non-use values and other resources located below the dam. Generally, GAO found the methodologies used to be reasonable and appropriate. For example, the power analysis was conducted by a committee of specialists representing the federal government, the utility industry, private contractors, and the environmental community. This committee used utility-specific data and state-of-the-art simulation models to estimate the economic impact of the alternative dam flows on large regional utilities.

In assessing Reclamation's implementation of the various methodologies, GAO did note several shortcomings and controversy over the methodology used to estimate non-use values. For example, in the hydropower analysis, Reclamation's assumptions do not explicitly include the mitigating effect of higher electricity prices on electricity demand (price elasticity). GAO also found that Reclamation's assumptions about future natural gas prices were relatively high and that two computational errors were made during the third phase of the power analysis. These limitations suggest that the estimated economic impacts for power are subject to uncertainty. However, Reclamation and many experts associated with the process do not believe that these limitations make the results of the analysis unusable. For example, an association that represents the affected power utilities, which has maintained throughout the power studies process that the impact statement understates the costs to the power system, does not believe that Reclamation's cost estimate is understated by a large magnitude. To quantify the impact of various dam flow alternatives on recreation and non-use value, Reclamation used a methodology called contingent valuation. The use of contingent valuation studies, which rely on surveys to elicit information from consumers to estimate how much they would be willing to pay for something is controversial. Although contingent valuation is currently the only known approach for estimating non-use values, some prominent economists question whether this methodology can accurately elicit the value consumers place on non-use goods. However, many economists and survey researchers working in the natural resource and environmental areas have developed and used this methodology. Although these shortcomings affect the estimates for the alternatives, it is unlikely that they would alter the relative ranking of the fluctuating and steady flow alternatives.

GAO also found that Reclamation generally used the best available data in making its impact determinations. For example, for information on cultural resources and properties, Reclamation went beyond the federal requirements for the development of an impact statement by performing assessments of all previously identified archeological sites within the Colorado River corridor in the Glen and Grand canyons. According to many experts, when completed, this effort generated the best and most current scientific information available. However, GAO also found some limitations in the data used in the development of the impact statement. Specifically, some of the information was dated, some was preliminary, and some was incomplete. For example, to assess the economic impact of the alternative flows on recreational activities, Reclamation used a 1985 survey of a sample of anglers, day-rafters, and white-water boaters that asked about their experiences on the Colorado River and what effect, if any, different streamflows would have on their recreational experiences. Although Reclamation updated some of the data to 1991, it acknowledges that the survey information is generally dated. The National Research Council generally found the analysis to be adequate.

Many of the results of the sediment studies at Glen Canyon were preliminary, were in draft form, and had not been published at the time that the draft or even the final impact statement was written. However, according to the researchers that GAO interviewed, no new or additional information on sediment impacts has been obtained that would alter the information or conclusions presented in the final impact statement.

Finally, the information on some resources is incomplete, as is the knowledge of how changes in the Glen Canyon Dam's operations will affect those resources. For example, in part because of incomplete data, the experts' opinions vary on the interactions between native and nonnative fish and how operational changes would affect these interactions and, ultimately, fish populations. In its final biological opinion, the U. S. Fish and Wildlife Service stated that Reclamation's preferred alternative for the dam's future operations, the Modified Low Fluctuating Flow alternative, is likely to jeopardize the existence of two native endangered fish species (the humpback chub and the razorback sucker). The Service identified actions that would modify the preferred alternative with seasonally adjusted steady flows. The Service and Reclamation agreed to categorize these flows as experimental, or research flows. The purpose of this research is to study the effects of steady flows on endangered and native fish.

Reclamation recognizes that many uncertainties about the actual impact of the various flow alternatives still exist. To address such concerns, Reclamation intends to initiate a process of “adaptive management” that would provide for long-term monitoring, research, and measurement of the effects of the selected alternative. The results of this effort would form the basis for future modifications of the dam’s operations.

Most Key Parties Support the Preferred Alternative, but Some Concerns Remain

The process for selecting a preferred alternative for the future operations of the Glen Canyon Dam considered many factors, such as protecting natural and cultural resources and maintaining hydropower generating capability, and involved many parties with diverse interests. Reclamation’s goal was to select an alternative dam-operating plan that would permit downstream resources to recover to acceptable long-term management levels while maintaining some level of hydropower flexibility. Reclamation believes that it accomplished this goal by selecting the Modified Low Fluctuating Flow as the preferred alternative. According to Reclamation, this flow alternative was developed to reduce daily flow fluctuations well below the dam’s historic operations and to provide periodic high, steady water releases of short duration with the goal of protecting or enhancing the downstream resources while allowing limited flexibility for power operations. This alternative has the same annual and essentially the same monthly water releases as the dam’s historic operations but would restrict daily and hourly water releases more than previously.

GAO judgmentally selected 37 key interested parties and surveyed them on whether they supported Reclamation’s preferred alternative and whether they have any remaining concerns about implementing this alternative as the future operating plan for the Glen Canyon Dam. GAO’s judgmental sample consisted of all of the organizations and individuals that Reclamation identified as providing significant comments on the draft impact statement, any organizations that were considered cooperating agencies in the impact statement’s development process, and other key interested parties. Over 83 percent (25 of 30) of the respondents to GAO’s survey supported the preferred alternative, and many expressed support for the process used by Reclamation to develop the impact statement. Of the five remaining respondents, three stated that they had no position on the issue, while two, the San Juan Southern Paiute Tribe and the Grand Canyon River Guides, believed that the current interim operating criteria would be more protective of resources and, therefore, more consistent with the intent of the Grand Canyon Protection Act.

Other interested parties, although supporting the preferred alternative, believed that several areas of concern still remain. For example, one organization stated that the final impact statement assumes that the dam's operations are the only cause of the impacts on downstream resources and, therefore, that changing the dam's operations is the only technique available for managing and enhancing those resources. The organization noted other causes of downstream impacts, including the introduction of nonnative fish and human usage. Still other organizations believed that there is a potential for negative impacts that will be difficult to measure because, between the draft and the final impact statement, Reclamation revised the preferred alternative to simultaneously increase two of the dam's operating parameters: the maximum daily peak releases and the upramp rate (the hourly rate of increase). Others stated that they were concerned about flood protection measures. Also, concerns were expressed about the future implementation of Reclamation's Adaptive Management Program, including its continued monitoring and research efforts.

Recommendations

GAO is making no recommendations in this report.

Agency Comments

GAO provided copies of a draft of this report to the Department of the Interior for its review and comment. Interior generally agreed with the information presented in the report and stated that they were impressed with the quality of the product developed by the audit team. Interior also provided several technical clarifications to the draft, which have been incorporated into the report as appropriate. Interior's comments and GAO's responses are included in appendix XII.

Contents

Tables

Figures

Abbreviations

ABT	Aquatic Biology Team
cfs	cubic feet per second
CROD	Contract Rate of Delivery
CRSP	Colorado River Storage Project
CRSS	Colorado River Simulation System
CVM	contingent valuation method
EGEAS	Electronic Generation Expansion Analysis System
EIS	environmental impact statement
Elfin	Electric Utility Financial and Production Cost Model
EPA	U.S. Environmental Protection Agency
FWCA	Fish and Wildlife Coordination Act
FWS	U.S. Fish and Wildlife Service
GCES	Glen Canyon Environmental Studies
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
SLCA/IP	Salt Lake City Area/Integrated Projects
WAPA	Western Area Power Administration

Introduction

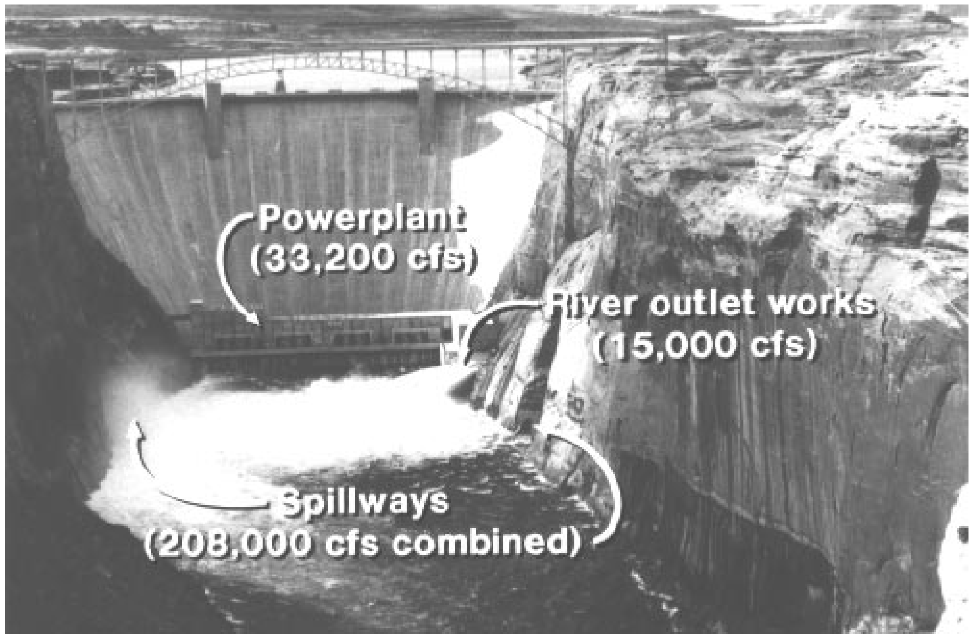
The Glen Canyon Dam was completed by the Bureau of Reclamation in 1963 as a multipurpose facility. It is the key feature and major storage unit of the Colorado River Storage Project. The Colorado River Storage Project was authorized in 1956 to develop and use the water resources in the Upper Colorado River Basin. The operations of the Glen Canyon Dam and its reservoir, Lake Powell, enable the Colorado River Storage Project to fulfill the downstream water release requirements while the runoff from the Upper Basin is stored and used for irrigation, recreation, and municipal and industrial purposes.

The powerplant at the Glen Canyon Dam has been used primarily for generating power during high-demand periods (peaking power). The fluctuating releases of water associated with peaking power operations have caused concern among federal, state, and tribal resource management agencies; river users who fish in Glen Canyon or take white-water raft trips in the Grand Canyon; and Native American and environmental groups, in connection with the detrimental effects that such water releases have on the cultural resources and the downstream plants, animals, and their habitats.

Operation of the Glen Canyon Dam's Powerplant

The Glen Canyon Dam powerplant has eight generators with a maximum combined capacity of 1,288,000 kilowatts at a 95-percent power factor. The maximum combined discharge capacity of the eight turbines is approximately 33,200 cubic feet per second (cfs) when Lake Powell is full; however, Reclamation has limited such releases to 31,500 cfs. Fluctuations within a day have typically ranged from 12,000 cfs in October to about 16,000 cfs in January and August. Although water can be released from the dam through the powerplant, the outlet works, or the spillways, discharging water through the powerplant's turbines is the preferred method because electricity and its associated revenue can be produced. The power generated by the Glen Canyon Dam is marketed principally in a six-state area—Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming. Figure 1.1 shows the various release capacities for the Glen Canyon Dam.

Figure 1.1: Water Release Capacities of the Glen Canyon Dam's Powerplant, Outlet Works, and Spillways



Source: Bureau of Reclamation.

Historically, the Glen Canyon Dam, as part of the Colorado River Storage Project, was operated to produce the greatest amount of firm capacity and energy practicable while adhering to the releases required under the "Law of the River." The Law of the River—a collection of federal and state statutes, compacts, court decisions and decrees, federal contracts, a treaty with Mexico, and formally determined long-range operating criteria—defines the operation and management of the Colorado River. The operating criteria for the dam were established under the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs" (Long-Range Operating Criteria), which include the criteria for annual operations. The Annual Operating Plan, which is prepared under the Long-Range Operating Criteria, addresses monthly operations while interagency agreements control the dam's hourly operations.

The annual volume of releases from the dam is based on the water inflow to Lake Powell and the remaining space in Lake Powell and Lake Mead. The annual release volumes vary greatly, but all adhere to the Long-Range

Operating Criteria's objectives of an 8.23-million-acre-feet[1] minimum annual release and equalized storage between the two reservoirs. From 1968 to 1989, the annual releases ranged from 8.23 million acre-feet to 20.4 million acre-feet. Annual releases greater than the minimum were permitted to avoid anticipated spills (excess annual releases that cannot be used for project purposes) and to equalize storage. The minimum release occurred in about half the years.

The volume of water released from Lake Powell each month depends on the forecasted inflow, existing storage level, monthly storage targets, and annual release requirements. Demands for electrical energy, fish and wildlife needs, and recreation needs are also considered and accommodated as long as the risk of spilling and storage equalization between Lakes Powell and Mead are not affected. Power demand is highest during the winter and summer months, and recreation needs are highest during the summer. Therefore, higher-volume releases are scheduled during these months whenever possible. Each month during the inflow forecast season (January to July), the volume of water to be released for the rest of the year is recomputed on the basis of updated streamflow forecast information. The Scheduled releases for the remaining months are adjusted to avoid anticipated spills and maintain conservation storage in accordance with the Long-Range Operating Criteria.

Hourly releases from the dam are set to reach monthly release volumes, to maintain established minimum flow rates, and to follow energy demand. Hourly power operations are most flexible during those months with moderate release volumes. The need to maintain minimum flows in the months with low release volumes limits the flexibility to accommodate changing hourly power demands. If the reservoir is nearly full and the inflow is extremely high, the monthly releases are scheduled at or near the maximum capacity most of the time, again leaving little flexibility for the hourly releases to change in response to power demand.

To the extent possible, the Glen Canyon Dam follows these guidelines in producing hydropower:

- Maximize water releases during the peak energy demand periods, generally Monday through Saturday between 7 a.m. and 11 p.m.,

[1]An acre-foot is the amount of water needed to cover 1 acre of land to a depth of 1 foot—or about 326,000 gallons.

- Maximize water releases during peak energy demand months and minimize during low demand months,
- Minimize and, to the extent possible, eliminate powerplant bypasses.

Glen Canyon's Environmental Studies and Environmental Impact Statement

Before the construction of the Glen Canyon Dam, the Colorado River's sediment-laden flows fluctuated dramatically during different seasons of the year. Flows of greater than 80,000 cfs were common during the spring runoff. In contrast, flows of less than 3,000 cfs were typical throughout the late summer, fall, and winter. Water temperatures ranged from near freezing in the winter to more than 80 degrees Fahrenheit in the summer. The construction of the Glen Canyon Dam altered the natural dynamics of the Colorado River. The dam replaced seasonal flow variations with daily fluctuations, greatly reduced the amount of sediment in the river, and resulted in nearly constant water release temperatures of about 46 degrees Fahrenheit.

In response to the concerns of federal, state, and tribal agencies and the public about the negative effects of the dam's operations, in December 1982 the Secretary of the Interior directed Reclamation to initiate a series of interagency scientific studies. These studies were to examine the short- and long-term effects of the dam's historic, current, and alternative operations on the environmental and recreational resources of the Glen and Grand canyons. The studies became known as phase I of the Glen Canyon Environmental Studies. From 1982 through 1987, 39 technical reports were prepared evaluating terrestrial biology, aquatic biology, sediment and hydrology, recreation, and the dam's operations. However, no studies were conducted on the economic impact to hydropower from changes in the dam's operations. According to Reclamation, of primary importance in the Glen Canyon Environmental Studies was the research connected with endangered fish. The existence and operations of the dam were believed to be important factors involved in the extinction of two fish species (the Colorado squawfish and bonytails) from the river corridor. The dam and its operations were also considered to present survival problems for the existing populations of the humpback chub and razorback sucker as well as other native fish species. Therefore, according to Reclamation, the biological opinion issued by the U.S. Fish and Wildlife Service in 1994 was an important factor in the ultimate formulation of the preferred alternative in the environmental impact statement (EIS).

The Glen Canyon Environmental Studies technical reports were concurrently reviewed by the National Research Council and the

Executive Review Committee. The Executive Review Committee was made up of policy-level representatives from Reclamation, the National Park Service, the U.S. Fish and Wildlife Service, the Department of the Interior's Office of Environmental Policy and Compliance, and the Western Area Power Administration. This Committee then prepared a report[2] in January 1988 on the findings and conclusions of phase I of the Glen Canyon Environmental Studies and made recommendations and suggested options for revising the dam's operations.

In June 1988, phase II of the Glen Canyon Environmental Studies was initiated to gather additional data over a 4- to 5-year period on the dam's specific operational elements. Phase II was to further define the impacts on the natural environment, public uses associated with recreation, cultural resources, and power-generation economics. At the urging of the National Research Council, an entity of the National Academy of Sciences, non-use values were incorporated into the studies. "Non-use value" is the term used to describe the monetary value that non-users place on the status of the environment. For example, the values that people may receive from the knowledge that such things as rare plants, animals, and unspoiled natural environments exist are defined as non-use values. A number of federal and state resource agencies, Indian tribes, private consultants, universities, and river guides participated in phase II of the Glen Canyon Environmental Studies.[3] Funding for these studies was provided mainly from the revenue derived from the sale of electricity generated by the Glen Canyon Dam.

In July 1989, the Secretary of the Interior decided that Reclamation should prepare an environmental impact statement to reevaluate the operations of the Glen Canyon Dam. The purpose of the EIS was to determine specific options for operating the dam that could minimize the adverse impacts on the downstream environmental and cultural resources, as well as on the Native American interests in the Glen and Grand canyons, while still producing hydropower. Reclamation was designated by the Secretary to be the lead agency responsible for preparing the EIS; other participants were the following cooperating agencies: the Bureau of Indian Affairs, the National Park Service, the U.S. Fish and Wildlife Service, the Western Area Power Administration, and the Arizona Game and Fish Department. In

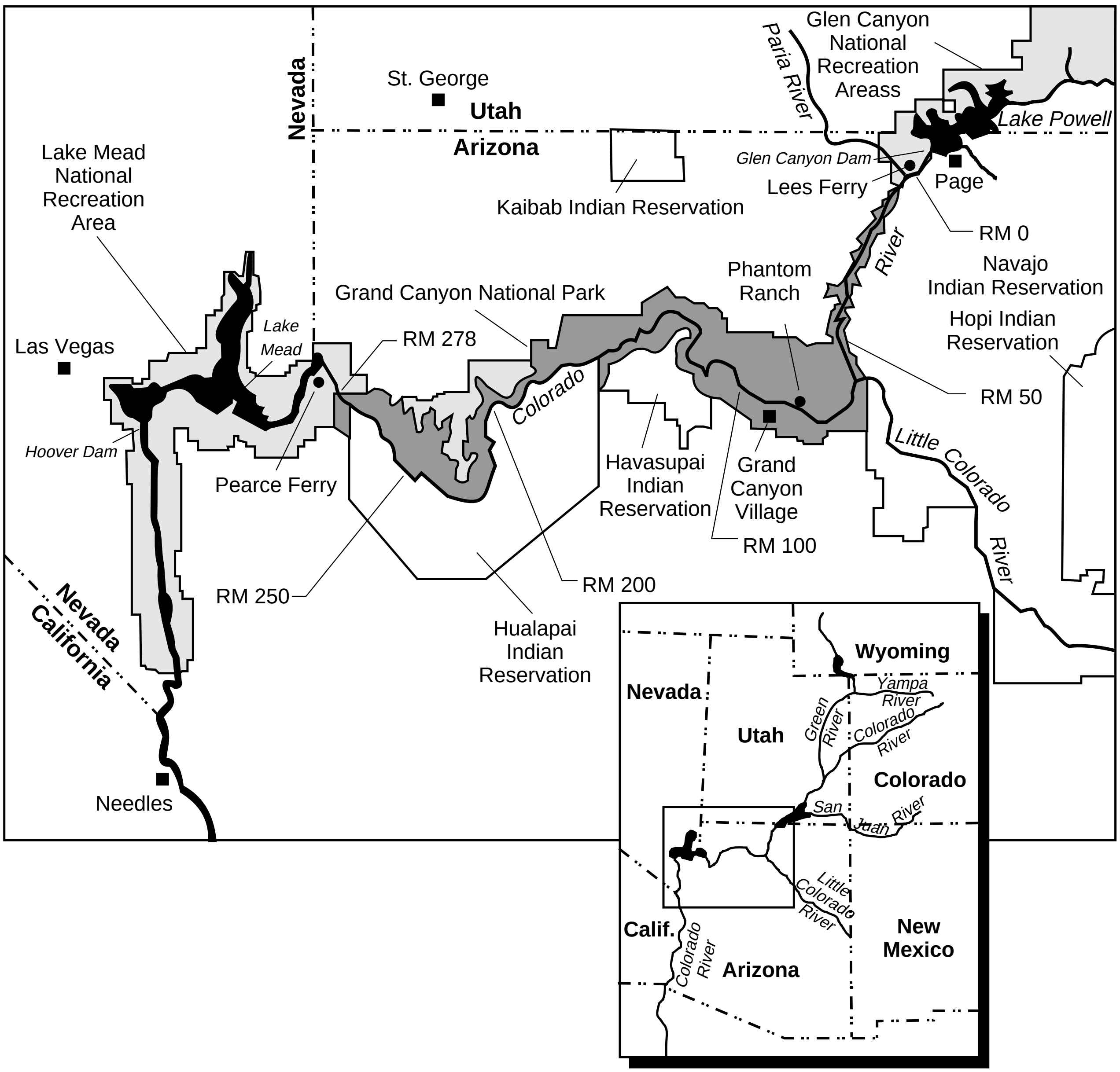
[2]The Glen Canyon Environmental Studies Final Report, U.S. Department of the Interior, 1988.

[3]Agencies participating in phase II of the Glen Canyon Environmental Studies included Reclamation, the National Park Service, the Western Area Power Administration, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, the Hopi Tribe, the Hualapai Tribe, the Navajo Nation, the Pueblo of Zuni, the San Juan Southern Paiute Tribe, the Southern Paiute Consortium, and the Arizona Game and Fish Department.

1989, after the EIS process started, Reclamation also made the following Native American tribes cooperating agencies: the Hopi Tribe, the Hualapai Tribe, the Navajo Nation, the Pueblo of Zuni, the San Juan Southern Paiute Tribe, and the Southern Paiute Consortium. Officials from many of these same agencies and tribes participated in the Glen Canyon Environmental Studies, which formed the basis for the analyses of alternatives for the EIS.

The EIS was designed primarily to focus on the Colorado River corridor from the Glen Canyon Dam in northwestern Arizona, southward through the Glen and Marble canyons and westward through the Grand Canyon to Lake Mead. The map in figure 1.2 shows the area of study under the Glen Canyon Environmental Studies and the EIS for the Glen Canyon Dam.

Figure 1.2: Map of the Study Area of the Glen Canyon Dam's Environmental Studies and Environmental Impact Statement



Note: RM - River Mile.

Source: Bureau of Reclamation.

The requirement to prepare an EIS accelerated the scheduled completion of the research studies in phase II of the Glen Canyon Environmental Studies to provide more timely data for the EIS. This acceleration was accomplished by designing special "research flows," a series of carefully designed discharges of water and data collection programs conducted in June 1990 through July 1991. Each research flow lasted 14 days and included 3 days of steady 5,000 cfs flows and 11 days of either steady or fluctuating flows. The research flows provided a means to evaluate the short-term responses of certain resources to a variety of discharge parameters, including minimum and maximum flows, the rate of change in flow, and the range of daily fluctuations.

To protect downstream resources until the completion of the EIS and the formal adoption of new operating criteria for the Glen Canyon Dam, Reclamation implemented the interim dam operations on November 1, 1991. The interim operating criteria were purposely designed to be conservative for the protection of natural and cultural resources. Specifically, the interim criteria reduced peak water releases from the approved maximum of 31,500 cfs to 20,000 cfs; restricted daily fluctuations in releases to between 5,000 cfs and 8,000 cfs; and restricted the rate of change in releases (ramp rates) to 2,500 cfs per hour when increasing and to 1,500 cfs per hour when decreasing. While these limitations were imposed, the interim criteria met the minimum annual release of 8.23 million acre-feet in accordance with the 1970 Long-Range Operating Criteria. Although the interim operating criteria could be modified on the basis of new information, they were to remain in effect until the EIS and the Secretary's Record of Decision for new operating criteria for the dam were completed.

Grand Canyon Protection Act of 1992

Subsequent to Reclamation's initiation of the EIS process, on October 30, 1992, the Congress enacted the Grand Canyon Protection Act of 1992 (title XVIII of P.L. 102-575). The act addresses the protection of the Grand Canyon National Park, the Glen Canyon National Recreational Area, the interim operating criteria for the dam until the EIS is completed, long-term monitoring and research, and the replacement of lost power from any changes to the dam's operation. The act requires that the Glen Canyon Dam be operated to protect, mitigate adverse impacts to, and improve the downstream resources of the Grand Canyon National Park and the Glen Canyon National Recreational Area. The act also required the Secretary of the Interior to complete a final environmental impact statement for the Glen Canyon Dam's operations by October 30, 1994. Furthermore, the act required GAO to audit the costs and benefits of the various operating alternatives identified in the final environmental impact statement. On the basis of the findings, conclusions, and recommendations made in the EIS, other relevant information, and our audit report, the Secretary is to issue a Record of Decision adopting future operating criteria and operating plans for the Glen Canyon Dam.

National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.) establishes the national environmental policy and goals for protecting, maintaining, and enhancing the environment, and it provides a process for implementing these goals within federal agencies. The act requires, among other things, that the applicable federal agency prepare a detailed EIS for every major federal action that may significantly affect the quality of the human environment. The EIS is designed to ensure that important environmental impacts will not be overlooked or underestimated before the government commits to a proposed action. The act also established the Council on Environmental Quality, which oversees the NEPA process.

The Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 C.F.R. 1502.4) provide federal agencies with a process for determining whether or not to prepare an EIS. If it is determined that an EIS is necessary, regulations require, among other things, that the EIS must (1) address the purpose of and need for the action, (2) describe the environment that will be affected, (3) identify alternatives to the proposed action, (4) present the environmental impacts of the proposed action (including the direct, indirect, and cumulative impacts), (5) identify any adverse environmental impacts that cannot be avoided should the proposed action be implemented, and (6) identify any irreversible and irretrievable commitment of resources that would occur should the proposed action be implemented. The regulations also require each federal agency to identify the agency's preferred alternative or alternatives, if one or more exists, in the draft and the final EIS. In addition, before making a decision, the responsible agency must solicit comments from the public and from other government agencies that may have jurisdiction by law or expertise with respect to any environmental impacts.

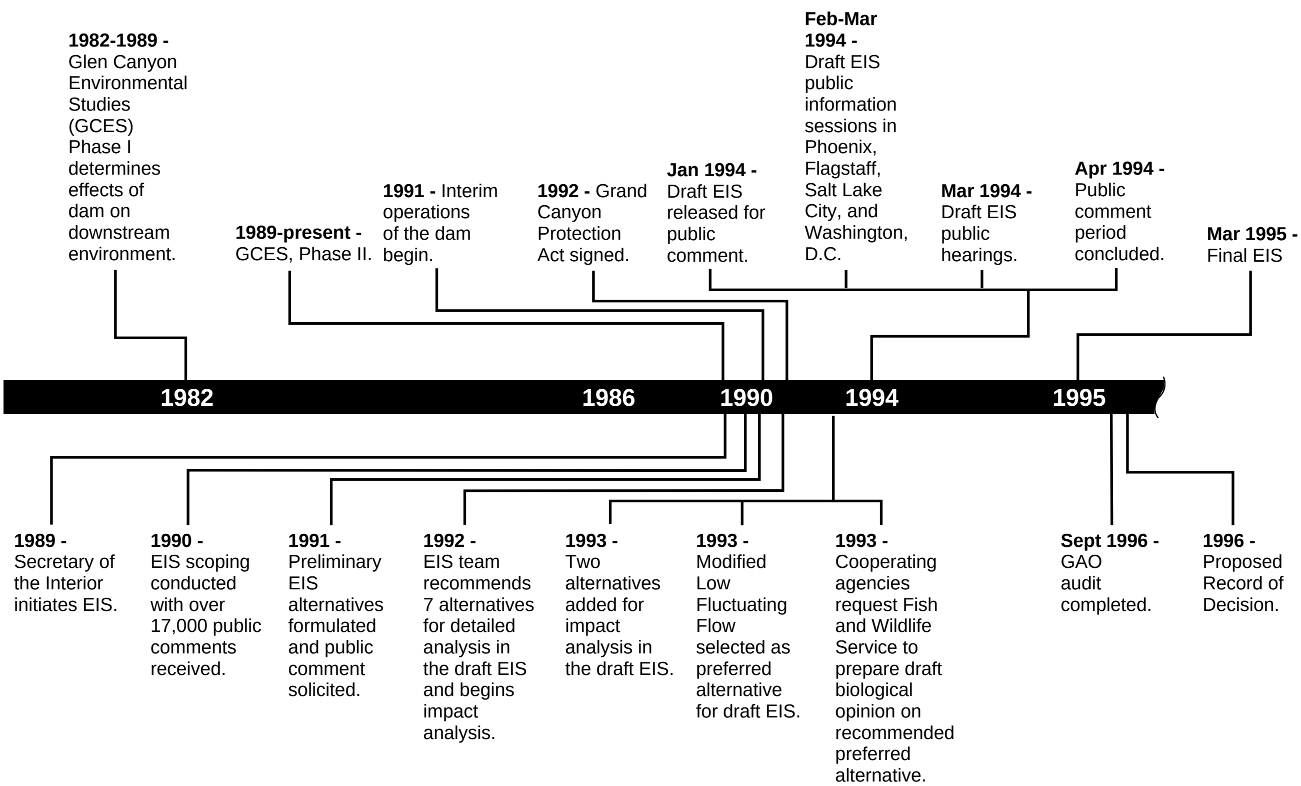
Under section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) is required to review and publicly comment on the environmental impacts of major federal actions, including actions that are the subject of a draft or final EIS. EPA reviews and comments on both the adequacy of the analyses and the environmental impacts of the proposed action. If the Administrator, EPA, determines that the action is environmentally unsatisfactory from the standpoint of the public's health or welfare or environmental quality, this determination shall be published and the matter will be referred to the Council on Environmental Quality. If the action involves a federal project located at a specific site, the appropriate EPA regional office has the jurisdiction and delegated responsibility for carrying out the section 309 review and working with the proposing federal agency to resolve any problems. EPA's Region IX in San Francisco, California, was the region responsible for reviewing the draft and final EIS for the operation of the Glen Canyon Dam.

Reclamation's Process for Completing the Glen Canyon Dam's EIS

The preparation of the Operation of Glen Canyon Dam Final Environmental Impact Statement was a cooperative effort involving Reclamation, the cooperating agencies, the participants in the Glen Canyon Environmental Studies program, and the representatives of an interagency EIS team. Although Reclamation was designated to be the lead agency responsible for preparing the EIS, its objective was to obtain substantial input from these organizations during the decision-making process, and its goal was to build a consensus for the ultimate decision of recommending a preferred alternative in the EIS.

The group of cooperating agencies, which prior to the development of the formal EIS included only federal agencies, was established in July 1989. This group ultimately included representatives from Reclamation, the Bureau of Indian Affairs, the Environmental Protection Agency, the National Park Service, the U.S. Fish and Wildlife Service, the Western Area Power Administration, the Arizona Game and Fish Department, the Hopi Tribe, the Hualapai Tribe, the Navajo Nation, the San Juan Southern Paiute Tribe, the Southern Paiute Consortium, and the Pueblo of Zuni. The EIS team was established in mid-1990 and included representatives from Reclamation, the National Park Service, the U.S. Fish and Wildlife Service, the Western Area Power Administration, the U.S. Geological Survey, the Arizona Game and Fish Department, the Hopi and Hualapai Tribes, the Navajo Nation, and a private consulting firm. Reclamation charged the EIS team with formulating alternatives for operating the dam and assessing their impacts on the environment. For resources that were to be studied in detail, subteams were formed to make the impact determinations, document their findings, and draft that particular section of the EIS. For the other resources, individuals with expertise in a particular field were assigned the responsibility for determining the impacts and preparing the documentation. Figure 1.3 shows some of the key dates in the preparation of the Glen Canyon Environmental Studies and the EIS.

Figure 1.3: Key Dates in the Environmental Studies and the Environmental Impact Statement Processes for the Glen Canyon Dam



Source: GAO's presentation of the Bureau of Reclamation's data.

Scoping Phase

The initial step in preparing an EIS involves a scoping phase that provides for the early identification and consideration of environmental issues and alternatives. In February 1990, Reclamation published a notice in the Federal Register announcing the opening of the scoping phase of the Glen Canyon Dam's EIS. This phase included environmental scoping meetings to obtain public comments and determine the appropriate scope of the EIS. The comment period, initially established for March 12 through April 16, 1990, was extended to May 4, 1990, in response to comments by the public. Reclamation provided opportunities for public participation in the scoping phase through news releases, mailings, legal notices, and contacts with media, organizations, and individuals. Throughout the process, the EIS team periodically reported the results of its analyses to the cooperating agencies and the public. The cooperating agencies acted as a steering committee and provided input to Reclamation on both the EIS process and the EIS document after a period of review and discussion.

More than 17,000 comments were received during the scoping period. Numerous comments were received about suggested alternatives and factors to be considered in the development of alternatives. These comments ranged from general suggestions about the management of the dam to specific flow release recommendations. As a result of the analyses and the categorization of the oral and written scoping comments by a Reclamation contractor, the EIS team consolidated and refined the public's issues of concern. The following resources were identified to be analyzed in detail in the EIS: water, sediment, fish, vegetation, wildlife and their habitat, endangered and other special-status species, cultural resources, air quality, recreation, hydropower, and non-use value.

In July 1990, representatives from the cooperating agencies and various interest groups participated in a "brainstorming" workshop to fully consider all concepts and suggestions in formulating alternatives for the dam's operations. On the basis of the results of the workshop, scoping comments, and the Glen Canyon Environmental Studies phase I report, the interdisciplinary EIS team formulated 10 preliminary alternative flow scenarios. Some of these alternatives would provide for warmer water release temperatures in the summer, add sediment to the river below the dam, or reregulate releases to provide steady flows downstream. The EIS team presented these alternatives to the cooperating agencies and, following their approval, presented them to the public in March 1991.

The public was asked to comment on the range of preliminary alternatives as part of the EIS scoping process. The predominant public comment was the need to separately consider alternatives that deal with the operations of the dam from those considering changes to the structure of the dam. Using the additional input received from the public, professional judgment, and analysis of interim flows, the EIS team reviewed and revised the preliminary alternatives. Seven alternatives were then identified for detailed analysis. Later, to present a full range of reasonable operations for study in the EIS, two more alternatives were formulated. These included the Maximum Powerplant Capacity alternative, which was developed to allow use of the powerplant's maximum discharge capacity of 33,200 cfs, and the eventual preferred alternative—the Modified Low Fluctuating Flow alternative. The Modified Low Fluctuating Flow alternative was similar to the Interim Flow but included a habitat maintenance flow. Habitat maintenance flows are high, steady releases of water within the powerplant's capacity for 1 or 2 weeks in the spring. The purpose of these flows is to reform and rejuvenate backwaters and maintain sandbars, which are important for native fish habitat. Table 1.1 presents the nine alternative flows studied in detail in the Glen Canyon Dam's environmental impact statement. These alternatives can be categorized as follows: unrestricted fluctuating flows, restricted fluctuating flows, and steady flows.

Table 1.1: Alternative Operating Procedures Studied in the Glen Canyon Dam's EIS

Unrestricted fluctuating flows	The two unrestricted fluctuating flow alternatives would allow flows to vary, as necessary, for power generation purposes.
No-Action	Maintain historic fluctuating releases the same as they were from 1964, when the dam was placed in hydropower operation, until the research flows began in June 1990. The maximum allowable discharge during these fluctuations would be 31,500 cfs.
Maximum Powerplant Capacity	Permits use of full powerplant capacity (33,200 cfs).
Restricted fluctuating flows	The four restricted fluctuating flow alternatives would provide a range of downstream resource-protection measures, while offering varying amounts of flexibility for power operations.
High	Slightly reduce daily fluctuations from historic no-action levels.
Moderate	Moderately reduce daily fluctuations from historic no-action levels; includes habitat maintenance flows, which are short-duration high releases during the spring that allow sand to be transported and deposited for maintaining camping beaches and fish and wildlife habitat.
Modified Low (preferred alternative)	Substantially reduce daily fluctuations from historic no-action levels; includes habitat maintenance flows.
Interim Low	Substantially reduce daily fluctuations from historic no-action levels; same as interim operations.
Steady flows	The three steady flow alternatives would provide a range of downstream resource-protection measures by minimizing daily release fluctuations. Flows would be steady on either a monthly, seasonal, or year-round basis.
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.

Resource Protection Measures (Common Elements)

All of the restricted fluctuating flow and steady flow alternatives include elements designed to provide additional resource protection or enhancement. Since these elements were common to all such alternatives, they became known as the "common elements." Each impact analysis includes these common elements. The common elements include adaptive management, monitoring and protecting cultural resources, flood frequency reduction measures, beach/habitat-building flows, further study of selective withdrawal structures, measures to increase populations of an endangered fish—the humpback chub,[4] and emergency operating exception criteria.

Adaptive Management

The concept of adaptive management is based on the recognized need for operational flexibility to respond to future monitoring and research findings and varying resource conditions. The purpose of the Adaptive Management Program would be to develop future modifications to the dam's operating criteria if monitoring and/or research results indicate a need for change. Long-term monitoring and research would measure how well the selected alternative meets the resource management objectives. The basis for any decision would be linked to the response of the resources to the operations of the dam. (Further details on the Adaptive Management Program are provided in ch. 2.)

Monitoring and Protecting Cultural Resources

The existence and operation of Glen Canyon Dam has had an effect on the historic properties within the Colorado River corridor of the Glen and Grand canyons. These properties include prehistoric and historic archeological sites and Native American traditional cultural properties and resources. Impacts are likely to occur to some of these historic properties regardless of the EIS alternative chosen for implementation. The National Historic Preservation Act, as amended in 1992, instructs federal agencies to develop measures to avoid or minimize the loss of historic properties resulting from their actions.

Flood Frequency Reduction Measures

Under this common element, the frequency of unscheduled flood flows greater than 45,000 cfs would be reduced to no more than once in 100 years as a long-term average. This would allow management of certain other common elements—habitat maintenance flows and beach/habitat-building flows.

The two separate methods of reducing flood frequency that were identified include (1) increasing the capacity of Lake Powell by raising the

[4]Measures to provide protection for, or enhancement of, populations of the razorback sucker are not specifically included as a common element because currently very few of the species exist in the mainstream Colorado River and no reproduction is known to occur.

height of the spillway gates by 4.5 feet and (2) reducing the volume of the lake by 1 million acre-feet from its current capacity in the spring until the runoff peak has clearly passed.

Beach/Habitat-Building Flows

Sandbars above the river's normal peak stage will continue to erode, and backwater habitat within the river's flow will tend to fill with sediment under any EIS alternative. Beach/habitat-building flows involve controlled high releases of water greater than the powerplant's capacity for a short duration; they are designed to rebuild high-elevation sandbars, recycle nutrients, restore backwater channels, and provide some of the dynamics of a natural system.

Further Study of Selective Withdrawal Structures

Reclamation would perform a study to determine if structures that would allow the withdrawal of water from various depths of the reservoir should be installed at the Glen Canyon Dam. Currently, water released from the dam to produce hydropower is withdrawn from the cold depths of Lake Powell, averaging 230 feet below the water's surface when the reservoir is full. This withdrawal process is accomplished by a series of eight 15-foot-diameter intake pipes that provide the water directly to the dam's eight turbines. This water withdrawal process results in the river water temperature downstream of the dam being a nearly constant year-round average of about 46 degrees Fahrenheit. Many native fish species cannot reproduce and survive in these constant cold temperature conditions. Increasing mainstream water temperatures by means of selective withdrawal structures offers the greatest potential for creating new spawning populations of humpback chub and other native fish in the Grand Canyon. Multilevel intake structures (a means of selective withdrawal) could be built at Glen Canyon Dam to provide seasonal variation in the water temperature. A structure would be attached to each of the eight existing intake pipes to withdraw warmer water from the upper levels of the reservoir. However, the cost of installing multilevel intake structures at the Glen Canyon Dam has been estimated at $60 million.

New Population of Humpback Chub

With the assistance of the U.S. Fish and Wildlife Service, the National Park Service, the Arizona Game and Fish Department, and other land management entities, such as the Havasupai Tribe, Reclamation would make every effort—through funding, facilitating, and technical support—to establish a new population of humpback chub within the Grand Canyon. The humpback chub is currently a listed species under the federal Endangered Species Act of 1973 (16 U.S.C. 1532 et seq.) and is one of the native fish species that faces continued ecological health problems due to the cold water temperatures of the Colorado River. Such cold temperatures are not conducive to the humpback chubs' spawning or the survival of eggs and young.

Emergency Exception Criteria

Normal operations described under any alternative could be altered temporarily to respond to power and water emergencies, such as insufficient generating capacity, the restoration of the electrical system, or search and rescue operations. These changes in operations would be of short duration (usually less than 4 hours) and would be the result of emergencies at the dam, downstream, or within the interconnected electrical system.

Draft EIS and Public Comments

On January 4, 1994, Reclamation filed a draft EIS with EPA. The Draft EIS presented the impacts of the nine flow alternatives, including the No-Action alternative (historic operations) that provided a baseline for comparison, on the 11 resources that could be affected by the various dam-operating regimes. Over 33,000 written comments were received on the draft EIS. More than 2,300 separate issues and concerns were extracted from an analysis of the comments.

EPA's Region IX supported the preferred alternative (Modified Low Fluctuating Flow) selected by Reclamation in the draft EIS. However, EPA gave the draft EIS a qualified rating based on insufficient information on two issues. First, EPA expressed concern about the lack of information on the impacts of raising the dam's spillway gates as a flood frequency reduction measure and recommended that the final EIS include a more thorough evaluation of the flood frequency reduction options. Second, EPA recommended that the final EIS contain further discussion of Reclamation's Adaptive Management Program and how it plans to implement beach/habitat-building flows.

Preliminary Final EIS

Reclamation issued a preliminary final EIS for the operations of the Glen Canyon Dam in December 1994. The preliminary final EIS also took into consideration the discussions with the U.S. Fish and Wildlife Service (FWS) in connection with the consultation requirements of the Endangered Species Act and with the provisions of the Fish and Wildlife Coordination Act. Section 7 of the Endangered Species Act, as amended (16 U.S.C. 1536), requires federal agencies to consult with FWS to ensure that the actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a species listed under the act as endangered or threatened. If the action would jeopardize a listed species, FWS suggests a reasonable and prudent alternative that the federal agency can implement to minimize and/or mitigate the activity's impact on the species or their critical habitat. The Fish and Wildlife Coordination Act of 1958 (16 U.S.C. 661 et seq.) was enacted to ensure that fish and wildlife receive equal consideration during the planning and construction of federal water projects. FWS prepares a Fish and Wildlife Coordination Act report that contains nonbinding recommendations for actions that would be beneficial to fish and wildlife. The cooperating agencies and the EIS team reviewed the preliminary final EIS, and additional changes were made to the EIS on the basis of that review.

Final EIS

On March 21, 1995, Reclamation filed the final EIS with EPA. In June 1995, EPA informed Reclamation that it continues to support the preferred alternative and was pleased that Reclamation had addressed EPA's concerns about the draft EIS. Specifically, the final EIS states that Reclamation will conduct a detailed evaluation of the flood frequency reduction measures before a decision is made and provides more information on the approach that Reclamation will use to implement an Adaptive Management Program and conduct beach/habitat-building flows. EPA applauded the efforts made by all of the agencies, tribes, organizations, and individuals involved in the research, scoping, and preparation of the EIS. EPA summarized that the dedication to sound science and cooperative relations was critical to developing a preferred alternative (including adaptive management), which it believes will protect and enhance the environmental and cultural resources downstream from the Glen Canyon Dam.

Reclamation's Preferred Alternative for Future Operations of the Glen Canyon Dam

In the Glen Canyon Dam's final environmental impact statement, Reclamation recommends the Modified Low Fluctuating Flow as the preferred method for the future operations of the Glen Canyon Dam. According to the final EIS, the Modified Low Fluctuating Flow alternative was developed to reduce daily flow fluctuations well below no-action levels and to provide periodic high, steady releases of short duration, with the goal of protecting or enhancing downstream resources while allowing limited flexibility for power operations. This alternative would have the same annual and essentially the same monthly operating plan as under the No-Action alternative but would restrict daily and hourly water releases. Specifically, minimum flows would be no less than 8,000 cfs between 7 a.m. and 7 p.m. and 5,000 cfs at night. The maximum rate of release would be limited to 25,000 cfs during fluctuating hourly releases. Ramp rates would be limited to 4,000 cfs per hour for increasing flows and 1,500 cfs per hour for decreasing flows. Daily fluctuations would be limited to 5,000, 6,000, or 8,000 cfs depending on the monthly release volume.

The preferred alternative also included periodic habitat maintenance flows, which are steady high releases within the powerplant's capacity for 1 to 2 weeks in the spring. The purpose of these flows is to rejuvenate backwater channels that are important to fish habitat and maintain sandbars that are important for camping. Habitat maintenance flows differ from beach/habitat-building flows in that they would be within the powerplant's capacity and would occur nearly every year when the reservoir's volume is low. According to Reclamation, when the reservoir is low, water flows normally would not exceed about 22,000 cfs, and the probability of an unscheduled spill is small. Therefore, the habitat maintenance flows would be scheduled in those years. Habitat maintenance flows would not occur in years when a beach/habitat-building flow is scheduled. Beach/habitat-building flows are controlled floods with scheduled high releases of water greater than the powerplant's capacity for a short duration, designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural river system.

According to Reclamation, instead of conducting the beach/habitat building flows in years in which Lake Powell storage is low on January 1, it has been agreed to modify the preferred alternative in the Record of Decision to accomplish the flows in high reservoir years when bypassing the powerplant would be necessary for safety purposes at the dam. In the spring of 1996, Reclamation conducted its first experiment of the controlled flood concept. The controlled experiment commenced with 4 days of constant flows at 8,000 cfs. Flows began to increase incrementally on March 26, 1996, until they reached a maximum of 45,000 cfs, where they remained for 7 days. After 7 days of high flows, the releases were reduced, gradually, to a constant flow of 8,000 cfs for 4 days of evaluation. According to Reclamation, the preliminary results indicate that the release increased sandbars in the Glen and the Grand canyons by as much as 30 percent and also created numerous backwaters for fish.

Objectives, Scope, and Methodology

Subsection 1804(b) of the Grand Canyon Protection Act states that the Comptroller General shall (1) audit the costs and benefits to water and power users and to natural, recreational, and cultural resources resulting from the management policies and dam operations identified pursuant to the environmental impact statement and (2) report the results of the audit to the Secretary of the Interior and the Congress.

While the act states that GAO should audit the "costs and benefits" of various alternative dam operations identified in the EIS, the National Environmental Policy Act does not require, and Reclamation did not perform, a cost and benefit analysis. In preparing the impact statement, Reclamation studied the impact of nine dam-operating alternatives on 11 resources. In the absence of a cost and benefit analysis, we determined that the statute does not require us to conduct our own cost and benefit analysis. As discussed with the staff of the Majority and Ranking Minority members of the Senate and House committees having jurisdiction over these matters, to fulfill the requirements of the act, we examined

- whether Reclamation's determination of the impact of various flow alternatives on selected resources was reasonable and
- what, if any, concerns still exist on the part of key interested parties about the final EIS.

To assess whether Reclamation's impact determinations were reasonable, we assessed for each resource, the methodologies and data used to make the impact determinations, how the methodologies were implemented, and the results achieved. The details of our analysis, and a comprehensive list of individuals contacted and key studies identified, are contained in appendixes I through X of this report. The title of each appendix is the designation (name) of the resource, and they are numbered in alphabetical order. We combined our analysis of the vegetation and wildlife/habitat impact determinations into one appendix—appendix IX. We made this choice because (1) similar indicators were studied in making the impact determinations for these resources, (2) the riparian vegetation that developed along the Colorado River corridor plays an important role as habitat to support the diversity of wildlife within the Glen and the Grand canyons, and (3) the same EIS team member was responsible for the impact determinations of both resources.

For three resources—hydropower, recreation, and non-use values—Reclamation quantified the economic impact of the cost or benefit that the various flow alternatives would have on the resource. For these resources, we also reviewed the documentation on the modeling techniques and economic assumptions used to make the impact determinations. For example, for Reclamation's power methodology, we reviewed key economic assumptions, results, and documentation, including reports entitled Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations, [Phase II] Final Report, October 1993, and Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations, Phase III Final Report, July 1995. These reports were prepared by the Power Resources Committee, a subgroup of the EIS team which included experts from the federal government, the utility industry, and the environmental community. This committee was charged with determining the impact of the nine flow alternatives on hydropower.

We interviewed members of the Power Resources Committee, including the Reclamation officials who served as Chairman and economist, and representatives from the Western Area Power Administration, the Colorado River Energy Distributors Association, the Environmental Defense Fund, and the Reclamation contractor that conducted the studies.

In addition, to assess the methodology used, economic assumptions, and results, we reviewed federal guidance on water resource projects entitled Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, U.S. Water Resources Council, March 10, 1983; public comments on the draft and final EIS, and comments provided by three energy consultants retained by HBRS, Inc. to review the power analysis. HBRS, Inc. (now called Hagler Bailly Consulting), was Reclamation's primary contractor for conducting the power analysis. Also, we reviewed the comments provided by the National Research Council on the power analyses in the draft and final EIS. We used standard microeconomic principles to assess the reasonableness of key economic assumptions. Our assessment of the reasonableness of Reclamation's methodology was limited to a review of the general analytical framework and an assessment of the reasonableness of the key assumptions and data. We did not evaluate the Power Resources Committee's calibration of the power simulation models used or the spreadsheet models used, nor did we verify the accuracy of all data inputs.

For both the recreation and non-use methodologies, we reviewed the literature and research principles on the contingent valuation method to assess the reasonableness of the methodology, assumptions used, and results in conjunction with standard economic principles. Economists and survey researchers working in the natural resource and environmental areas have developed the theory and practice of contingent valuation to estimate non-use values.

To gain an understanding of Reclamation's recreational methodology, key assumptions, and results, we reviewed documentation that describes these in detail, including the EIS. We also interviewed members of the Recreation subgroup, including Reclamation officials and their contractors, as well as representatives from the National Park Service and the Arizona Game and Fish Department. In addition, we interviewed academic experts in the field and a member of the National Academy of Sciences' team that reviewed the EIS.

To gain an understanding of Reclamation's non-use value study methodology and results, we reviewed the final report entitled GCES Non-Use Value Study, dated September 8, 1995. We interviewed Reclamation officials responsible for the preparation of the report, and a Senior Associate at Hagler Bailly Consulting, who was a primary contributor to the development of the report. To evaluate Reclamation's non-use study, we made use of some general guidelines that focus on the quality of a contingent valuation study and on the underlying survey research. Specifically, to assess the contingent valuation study, we relied on general guidelines developed by a panel of prominent researchers convened by the National Oceanic and Atmospheric Administration. The panel's report was published in the Federal Register on January 15, 1993. To assess the total design method for conducting mail surveys used by Reclamation in the non-use study we used the most widely accepted written standards for mail questionnaires published by Don A. Dillman in 1978. We also interviewed a number of the Non-Use Value Committee members to obtain their opinion of the methodologies and data used and the results achieved. The Committee included members from the power industry, environmental groups, Native American tribes, and federal agencies. The Committee was tasked to consider interim study results and provide input to the study process.

For the eight resources whose impact determinations were not economically quantified, to determine the methodology and data used to make an impact determination, we obtained and reviewed the following documents: the draft EIS and associated appendixes, the preliminary final EIS, the final EIS, public comments on the draft EIS, Reclamation's analysis of and responses to these comments, copies of the minutes of EIS team meetings, summaries of the cooperating agency meetings, and Reclamation's newsletters on the EIS process. We also obtained and reviewed the U.S. Fish and Wildlife Service's draft biological opinion and final biological opinion on the Glen Canyon Dam's EIS, Reclamation's comments and responses to the biological opinions, and the U.S. Fish and

Wildlife Service's report required by the Fish and Wildlife Coordination Act. Also, we reviewed numerous scientific studies related to each of the resources that were identified by EIS team members as the most useful in developing the impact determinations for the respective resources.

To obtain a better understanding of other issues related to the EIS process, we also reviewed the Colorado River Simulation System Overview, the Final Analysis Report on Scoping Comments, and the Glen Canyon Dam EIS Preliminary Alternatives Report. Other documents reviewed included the draft and final environmental assessment of the spring 1996 beach/habitat-building test flow and papers presented at a 1991 National Research Council Symposium on the Glen Canyon Environmental Studies.

Because certain parameters included in the preferred alternative were changed, we reviewed a document entitled "Assessment of Changes to the Glen Canyon Dam Environmental Impact Statement Preferred Alternative from Draft to Final EIS," issued by Reclamation in October 1995. This paper explained the background and scientific basis of the changes to the preferred alternative between the draft and final EIS. A comprehensive list of the documents we reviewed is contained in the discussion of each of the 11 resources in appendixes I through X (vegetation and wildlife/habitat are both discussed in appendix IX).

To assess the reasonableness of the impact determinations for the eight resources that were not economically quantified, we interviewed the EIS team members and/or subgroup members who had the primary responsibility for making the impact determinations, writing sections of the draft EIS, and revising the EIS following the receipt of public comments. We also spoke with scientists identified by EIS team members and members of EIS subgroups who commented on issues in their area of expertise. Finally, we interviewed other agency officials with information on the EIS and Glen Canyon Environmental Studies processes. For each of these resources, we obtained his or her views on the reasonableness of the methodology and data used in making the impact determinations, how well the methodologies were implemented, and the reasonableness of the results achieved.

To obtain information on what, if any, concerns still exist on the part of key interested parties about the final impact statement, including how many supported the preferred alternative, we surveyed 37 key organizations and individuals knowledgeable about the EIS and its development. Our judgmental sample included officials of federal agencies, state agencies, Indian tribes, environmental organizations, water and power suppliers and users, and individuals involved in the development of the EIS. Specifically, among the 37 organizations and individuals we asked to respond to our survey, 23 were organizations and individuals that provided what Reclamation considered to be the most substantive comments on the draft EIS. These agencies and individuals include the Navajo Nation, Hualapai Tribe, Hopi Tribe, Bureau of Indian Affairs, National Park Service, Arizona Game and Fish Department, U.S. Fish and Wildlife Service, Western Area Power Administration, Plains Electric Generation and Transmission Coop, Inc., Environmental Protection Agency, Environmental Defense Fund, National Research Council, Upper Colorado River Commission, Department of the Interior's Office of Environmental Policy and Compliance, Salt River Project, Colorado River Energy Distributors Association, Grand Canyon Trust, American Rivers, Sierra Club Legal Defense Fund, American Fisheries Society, Grand Canyon River Guides, and Dr. Larry Stevens. Dr. Stevens is considered by many to be the leading authority on vegetation in the Grand Canyon region. He was a major contributor of research on both the vegetation and wildlife/habitat resources for the EIS. We also contacted Mr. David Marcus, whom Reclamation stated also provided substantive comments on the draft EIS. However, Mr. Marcus stated that he worked as a consultant for American Rivers and that he preferred to provide us with his comments through that organization, not as an individual. As such, we did not include Mr. Marcus as part of our survey universe.

We also contacted the three cooperating agencies (Pueblo of Zuni, Southern Paiute Tribe, and Southern Paiute Consortium) that were not among the 22 above. Furthermore, the seven Colorado River Basin states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) were asked to respond to our survey. In addition, another five environmental groups with interests in the Glen Canyon Dam area (Sierra Club, Arizona Flycasters, Friends of the River, America Outdoors, and Trout Unlimited) were also contacted. We received responses from 30 of the 37 (81 percent) organizations and individuals we contacted. The seven nonrespondents did not represent any particular interest group. Specifics on how the 37 organizations and individuals responded to our survey are provided in chapter 3 of this report.

We conducted our work from January 1995 through September 1996 in accordance with generally accepted government auditing standards.

We provided copies of a draft of this report to the Department of the Interior for its review and comment. Interior generally agreed with the information presented in the report and stated that they were impressed with the quality of the product developed by the audit team. Interior also provided several technical clarifications to the draft, which have been incorporated into the report as appropriate. Interior's comments and our responses are included in appendix XII.

Reclamation's Impact Determinations Are Usable for Decision-Making

In preparing the Glen Canyon Dam's environmental impact statement, Reclamation studied the impact of the dam's various flow alternatives on hydropower, non-use values, and other selected resources located below the dam. To make these impact determinations, Reclamation used a variety of methodologies and data sources. Generally, we believe the methodologies used to be reasonable and appropriate and the data used to be the best available at the time. Some prominent economists, however, question the credibility of results obtained from the methodology Reclamation used to derive non-use values. We also noted some shortcomings in some of Reclamation's economic assumptions and its application of certain methodologies. In addition, we found that some of the data used in the resource analyses were dated, preliminary, or incomplete. Overall, these limitations reduce the precision of the estimated impacts contained in the EIS. In addition, there is general agreement that as a result of incomplete information, the impact of steady flow alternatives on fish resources remains uncertain. Nonetheless, our work disclosed no evidence that these limitations would alter the relative ranking of the fluctuating and steady flow alternatives. Therefore, we believe that these limitations are not significant enough to render the final impact statement unusable to the Secretary of the Interior as a decision-making document.

Generally, Reclamation and other experts associated with the development of the Glen Canyon Dam's environmental impact statement believe that the impact determinations are reasonable. At the same time, they recognize that there are limitations to the EIS. However, they believe that these limitations are not significant enough to make the results unusable. Furthermore, Reclamation recognizes that many uncertainties still exist. To address these uncertainties, Reclamation intends to initiate a process of "adaptive management" that would provide for long-term monitoring and research to measure the actual effects of the selected alternative. The results of this effort would form the basis for possible future modifications of the dam's operations.

Methodologies Used to Make Impact Determinations Were Generally Reasonable

We found that, in general, the variety of methodologies and research techniques used by Reclamation to make impact determinations were reasonable and appropriate. For most resource assessments, Reclamation relied on multidisciplinary subteams consisting of experts representing federal and state governments, tribal interests, academic and scientific communities, the electric utility industry, environmental organizations, and the recreation industry. The exact makeup of each team depended on the resource and the area of concern. In addition, for each resource, the subteam assessed, either quantitatively, qualitatively or both, how alternative flows would affect the resource relative to a No-Action (base case) flow. The EIS teams generally used state-of-the-art modeling techniques and/or the latest scientific research to make the impact determinations. Furthermore, the methods used and results achieved were reviewed by peers and outside experts, including the Glen Canyon Environmental Studies Review Team and the National Academy of Sciences.

To conduct the impact analyses of various flows on hydropower, Reclamation established the Power Resources Committee—a group of electricity and modeling experts from Reclamation, the Western Area Power Administration, the electric utility industry, private contractors, and the environmental community. Using a 50-year analysis period (1991-2040) and the No-Action Flow alternative (historic operations) as the base case, the Committee assessed how various flow alternatives would affect hydropower production and then projected the subsequent economic costs that would be incurred by regional utilities and end-users to replace the dam's forgone power production. The Committee considered the fixed costs associated with the existing generating capacity in the region to be "sunk" costs and, hence, excluded them from the economic cost calculations. The Committee also used two state-of-the-art modeling techniques and detailed utility-specific data to quantify the economic impacts. In addition, the Committee used sensitivity analysis to test the impact of changes in key economic assumptions. The results of the power study were then incorporated into the draft EIS for public comment. The Committee solicited and received an independent review of the power study from three energy experts. On the basis of the comments received from the public and outside experts, the Committee partially revised its initial power study. For example, the Committee updated the projected costs of building gas-combustion powerplants, revised its retail rate analysis, and conducted additional sensitivity analyses. The results of both power studies were incorporated into the final EIS. (See app. V for details on the results of the power study.)

For fish resources, numerous public comments were received by Reclamation expressing concern about the impact determinations presented in the draft EIS. To respond to these concerns, Reclamation formed an Aquatic Biology Team workgroup. This work group consisted of EIS team members representing Reclamation, the U.S. Fish and Wildlife Service, the Arizona Game and Fish Department, and two Indian tribes.

The workgroup was tasked to respond to comments and to reorganize and rewrite the fish section of the final EIS. Individual workgroup members were given specific assignments, interactive discussions were held, and decisions were made through consensus. As a result of this effort, several major changes were made to the final EIS, including more explicit recognition of the uncertainty and disagreement that exist among scientists about the response of fish to the steady flow alternatives. (See app. IV for details on the results of the fish impact determinations.)

To assess the impact of various flow alternatives on water and sediment, Reclamation's EIS team used the Colorado River Simulation System (CRSS) to project the long-term (50 years) and short-term (20 years) impacts on annual and monthly streamflows, floodflows and other water spills, water storage, water allocation deliveries, and Upper Colorado River Basin yields. CRSS is a package of computer programs and databases designed to assist water resource managers in performing comprehensive long-range planning and operations studies that arise from proposed changes in the Colorado River's operations, proposed development of the Colorado River Basin, or changes in present water use throughout the basin. The development of CRSS took place over a 10-year period and stemmed from the need for a comprehensive model of the Colorado River Basin that would incorporate all areas of interest, including legislative requirements. According to Reclamation and other experts, CRSS is the most comprehensive and detailed simulation of the Colorado River system that exists. (See app. VIII and app. X for details on the results of the sediment and water analyses, respectively.)

To quantify the economic impact of the dam's various flow alternatives on non-use values and recreation, Reclamation primarily relied on a methodology called contingent valuation. Social scientists and economists have long acknowledged the existence of non-use values—the monetary value placed on the status of the environment by people who never visit or otherwise use these features. Contingent valuation relies on public surveys to elicit information from consumers and estimate how much they would be willing to pay for a non-use good. For valuing most goods and services, economists are able to rely on people's actual purchases of goods in markets. However, by definition people do not purchase non-use goods, and some prominent economists question whether the contingent valuation method can accurately elicit the values consumers place on non-use goods. For example, Peter A. Diamond and Jerry A. Hausman state, "We believe that contingent valuation is a deeply flawed methodology for measuring non-use values, one that does not estimate what its proponents claim to be estimating."[1] Still many economists and survey researchers working in the natural resource and environmental areas have developed and used this methodology, and it is currently the only known approach for estimating non-use values. (See app. VI for details on the results of the non-use value study.) Economists generally have fewer questions about the application of the contingent valuation methodology in measuring the value of goods and services that consumers actually purchase. Therefore, there are fewer questions about the usefulness of this approach for measuring the values associated with recreational activities. (See app. VII for details on the results of the recreation studies.)

Shortcomings Noted in Reclamation's Economic Assumptions and Implementation of Certain Methodologies

In light of the results of our work and the opinions of the experts we contacted, we believe the methodologies used by Reclamation and its EIS teams to make impact determinations were generally reasonable. We did note, however, some shortcomings in the economic assumptions used in the hydropower analysis and in Reclamation's implementation of certain methodologies. Specifically, in the hydropower analysis, the assumptions used do not explicitly include the mitigating effect that higher electricity prices would have in reducing the demand for electricity (that is, price elasticity). For example, the Power Resources Committee assumed that both the demand for and price of electricity would continue to rise over the planning period. However, we believe the rise in the price of electricity would likely induce some electricity consumers (both wholesalers and end-users) to consume less electricity or switch to cheaper alternative suppliers, which is not taken into account in the analysis. Consequently, fewer resources would be needed to replace forgone power at the Glen Canyon Dam, and the subsequent economic impacts would be lower than estimated (all else being the same).

In addition, the Committee's assumptions about future natural gas prices are relatively high. The Committee assumed that the average gas price would increase annually by 8 percent from 1991 through 2010. In 1994, industry forecasters projected that the price of natural gas would increase by about 6 percent for the same time period, and in 1995, forecasts assumed that prices will rise by only 5 percent. The higher escalation rates could affect the power analysis by overstating the economic cost of replacing the Glen Canyon Dam's power.

[1]Peter A. Diamond and Jerry A. Hausman, "Contingent Valuation: Is Some Number Better than No Number?" Journal of Economic Perspectives, 8(4), Fall 1994, pp. 45-64. (quotation on p. 62).

We also found that Reclamation's staff made two computational errors during the revision of the initial power analysis. The Power Resources Committee acknowledged these errors in its final report and stated that the errors affected the results in opposite directions, that is, one error may have overstated costs while the other error may have understated costs. The Committee was unable to correct the errors in the report because of time and funding constraints.

These shortcomings, combined with the inherent uncertainty in making economic forecasts, reduce the precision of the estimated economic impacts. However, an association that represents the affected power utilities, while maintaining that the costs to the power system are understated, does not believe that Reclamation's analysis is inaccurate by a large magnitude. Furthermore, because these shortcomings affect the estimated economic impact of all alternatives equally, we believe that addressing these shortcomings would not alter the relative ranking of the fluctuating and steady flow alternatives.

Although we believe the recreation impacts methodology is generally reasonable, we noted several limitations. For example, the survey data used as the basis of the analysis were gathered during an unusually high-water year; therefore, some respondents may not have actually experienced how various alternative flows would have affected their recreational experience, which is what they were being asked to value. In addition, the survey was designed well before the flow alternatives to be studied in the Glen Canyon Dam's EIS were finalized. As a result, the survey scenarios do not systematically correspond to the flow alternatives presented in the EIS. Finally, although researchers tested proposed questions to determine which ones offered the highest response rate, they did not adequately pretest some survey instruments to detect wording, construction, and presentation defects or other inadequacies. Because the recreation economic model used the results of these survey instruments as a basis for the analysis, the estimated dollar value of the benefits may not be very precise. Reclamation and National Park Service officials involved in the process acknowledged that the recreation analysis has limitations but stated that these limitations would not affect the ranking of the alternatives. They also noted that the estimated recreation benefits identified by this research were not a key element in the selection of the preferred alternative.

In addition to the shortcomings in the hydropower and recreation analyses, we also noted that there was no formal opportunity for affected parties as well as the general public to offer comments on the Glen Canyon non-use value study. Although the final EIS notes that the non-use value is positive and significant, the actual quantified results are not included in the final EIS. Reclamation did not include the non-use value study results because they were not available when the final EIS was published. The non-use study was completed as a separate Glen Canyon Environmental Studies report and, according to Reclamation, will be attached to the Record of Decision package sent to the Secretary of the Interior. In that way, it will become part of the final decision-making process. Reclamation noted that although the non-use study did not go through the public comment process, the study team solicited and received peer review at various key decision points and that the final results of the non-use value study received a positive review by the National Academy of Sciences and the Office of Management and Budget. Reclamation also noted that interests likely to be affected by any changes in the operations of the Glen Canyon Dam, such as power groups and environmental groups, were involved in the non-use value study process. In addition, there were scoping sessions and focus groups that were derived from members of the general public. The results of these sessions were used to assist in the development of the content of the survey and the relevant issues to be addressed.

Data Used in Impact Determinations Were the Best Available

Reclamation's National Environmental Policy Act Handbook requires that all EIS analyses be based on the best reasonably obtainable scientific information. According to Reclamation and other experts who developed the Glen Canyon Dam's environmental impact statement, the data used to make the impact determinations were the best available at the time. For example, for the impact of various flow alternatives on nonfish endangered species, one researcher said the terrestrial and bird-related research used as a basis for making impact determinations was "top notch." Another researcher who worked on endangered species stated that when they were clarifying information or needed data to fill gaps, the EIS team contacted researchers directly to get the latest available data. For information on cultural resources and properties, members of that resource team believe that Reclamation went beyond federal requirements for the development of an impact statement by performing assessments of all previously identified archeological sites within the Colorado River corridor in the Glen and Grand canyons. According to many experts, when completed, this effort generated the best and most current scientific information available.

For some resources, we found that although the data were the best available, they had limitations. Some of the data used in making the impact determinations were dated, preliminary, or incomplete. For example, Reclamation used survey data collected in 1985 to assess the economic impact of alternative dam flows on recreational activities. Reclamation's contractor surveyed a sample of anglers, day-rafters, and white-water boaters about their recreational experiences on the Colorado River and what effect, if any, different streamflows would have on their recreational experiences. However, because the survey was undertaken in 1985, it may not represent more recent trends in recreational experiences. For example, the number of angling trips on the Colorado River more than doubled between 1985 and 1991 (the base year used by Reclamation in preparing the draft EIS), which may influence the value of each trip. Reclamation updated some of the data to 1991 but acknowledges that the survey data were generally dated. Reclamation stated, however, that the recreation analysis was adequate to present a good picture of the potential impact of alternative flows on various recreational experiences and that because of the limited impact of alternative flows on recreation, limited research funds could be better used to improve other analyses. The National Research Council generally found the recreation analysis to be adequate.

In addition, the estimated non-use values for the steady flow alternatives could be overstated because of new information that was not available at the time the survey instruments were developed. The non-use value surveys described the environmental impacts based on information that was the best available at the time. This information indicated that improvements would be obtained for fish resources under fluctuating and steady flow alternatives. However, after the development of the survey instruments, the fish section of the EIS was revised to recognize the uncertainty that exists about the impact of steady flow alternatives. To the extent that the non-use value surveys did not capture this degree of uncertainty, the precision of the non-use value estimates could be reduced.

Many of the results of the Glen Canyon sediment studies were preliminary, in draft form, and had not been published at the time that the draft impact statement or the final impact statement was written. In addition, in some cases definitive information on the impact of a specific flow alternative was not available. Therefore, the EIS team had to extrapolate from the existing data using their professional judgment to estimate the potential impact of a specific alternative. The EIS team told us that they always verified the reasonableness of their conclusions and extrapolations with the researchers. However, they believed that if finalized data had been available, the reasons for the selection of the preferred alternative would have been more clearly supported. These researchers added that no new or additional information on sediment impacts has been obtained that would alter the information or conclusions presented in the final impact statement.

Finally, information on some resources is incomplete, as is the knowledge of how changes in the Glen Canyon Dam's operations will affect those resources. For example, the experts' opinions vary, in part because of incomplete data, on how native and nonnative fish interact and how changes to the dam's operations would affect these interactions. Many researchers and EIS team members we interviewed expressed regret about the lack of coordinated time frames between the completion of the Glen Canyon Environmental Studies and the development of the Glen Canyon Dam EIS. The leader of the workgroup responsible for developing the EIS impact determinations for fish stated that this difference in time frames was especially problematic when the preferred alternative was selected. At that point, decisions had to be made, but data and analyses were not complete.

Reclamation explicitly acknowledges the uncertainty that exists about the impact of the steady flow alternatives on fish resources in the final EIS. In its final biological opinion, the U.S. Fish and Wildlife Service stated that Reclamation's preferred alternative is likely to jeopardize the existence of two native endangered fish species (the humpback chub and the razorback sucker). In general, the biological opinion's "reasonable and prudent alternative" would modify the preferred alternative by including seasonally adjusted steady flows. The U.S. Fish and Wildlife Service and Reclamation have agreed to categorize these flows as experimental and include them as part of the Adaptive Management Program.

The Results of the Glen Canyon Dam's EIS Are Generally Reasonable, but Future Studies Will Be Needed

Reclamation and other experts associated with the development of the Glen Canyon Dam's EIS generally believe that the impact determinations presented in the final EIS are reasonable. (A summary of Reclamation's comparison of alternatives and impacts is presented in app. XI of this report.) They recognize that there are limitations to the results, but they believe that these limitations are not significant enough to make the impact determinations unusable for the Secretary's decision-making. For example, one EIS team member stressed that in the process of scientific decision-making and economic forecasting, complete and certain information is never available. Furthermore, Reclamation noted that the Congress had mandated that the final EIS be issued within a certain time frame; therefore, decisions had to be made on the basis of the best information available at the time.

Reclamation recognizes that uncertainties still exist about the impact of the various flow alternatives on resources. To address these uncertainties, Reclamation intends to initiate a process of "adaptive management."

Impact Determinations in the Glen Canyon Dam's EIS Are Generally Reasonable

We discussed the results of the impact determinations for each resource with Reclamation and other experts involved in the development of the Glen Canyon Dam's EIS. Although these individuals recognized that there were some shortcomings in the analyses, they generally agreed that the results of the impact determinations as presented in the Glen Canyon Dam's final EIS were reasonable. For example, although some researchers described the model used (the sand-mass balance model) to determine the impact of various flows on sediment as "simplistic" compared with models that are currently being developed by U.S. Geological Survey researchers, none of the preliminary results from the new models contradict the conclusions reached by the sand-mass balance model. Another researcher who worked on the vegetation and wildlife resources told us that although the EIS may have been based on incomplete information, subsequent science supports it. The researcher further added that the results of the EIS were right on track with the best scientific evidence available at the time.

The results of some impacts, however, such as how steady flows will affect fish, are still uncertain. The individual responsible for leading the fish impact determinations process stated that the lack of final results from the fish research studies was frustrating and that the limited data allowed differences of opinion and scientific interpretation to arise about the impacts on fish resources. However, he added that he believed that if final data had been available, they would have refined the EIS team's conclusions but would not have changed the impact determinations or the preferred alternative.

Although there is general agreement that the results of the Glen Canyon Dam's EIS are reasonable, there is also general agreement that additional research is needed to further refine or, in the case of fish resources, define the impact on resources of changes to the dam's operations. For example, impacts to some archeological and cultural properties are bound to occur regardless of the flow alternative chosen. To avoid or minimize the loss of historic properties and comply with the requirements of the National Historic Preservation Act, Reclamation developed a programmatic agreement between federal and state agencies as well as affected Native American tribes. Implemented in 1994, the agreement led to numerous monitoring trips and site-stabilization efforts, but all parties involved believe that more research is needed to understand how water flow affects cultural resources. Furthermore, several sediment researchers we interviewed stated that they supported the impact determinations and the preferred alternative. However, one stated that as more information is obtained about the various systems in the canyon, the preferred alternative may become less restrictive in terms of the allowed water releases for hydropower use.

Reclamation's Proposed Adaptive Management Program

Reclamation recognizes that uncertainties exist about the downstream impacts of water releases from the Glen Canyon Dam. To address these uncertainties, Reclamation plans to initiate an Adaptive Management Program. The concept of adaptive management is based on the recognized need for ongoing operational flexibility to respond to future monitoring and research findings and varying resource conditions. The objective of the Adaptive Management Program is to establish and implement long-term monitoring programs that will ensure that the Glen Canyon Dam is operated, consistent with existing law, in a manner that will protect, mitigate adverse impacts to, and improve the values for which the Glen Canyon National Recreational Area and the Grand Canyon National Park were established. According to Reclamation, long-term monitoring and research are essential to adaptive management. Reclamation believes that such an effort is needed to measure the performance of any selected EIS alternative. In this way, managers can determine whether the alternative is actually meeting resource management objectives and obtain an additional understanding of the resources' responses to the dam's operations.

Under Reclamation's current proposal, the Adaptive Management Program, which would be under the direction of the Secretary of the Interior, would be facilitated through an Adaptive Management Work Group. The Adaptive Management Work Group, chartered under the Federal Advisory Committee Act, would include representatives from each of the EIS cooperating agencies, the basin states,[2] contractors for the purchase of federal power, recreation interests, and environmental organizations. The work group would:

[2]The basin states consist of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

- develop proposals for (1) modifying the operating criteria, (2)research under the long-term monitoring program, and (3) other mitigation actions as appropriate and
- facilitate technical coordination and input from interested parties.

The Adaptive Management Work Group would be supported by a monitoring and research center and a technical work group. The Monitoring and Research Center would manage and coordinate monitoring activities, research, and inventory programs and maintain a scientific information database. The technical work group would include technical representatives from federal, state, and tribal governments and their contractors. This work group would translate the policy and goals of the Adaptive Management Work Group into resource management objectives and establish criteria and standards for long-term monitoring and research. The independent scientific review panel would include scientific experts not otherwise participating in the long-term monitoring and research studies. The responsibilities of this review panel would include reviewing scientific study plans, resource reports, and scientific logic and protocols.

Most Key Interested Parties Support Reclamation's Preferred Alternative for the Dam's Operations, but Some Concerns Remain

Since December 1982, Reclamation has been studying the effects of the Glen Canyon Dam on various resources within the Glen and the Grand canyons. According to Reclamation, during this 14-year period, over $75 million was spent initially on the Glen Canyon Environmental Studies and then on the Glen Canyon Dam's EIS. This research and analysis was aimed at providing sufficient information to recommend an operating plan for the dam that would permit the recovery of downstream resources while maintaining some level of hydropower flexibility. Still, after all this time and money, the process of selecting a preferred alternative involved not only scientific evidence but also trade-offs and compromise. This occurred because no one alternative could maximize benefits to all resources and because the impacts of some of the flow alternatives remain uncertain. Nevertheless, over 83 percent of the key interested parties who responded to our survey support Reclamation's preferred alternative as a good starting point for the future operations of the Glen Canyon Dam. In addition, many respondents supported the process used to develop the Glen Canyon Dam's EIS. However, while expressing their support, some organizations still had concerns about the final EIS.

Reclamation's Process for Selecting a Preferred Alternative

The selection of a preferred alternative for the future operation of the Glen Canyon Dam involved a repetitive sequence of comparisons of the effects that each of the nine flow alternatives would have on the 11 resources studied in the EIS. All resources were evaluated in terms of whether each flow alternative had a positive or an adverse effect. Reclamation's goal was to find an alternative dam-operating plan that would permit downstream resources to be maintained and if possible recover to acceptable long-term management levels while maintaining some flexibility in hydroelectric power capability. The EIS team, which included up to 25 individuals representing 11 of the cooperating agencies, the U.S. Geological Survey, and a private consultant, was primarily responsible for initially recommending a preferred alternative to the cooperating agencies. This team, which also had been responsible for the scientific and technical development of the resource impact determinations, realized very early in the process that they would have to make trade-offs in the selection of a preferred alternative. None of the alternatives could maximize potential benefits to all of the resources. The Grand Canyon Trust environmental organization told us that

"The Glen Canyon Dam EIS was a lengthy, complex process with many individuals and interests involved. It is safe to say that the preferred alternative will not completely satisfy any one group, however it represents a balance of interests and a reasonable starting point for future dam operations."

Another factor that the EIS team considered was that some affected resources were renewable, while others were viewed as nonrenewable. They avoided recommending an alternative dam-operating procedure that would result in significant loss of any existing nonrenewable resource and tried to minimize the adverse impacts to most renewable resources. They eliminated the No-Action, Maximum Powerplant Capacity, and High Fluctuating Flow alternatives from consideration as a preferred alternative because the data indicated that while these alternatives were beneficial to hydropower, they would either increase or maintain conditions that result in adverse impacts to nonrenewable downstream resources.

The EIS team also eliminated the Year-Round Steady Flow alternative from consideration as the preferred alternative. This alternative exhibited the highest probability for net gain in riverbed sand, had the largest potential for expanding riparian vegetation, and received the highest ranking among all alternatives for white-water boating safety benefits. However, the EIS team believed that the alternative probably exceeded sediment protection requirements for long-term management and would result in the lowest-elevation sandbars. The team was also concerned that a completely stable flow alternative would permit vegetation to adversely affect camping beaches and over time reduce the value of wildlife habitat. In addition, a stable flow may increase the negative interaction between native fish and predator and competitor nonnative fish. Finally, the team eliminated this alternative because they believed that it did not provide benefits that could not be provided by other alternatives, yet it would cause large adverse effects to hydroelectric power generation.

Of the remaining alternatives, the Existing Monthly Volume Steady Flow alternative was eliminated for reasons similar to those discussed for the Year-Round Steady Flow alternative. The Low Fluctuating Flow alternative was eliminated to reduce redundancy—Reclamation considered the Modified Low Fluctuating Flow alternative an improved version of the Low Fluctuating Flow alternative.

The EIS team considered the impacts associated with the three remaining alternatives (Moderate Fluctuating Flow, Modified Low Fluctuating Flow, and Seasonally Adjusted Steady Flow), although they were substantially different from the effect of the No-Action alternative, to be very similar in their assumed benefits to most downstream resources. Reclamation's former NEPA Manager for the Glen Canyon Dam's EIS advised us that from an ecosystem perspective, sediment was identified as the key resource in the selection of a preferred alternative. Riverbed sand and sandbars were the sediment resources of primary interest affected by riverflows below the dam. For sandbars to exist, sufficient amounts of sand must be stored on the riverbed. Because the dam traps 90 percent of the sediment, the sand supply is currently limited to whatever is contributed by downstream tributaries and hundreds of side canyons. Of equal concern is the river's capacity to transport sediment. Riverflows must be large enough to move and deposit sediment but not so large as to carry the sediment out of the canyon ecosystem. Frequent high flows, either from floods or large daily fluctuations, can transport greater amounts of sand than are contributed, causing a net decrease in both the amount of stored riverbed sand and the size of sandbars. Water release patterns modify the natural process of sandbar deposition and erosion. Rapid drops in the level of the river drain groundwater from sandbars, thus accelerating sandbar erosion. The EIS team concluded that any of these three alternatives were very similar in their assumed benefits to most downstream resources.

The effects on native fish did, however, vary among the three remaining alternatives. The Moderate Fluctuating Flow alternative provides potential minor benefits to native fish over no-action conditions. The benefits from the Seasonally Adjusted Steady Flow alternative were uncertain given the improvement in habitat conditions that this alternative would provide for predator and competitor nonnative fish. The team also determined that seasonally adjusted steady flows would create conditions significantly different from those under which the current aquatic ecosystem had developed since the construction of the dam. Finally, for hydropower, the team determined that the Seasonally Adjusted Steady Flow alternative would have the highest economic cost of any alternative, estimated at about $124 million annually. Ultimately, the EIS team decided to recommend the Modified Low Fluctuating Flow for the preferred alternative in the draft EIS. The members believed that this alternative would create conditions that permit the recovery of downstream resources to acceptable management levels while maintaining a level of hydroelectric power flexibility. The EIS team presented this recommendation to the cooperating agencies. Most cooperating agencies concurred, and the group recommended that this alternative be adopted by Reclamation. The draft EIS was issued by Reclamation in January 1994 with the Modified Low Fluctuating Flow identified as the preferred alternative.

After the draft EIS was provided for public comment but before the issuance of the final EIS, Reclamation changed two parameters of the preferred alternative. Specifically, the draft EIS' preferred alternative had a maximum release level of 20,000 cfs and a maximum upramp rate of 2,500 cfs per hour. In the final EIS, Reclamation modified the preferred alternative to provide a maximum release level of 25,000 cfs and a maximum upramp rate of 4,000 cfs per hour. The primary reason for these changes was to benefit hydropower. The preferred alternative presented in the draft EIS had the same maximum release rate and upramp rate as the interim operating criteria. Reclamation stated that the interim operating criteria were based on the results of phase I of the Glen Canyon Environmental Studies and professional judgment and were designed to be environmentally conservative over the interim period. With the benefit of the additional phase II results of the Glen Canyon Environmental Studies and EIS impact analyses, Reclamation stated that the upramp rate and maximum flow criteria were found to be overly conservative for the long term and that the two changes would not cause adverse impacts to downstream resources. As a result, with the concurrence of the cooperating agencies, the preferred alternative was modified in the final EIS.

In July 1995, Reclamation issued a document entitled Flow Modifications to the Glen Canyon Dam Environmental Impact Statement Preferred Alternative. Those who commented on that document expressed concern that no studies on the specific upramp and maximum flow criteria had been conducted. In October 1995, Reclamation issued a new report entitled Assessment of Changes to the Glen Canyon Dam Environmental Impact Statement Preferred Alternative from Draft to Final EIS. This report provided a more detailed and focused assessment of the impacts associated with the increased upramp rate and maximum flow criteria. While acknowledging that no new studies were conducted, Reclamation pointed out that the same was true for the parameters of the interim flows when they were selected and implemented. Furthermore, Reclamation stated it was possible to determine the effects of these changes by using the extensive amount of knowledge gained from both phase I and phase II of the Glen Canyon Environmental Studies. Reclamation concluded that the analyses were fully adequate to justify the change.

Support for Preferred Alternative Is Significant

The respondents to our survey of key parties interested in the Glen Canyon Dam's EIS overwhelmingly supported Reclamation's preferred alternative—the Modified Low Fluctuating Flow operating regime. We surveyed 37 key organizations and individuals about whether they support the preferred alternative and what, if any, remaining concerns they may have about implementing this alternative as the future operating plan for the Glen Canyon Dam. Our judgmental sample included federal and state resource agencies, American Indian tribes, water and power suppliers and users, and environmental groups. Specifically, Reclamation identified 23 of these organizations and individuals as providing the most substantive comments on the draft EIS. We excluded David Marcus from our survey analysis because he had commented on the draft EIS as a consultant to American Rivers and preferred to provide us with his comments through that organization. In addition, we surveyed any other organizations that were considered to be cooperating agencies in the development of the impact statement as well as other key interested parties. We also queried the seven Colorado River Basin states: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Over 83 percent (25 of 30) of the respondents to our survey supported the preferred alternative. Of the five remaining respondents, three organizations stated that they had no position on the issue, while two, the San Juan Southern Paiute Tribe and the Grand Canyon River Guides, believe that the current interim flows would be more protective of resources and, as such, consistent with the intent of the Grand Canyon Protection Act. Table 3.1 provides details on whom we surveyed and their response, if any.

Table 3.1: Key Interested Parties' Responses on Support of the Preferred Alternative

Respondents	Support preferred alternative	Other alternative supported
Federal agencies		
U.S. Fish and Wildlife Service	Yes	Modified Low Fluctuating Flow as modified by the reasonable and prudent alternative
Environmental Protection Agency	Yes	None
National Park Service	Yes	None
Department of the Interior - Office of Environmental Policy and Compliance	No position	
Bureau of Indian Affairs	Yes	Interim Low Fluctuating Flow and Seasonally Adjusted Steady Flow
National Research Council	Nonrespondent	
Western Area Power Administration	Yes	None
State agencies		
Arizona Game and Fish Department	Yes	None
Colorado River Board of California	No position	
Colorado River Commission of Nevada	Nonrespondent	

(continued)

Respondents	Support preferred alternative	Other alternative supported
Arizona Department of Water Resources	Yes	None
New Mexico Interstate Stream Commission	Yes	Modified Low Fluctuating Flow as modified by adaptive management
Colorado Department of Natural Resources	No position	
Utah Division of Water Resources	Yes	None
Wyoming State Engineer's Office	Yes	None
Indian tribes		
Hopi Tribe	Yes	None
Hualapai Tribe	Nonrespondent	
Navajo Nation	Yes	None
San Juan Southern Paiute Tribe	No	Interim Low Fluctuating Flow
Pueblo of Zuni	Yes	None
Southern Paiute Consortium	Yes	None
Water and power suppliers, users, associations, etc.		
Colorado River Energy Distributors Association	Yes	None
Plains Electric Generation and Transmission Coop, Inc.	Nonrespondent	
Salt River Project	Yes	None
Upper Colorado River Commission	Yes	Modified Low Fluctuating Flow as modified by adaptive management
Interest groups		
America Outdoors	Yes	Seasonally Adjusted Steady Flow
American Fisheries Society	Nonrespondent	
Arizona Flycasters	Nonrespondent	
American Rivers	Yes	None
Environmental Defense Fund	Yes	None
Trout Unlimited (Arizona Council)	Yes	None
Friends of the River	Nonrespondent	
Grand Canyon River Guides	No	Interim Low Fluctuating Flow
Grand Canyon Trust	Yes	None
Sierra Club Legal Defense Fund	Yes	None
Sierra Club	Yes	None
Individual		
Dr. Larry Stevens	Yes	None

Respondents Also Support Reclamation's EIS Process

Many respondents to our survey supported the process used by Reclamation to complete the EIS. In fact, many respondents commended Reclamation for its efforts to produce a comprehensive EIS. For example, the National Park Service stated that the EIS process was directed very well by Reclamation and that alternatives for the operation of the dam were fully explored. American Rivers, an environmental interest group, stated that the EIS is a high-quality document that reflects a process that was exemplary in its scope, thoroughness, and overall achievement. The Grand Canyon Trust stated that the EIS represents a significant and productive effort to understand the complexities of the river's ecosystem below Glen Canyon Dam and to include broad participation by the public and parties vitally interested in the issue. They further stated that in addition to increasing the scientific understanding of the Colorado River system, a great deal of trust and good faith were created between traditionally contentious interest groups. The Navajo Nation stated that overall, they were very pleased with the EIS process, citing that Native American concerns were taken into account by Reclamation and that the affected tribes had real input into the development of the EIS.

Several Concerns Remain About the Implementation of the Dam's New Operating Procedures

While respondents to our survey were generally positive about the selection of a preferred alternative and the process used by Reclamation to develop the EIS, some were still concerned about the preferred alternative and the Glen Canyon Dam's final environmental impact statement. These concerns focus on the manner in which compliance with the Endangered Species Act will be achieved, the economic impact of reducing the Glen Canyon Dam's hydroelectric power capacity, the lack of consideration in the EIS of other causes of downstream adverse impacts other than water releases from Glen Canyon Dam, the simultaneous changing of two of the dam's operating parameters very late in the EIS process, the adequacy of the flood frequency reduction measures, the need for selective withdrawal structures, and issues related to adaptive management, including future research and monitoring.

The U.S. Fish and Wildlife Service supports the preferred alternative as modified by its reasonable and prudent alternative. FWS's biological opinion expressed concern that the preferred alternative recommended flows would likely jeopardize the continued existence of two endangered species, the humpback chub and the razorback sucker. The biological opinion's reasonable and prudent alternative would modify the preferred alternative with seasonally adjusted steady flows about 25 percent of the time. FWS and Reclamation agreed to categorize these flows as experimental, or research flows, so that studies could be conducted to verify an effective dam-operating plan and to include those flows with another element of the reasonable and prudent alternative, adaptive management. However, there are concerns on the part of the Colorado River Energy Distributors Association, which represents over 140 nonprofit utilities that purchase power from the Western Area Power Administration (WAPA), that the implementation of endangered fish research flows will proceed regardless of the outcome of the Adaptive Management Program. The association strongly supports the EIS preferred alternative as a reasonable point to begin modified dam operations and adaptive management. However, the association also believes that an important part of the adaptive management process is that if an analysis of a research proposal indicates an inappropriate risk to the endangered fish or other resource, the Secretary could decide not to pursue this element of the preferred alternative. As such, the association objects to the language in the final EIS and the final biological opinion that indicates that the research flows will go forward regardless of the outcome of the adaptive management research design and risk assessment.

The Colorado River Energy Distributors Association and the Salt River Project, an agricultural improvement district that provides electrical service to various counties in the state of Arizona, are concerned that the economic cost of reducing the hydroelectric power capacity of the Glen Canyon Dam is understated in the EIS. Both the association and the Salt River Project believe that the preferred alternative does not adequately address the economic cost to power users of research flows. In addition, the Salt River Project believes that the EIS does not analyze the full economic impact of the preferred alternative on Salt River and its customers and on WAPA and its customers, resulting from WAPA's being unable to fulfill its obligations under an exchange agreement. The exchange agreement obligated Salt River to build and operate power generation facilities near customers in Colorado and New Mexico and to deliver the power produced by those facilities to WAPA to serve those customers. In exchange, WAPA was obligated to deliver a like amount of power to the Salt River Project from the Glen Canyon Dam.

WAPA stated that the EIS assumes that the dam's operations (water releases) are the only cause of the adverse impacts on the downstream resources and that, therefore, changing the dam's operations is the only technique or method available for managing and enhancing those resources. WAPA believes that other causes of downstream impacts include lack of sediment, cold water temperatures, nonnative fish species, and human usage. Accordingly, they believe that changing the operations at Glen Canyon Dam is not the only, or necessarily the best or lowest-cost, means of achieving positive resource changes. WAPA believes that a more holistic approach to the management of the downstream resources should be taken and supports the investigation of both operational and nonoperational management techniques, practices, and programs. Although WAPA supports the preferred alternative, it stated that the concepts of pumping sand, protecting beaches with native materials, augmenting sediment, managing vegetation, restricting human use, restricting raft moorings, reducing the competition for native fish, developing new tributary habitats for native fish, and using a reregulation dam (build another dam below the Glen Canyon Dam to regulate river flow) are all valid management techniques that merit detailed investigation and consideration.

Several environmental and recreational organizations, although supporting the preferred alternative, were concerned that Reclamation changed certain parameters of the preferred alternative very late in the EIS process. Specifically, the draft EIS' preferred alternative had a maximum release level of 20,000 cfs and a maximum rate of increase (upramp rate) of 2,500 cfs per hour. In the final EIS, Reclamation modified the preferred alternative to allow for a maximum release level of 25,000 cfs and a maximum upramp rate of 4,000 cfs per hour. Two basic concerns exist about this change: (1) the higher parameters were substituted in the final EIS without adequate scientific evidence that such flows would not negatively affect the downstream resources of the Glen and Grand canyons and (2) two parameters were changed simultaneously, which could compromise the ability to scientifically monitor and assess the future impacts of these flow parameters in the proposed adaptive management framework. Reclamation believes that it has adequately addressed both of these concerns by conducting an assessment of the proposed changes. Some agencies, including the Wyoming State Engineer's Office, America Outdoors, American Rivers, and the Sierra Club Legal Defense Fund still believe that adequate specific scientific testing was not done to fully evaluate the effect of changing these flow parameters. However, these groups still support the preferred alternative at this time because of Reclamation's proposed Adaptive Management Program.

The New Mexico Interstate Stream Commission believes that the spillway gates on the Glen Canyon Dam must be increased in height by about 4.5 feet to add the flexibility to accomplish flood protection without reducing the water supply available to the Upper Colorado Basin. The Commission, which supports the preferred alternative, also believes that the selective withdrawal outlet proposal for Glen Canyon Dam has not been adequately justified; the estimated cost of $60 million needs to be arrayed against the resulting benefits; and an assessment needs to be made of the potential adverse impacts associated with increasing water temperature.

Future monitoring and research efforts were a concern of several groups, including federal agencies, Native American tribes, and an environmental group. For example, American Rivers urged Reclamation to do everything in its power to ensure that an effective Adaptive Management Program be in place or sufficiently delineated in scope and substance and that a specific long-term monitoring program be identified that will quantify any impacts before the proposed flow changes are implemented.

Air Quality

In the Glen Canyon Dam's environmental impact statement (EIS), air quality is identified as an issue for both the immediate vicinity of the Grand Canyon and the surrounding six-state area, including parts or all of Utah, Wyoming, Colorado, Arizona, New Mexico, and Nevada. The power needs of this area are served by the Salt Lake City Area Integrated Projects, a group of power generation facilities that include the Glen Canyon Dam. Although the Glen Canyon Dam's hydroelectric powerplant does not cause air pollution, a change in its operations would affect the regional electrical power system. The Glen Canyon Dam has historically been used to generate power during periods of high demand for electricity, commonly known as peaking power. The loss or reduction of that capability would mean that another source of peaking power would be required. If that alternative source of power used fossil fuel, there would be a net change in the power system's emissions. Fossil fuels contain hydrocarbons, whose combustion can result in emissions of such atmospheric pollutants as sulfur dioxide and nitrogen oxides.

Reclamation found that the region's air quality would improve under all restricted fluctuating and steady flow alternatives for operating the dam. Generally, this would occur because the sources of replacement power would produce less emissions than the sources of power used by the current Integrated Projects System. According to Reclamation and the EIS team member who was responsible for the air quality impact determination, the process used to come to this conclusion was appropriate, the data used were the best scientific information available at the time, and the results were reasonable.

Description of the Resource

While the Grand Canyon region enjoys some of the cleanest air in the lower 48 states, the visual range is affected by haze. This haze is generally at its worse during the summer months. Air is carried into the Grand Canyon area from the south and west, where it picks up pollutants from urban and industrial areas. As a result, during the summer, the average visibility is only 100 miles, and it drops below 68 miles 10 percent of the time. Sulfates, which are produced from sulfur dioxide, are the major contributors to haze in the Grand Canyon. The Navajo Generating Station near Page, Arizona, has been identified as a major source of sulfates in the vicinity of the Grand Canyon.

During the winter, strong cold fronts bring in clean air from sparsely populated areas. The average visibility during these months is 158 miles, but it reaches more than 211 miles 10 percent of the time. Between the passages of cold fronts, however, the air stagnates, and pollution from local sources sinks into the canyon. The pollution can be trapped by strong inversions until another cold front again brings in clean air.

Effects of Pre- and Postdam Conditions on Air Quality

Although power production at the Glen Canyon Dam has had no direct effect on air quality at the Grand Canyon or in the region, an analysis of the impacts on air quality was included in the EIS because the Glen Canyon hydroelectric facility is part of a regional utility system that has some sulfate-producing facilities. The region's air quality is affected by the operation of these interconnected powerplants. For example, the National Park Service identified the Navajo Generating Station as a major source of sulfates in the Grand Canyon's air. In response to the Park Service's findings, the Environmental Protection Agency mandated modifications to reduce the plant's emissions. Although the Navajo Generating Station is independent of the Glen Canyon Dam's operations and modifications will be made to it regardless of which EIS operating alternative is selected, the air quality in the Grand Canyon would likely improve because of the modifications.

The changes in the operations at the Glen Canyon Dam might indirectly affect the region's air quality by forcing reliance on other types of power-generating facilities. For example, if power generated in the marketing area served by the Salt Lake City Area Integrated Projects were changed from older existing powerplants to new, cleaner-burning facilities, there would be less emissions, all else being the same. Conversely, if the reductions in power production from hydroelectric plants are replaced with power from existing powerplants that burn coal, there would be an increase in the amount of sulfur dioxide and nitrogen oxide emissions in the region.

Issue

The final EIS considers how the dam's operations affect other electricity-producing facilities in the area, including those that have impacts on air quality.

Indicators

The resource indicators considered in the EIS were the amount of sulfates in the Grand Canyon's air and the tons of sulfur dioxide and nitrogen oxides in the region's air.

Methodology Used to Make Impact Determination

Reclamation assigned the responsibility for the development of the air quality section of the EIS to a member of the National Park Service, who at the time was assigned to the Grand Canyon National Park. The impacts on the air quality in the Grand Canyon's immediate vicinity and across the region served by Salt Lake City Area Integrated Projects' power-marketing system were evaluated for each of the dam's operating alternatives. Reclamation used the same power-modeling data used to analyze hydropower impacts to determine the amount of sulfur dioxide and nitrogen oxide emissions that may occur under the dam's various operating scenarios. (See app. V of this report for details on Reclamation's hydropower analysis). For the final EIS, these studies indicate that the region's air quality will improve under the four restricted fluctuating and three steady flow alternatives. Because these emissions analyses included assumptions for long-term (50-year) power system expansion plans, some of the impacts are based on specific assumptions about power generation technology, demand for power, public attitudes, and political and economic climates.

In making the air quality impact determinations, Reclamation made a number of key assumptions. For example, the analysis assumes that any loss of power generation at the Glen Canyon Dam will be partly absorbed by currently available generation at other plants in the region. The analysis further assumes that, over time, gas combustion turbines will be added to the system to replace older, inefficient facilities. Because natural gas is a cleaner-burning energy source than coal, emissions will be reduced over the short term. However, as the demand for electric power increases in the future, new powerplants will be needed. These newer plants, it is assumed, will produce less emissions than the existing plants because existing clean air standards are more stringent than those in effect when the older plants were constructed. There would have to be a relaxing of current environmental laws and regulations to invalidate these assumptions.

The air quality impact analyses determined that any one of the steady or restricted fluctuating flow alternatives was acceptable. However, the EIS air quality team leader favors the preferred alternative because, in his opinion, it has the least detrimental impact when the entire ecosystem of the Glen and Grand canyons is considered.

Effects of the Flow Alternatives on Air Quality

According to the final EIS, the amount of Glen Canyon Dam hydropower that would need to be replaced varies under each of the dam-operating alternatives in the EIS. The net effect on the region's air quality under each alternative would be a slight reduction in emissions. Under the No-Action alternative, it was anticipated that gas combustion turbines, which are cleaner burning than coal-burning systems, will soon be added to the regional power system to replace older and more inefficient coal facilities. These additions should reduce the system's emissions over the first 5 years of operation. The assumptions under the Maximum Powerplant Capacity alternative would be essentially the same as those under the No-Action alternative.

Under the restricted fluctuating and steady flow alternatives, the amount of electrical energy produced at the dam during the day would be reduced, whereas the amount of energy produced at night would increase. Under this scenario, as the demand for electrical energy increases, especially during daytime hours, additional powerplants would be needed sooner than under the No-Action alternative. These new powerplants would produce less emissions than older, less-efficient existing plants because of today's more stringent emissions standards and because some of these plants would burn natural gas.

Assessment of Impact Determinations

During our review, we did not receive any negative comments about Reclamation's air quality impact determinations. However, the draft EIS generated 29 public comments related to concerns about air quality. The comments varied from observations and concerns about the analysis methods used, to the need for further details and support for some statements. For example, there was some concern that the EIS did not do a good job of identifying as speculative its projections of the potential developments in power generation technologies, future demand for power, public attitudes, and political and economic climates. Reclamation agrees that forecasts over a 50-year period are speculative, but it also believes that the results of the hydropower-modeling studies provide the best available information on the powerplants' impacts on air quality.

Another concern expressed was that the lost generating capacity at the Glen Canyon Dam would have to be replaced by the use of fossil-fueled powerplants or other sources that are more expensive, nonrenewable, and polluting. Reclamation told us that the hydropower studies, which looked at all affected utilities, concluded that there would be a decline in emissions under several alternatives, including the preferred alternative.

The individual who was responsible for the air quality section of the EIS told us that he believed that

- the process used in making the air quality impact determinations was reasonable,
- the methodologies employed in this process were adequate for the decision-making process, and
- the results of the analysis were reasonable.

However, he stated that he could not judge the overall quality of the data used in the analysis because it was proprietary and he did not have access.

Scope and Methodology

To identify how Reclamation determined the impact of various flow alternatives on air quality, we reviewed the scientific studies and research materials that were used by Reclamation in making its impact determinations.

Key Studies Identified

We identified the following studies as the primary scientific sources of the data included in the air quality section of the EIS:

- Electric Utility Financial and Production Cost Model (prepared by the Environmental Defense Fund).
- Material prepared by Mike Roluti, Bureau of Reclamation.
- Preliminary Research Findings - Glen Canyon Environmental Studies, by Duncan Patten and Dave Wegner, dated September 11, 1992.
- Stone and Webster Power Modeling Reports (prepared for the Western Area Power Administration).

In addition, to determine what, if any, concerns were expressed about the air quality analysis presented in the draft EIS, we reviewed the Bureau of Reclamation's Operation of Glen Canyon Dam Draft Environmental Impact Statement: Public Comments Analysis Report prepared by the Bear West Consulting Team for the Bureau of Reclamation. To determine other concerns that were expressed about air quality issues in the preparation of the EIS, we also reviewed the Final Analysis Report on Scoping Comments, Bureau of Reclamation, dated March 12-May 4, 1990, Bear West Consulting Team.

Officials Interviewed

In order to assess the methodology used, how well it was implemented, the quality of the data used, and the reasonableness of the results of the air quality segment of the EIS, we obtained the views of Mr. Jerry Mitchell, the official responsible for developing the air quality impact determination.

We also spoke with members of the Power Resource Committee who performed the hydropower analysis, which was the basis for the air quality analysis. The names of these individuals and details on the hydropower analysis are contained in appendix V of this report.

Cultural Resources

Cultural resources include archeological sites and Native American traditional cultural properties and resources. The affected area containing these sites and properties includes a 255-mile section of the Colorado River corridor within the Glen and the Grand canyons and lands adjacent to the Navajo Nation, the Havasupai and Hualapai Reservations, and the Lake Mead National Recreation Area. The tribes that have ancestral claims to the Grand Canyon and that continue to use the area today include the Havasupai, the Hopi, the Hualapai, the Navajo, the Southern Paiute, and the Zuni.

The Glen Canyon Dam changed the pattern of sediment deposition, erosion, and flooding through the Glen and Grand canyons. As a result, archeological sites that were once protected by sandbars and terraces have become increasingly exposed, making them vulnerable to erosion, deterioration, and ultimate destruction. While erosion will continue to occur under any operating alternative selected, some flow alternatives are more favorable for enhancing the long-term preservation of cultural resources than others.

According to representatives of Native American groups, the information used to analyze cultural resources issues was the best and most up to date available. In addition, many researchers and representatives of Indian tribes believe that Reclamation went beyond the requirements of the National Environmental Policy Act (NEPA) in preparing the cultural resource impact determination. Those involved in the process were also highly complimentary of Reclamation's efforts to include Native American tribes in making the impact determinations. As a result of the cooperation of all parties involved, the cultural resources team was able to reach a consensus on the impacts that various flow alternatives would have on the resources. Also, although not tasked to reach a consensus on a preferred alternative, the individual cultural resource team members each agreed on the Modified Low Fluctuating Flow alternative as the preferred dam operating regime.

Description of the Resource

All natural resources are considered sacred by Indian tribes, and some resources are considered vital for the continuation of traditional cultural practices. The cultural resources in the EIS study area include prehistoric and historic archeological sites, traditional cultural properties, and other resources that are important to Native Americans in maintaining their cultural heritage, lifeways, and practices. A variety of archeological sites were identified—for example, pueblos (habitation sites of four or more contiguous rooms); storage sites (granaries or cists); sherd and lithic scatter (scatter or concentration of ceramic sherds and debris from making stone tools); rock art (pecked, incised, scratched, or painted designs, symbols, or figures on rock); and burial sites. Many of these sites were determined to be eligible for inclusion on the National Register of Historic Places.

Also, many properties and resources within the Colorado River corridor, despite not being archaeologically significant, are culturally significant to Native American beliefs and practices. The culturally significant sites include plant-gathering areas, landforms, springs, prayer-offering sites (shrines), and mineral deposits. Also significant to some Native American tribes are willows, giant reeds, and many birds, including yellow warblers and yellow throats.

Effects of Pre- and Postdam Conditions on Cultural Resources

Until the mid-1980s, it was generally thought that cultural resources were not affected by the operation of the Glen Canyon Dam. The belief was that archeological remains would not be found below the historic high-water mark in the river corridor. This belief was based on two assumptions: (1) that prehistoric people were aware of the river's flood potential and would thus build above the floodplain and (2) that any cultural remains close to the river would have been washed away over the past thousands of years.

In 1989, the National Park Service and the U.S. Geological Survey conducted a pilot research project to evaluate erosion at archeological sites in the Grand Canyon. The project's results suggested that the operation of the Glen Canyon Dam contributed to ongoing site erosion. The dam affected sediment deposition, erosion, and flooding through the Glen and Grand canyons. As a result, river-deposited sandbars and high terraces (the surface form of a high sediment deposit having a relatively flat surface and a steep slope facing the river) have been eroded and, in some cases, destroyed. The archeological sites once protected by these sediment deposits have become increasingly exposed to erosion and ultimate destruction.

Issue

The issue presented in the final EIS for cultural resources is how do the dam's operations affect the continued existence of cultural resources in the Glen and Grand canyons?

Indicators

The indicators studied for cultural resources and listed in the final EIS were

- the number of archeological sites directly, indirectly, or potentially affected and
- the number of Native American traditional cultural properties and resources directly, indirectly, or potentially affected.

Methodology Used to Make Impact Determinations

To provide baseline cultural resource information for inclusion in the Glen Canyon Dam's EIS, Reclamation contracted with the National Park Service to conduct an archeological inventory in August 1990. The inventory, which was conducted by staff from the National Park Service and Northern Arizona University, was completed in May 1991. The inventory gathered basic information on the numbers, types, locations, National Register eligibility, and physical conditions of all cultural resources within the area that have been or could be affected by the operations of the Glen Canyon Dam. The inventory identified 475 sites in the Colorado River corridor, 336 of which had been or could be affected by the existence and operation of the dam. The remaining 139 sites did not exhibit any effects from the dam's operations and were excluded from further study. The EIS summarized these impacts, as shown in table II.1.

Table II.1: Glen Canyon Dam's Impacts on Archeological Sites

Type of impact	Number of sites
Direct—site erosion immediately caused by river flows	33
Indirect—sediment loss at the site or arroyo cutting near the site	124
Potential—loss of site due to catastrophic event such as unexpectedly high flows	179

In addition to the 336 sites, many Native American cultural properties and resources, especially plant and animal species that depend on sandbars and high terraces, have been adversely affected by the flows from the Glen Canyon Dam. According to the cultural resource writing team leader, the information on cultural resources and properties was obtained from research conducted by the following Native American tribes: Hopi, Hualapai, Southern Paiutes, Navajo, and Zuni.

The National Historic Preservation Act requires that an impact determination be made when any action by a federal agency could affect sites included in or eligible for the National Register of Historic Places.

The process for such determinations is spelled out in 36 C.F.R. 800 and requires that a determination of "effect" or "no effect" be made. When there is an effect, a "finding of no adverse effect" or "finding of adverse effect" is required. Mitigating measures must be taken when there is a "finding of adverse effect."

Because dam-related impacts to archaeological sites would continue regardless of the alternative flow patterns, the operations of the Glen Canyon Dam were considered to have an adverse effect on cultural resources located on the terraces that have formed along the river corridor. However, the rate at which impacts would occur could be affected by alternative operations, principally through flood frequency reduction measures.

To assess the impacts of various alternatives on cultural resources, Reclamation established a cultural resource team. The team leader was an archeologist with the National Park Service. The team leader was primarily responsible for cultural resource analysis, including archeological and tribal issues and compliance with the National Historic Preservation Act. The team members included representatives of the Hualapai Tribe, the Navajo Nation, and the Hopi Tribe.

The team was asked to analyze the archeological data and cultural resource issues and determine how various flow alternatives for the dam affected these resources. The team was not required to arrive at one specific preferred alternative.

In addition, tribal representatives from other interested tribes would periodically attend various EIS meetings to discuss the cultural resources issues. The cultural resource information for tribes that did not have representation on the team was prepared for them by the cultural resource team.

Effects of the Flow Alternatives on Cultural Resources

According to the final EIS, the dam's operations influence the rate at which archeological sites and cultural resources are affected. Flow alternatives that maintain the sand balance and allow for its distribution along the river corridor would enhance the long-term preservation of cultural resources. The most favorable operation alternatives are those which produce a positive net sand balance in the river system while maintaining a higher elevation of sand deposits. Of the nine alternatives, six (Moderate Fluctuating, Modified Low Fluctuating, Interim Low Fluctuating, Existing

Monthly Volume Steady, Seasonally Adjusted Steady, and Year-Round Steady flows) cause moderate impacts on the sites but nevertheless allow for a net positive sediment balance in the system and potential sediment redeposition in areas that would protect cultural resources. The No-Action and the Maximum Powerplant alternatives were shown to have major impacts affecting all of the archeological sites, and the High Fluctuating Flow alternative was found to have the potential to have major adverse impacts on 263 sites.

Need for Continued Studies of Cultural Resources

The assessment of impacts on cultural resources will be an ongoing endeavor. The National Historic Preservation Act, as amended in 1992, requires federal agencies to develop measures to avoid or minimize the loss of historic properties resulting from their actions and recommends a long-term monitoring program to assess the changing conditions of cultural resources. In addition, long-term monitoring is required by the Grand Canyon Protection Act of 1992.

To comply with these requirements, Reclamation and the National Park Service developed a programmatic agreement for the continued monitoring of cultural resources and for the mitigation of the adverse effects of the dam on threatened cultural resources. The programmatic agreement stipulates that these long-term responsibilities will be outlined in a Historic Preservation Plan to be developed for cultural resources along the river corridor. The following are signatories to the programmatic agreement.

Advisory Council on Historic Preservation
Arizona State Historic Preservation Officer
Bureau of Reclamation
Hopi Tribe
Hualapai Tribe
Kaibab Paiute Tribe
National Park Service
Navajo Nation
Paiute Indian Tribe of Utah for the Shivwits Paiute Tribe
San Juan Southern Paiute Tribe
Zuni Pueblo

At the time of our review, the Havasupai Tribe was also expected to be a signatory to the programmatic agreement. The agreement was officially implemented in February 1994, and numerous river-monitoring trips, site-stabilization efforts, and periodic meetings among the signatories have already been held. The agreement calls for continued monitoring within the river corridor.

Assessment of Impact Determinations

The cultural resource writing team members and several of the representatives from the cooperating agencies who were concerned about the cultural resource issues were complimentary of Reclamation's effort to solicit information from and include Native American tribes in the EIS process. There was a consensus that the data used to address the impacts on the cultural/archeological resources were the best and most up to date that were available.

Several comments commended Reclamation for conducting an open and well-researched and well-documented EIS process. For example, one commenter stated that Reclamation went beyond the requirements of NEPA by funding new research used to make impact determinations.

According to the leader and other members of the cultural resource team, there was consensus among the members on how to present cultural resource issues. The tribes also presented a unified position. A representative from the Bureau of Indian Affairs noted that he was not aware of any disagreement from any tribes about the EIS process. According to most representatives of the Native American groups we interviewed, the scientific data used in the archeological and cultural resource sections of the EIS were the most recent data available. Furthermore, many representatives stated that all relevant information available at the time was sought out and used and that the data presented in the EIS are factual and do not contradict historical tribal information or other known data. While most of the information used in the cultural resources section of the EIS was in draft form, no new or additional data have emerged that would change or contradict the information in the EIS.

The cultural resource team members, as well as most representatives from the Native American tribes, support the preferred alternative (the Modified Low Fluctuating Flow).

The cultural resources team leader's overall position was that

- the process used in making cultural resource impact determinations was reasonable,
- the methodologies employed in this process were appropriate,

- the data used were the best available, and
- new information that had been obtained at the time of our audit work did not alter the facts used in arriving at the impact determinations in the final EIS.

Scope and Methodology

In addition to identifying how Reclamation determined the impact of various flow alternatives on cultural resources, we evaluated the scientific foundations, the study review process, the EIS work groups, and the impact determinations. We also gathered studies and research materials that were instrumental to Reclamation in making the EIS decisions.

Key Studies Identified

We identified the following studies as the primary scientific foundations for the data included in the cultural resources section of the EIS:

- Big River Canyon: Southern Paiute Ethnographic Resource Inventory and Assessment for Colorado River Corridor, Glen Canyon National Recreation Area, Utah and Arizona, and Grand Canyon National Park, Arizona, June 1994, and Storied Rocks: Southern Paiute Rock Art in the Colorado River Corridor, September 1995. These reports were prepared by the Southern Paiute Consortium and the University of Arizona. According to the consortium, research data collected for the studies were used in preparing the EIS. The fieldwork for the ethnographic resource study began in July 1992. We did not obtain data on a peer review of the reports.
- The Grand Canyon River Corridor Survey Project: Archeological Survey Along the Colorado River Between Glen Canyon Dam and Separation Canyon prepared in cooperation with the Glen Canyon Environmental Studies Cooperative Agreement No. 9AA-40-07920. Although this study was not published until December 1994, research conducted for it was used in preparing the EIS. The researchers for the study included professional staff from the National Park Service and Northern Arizona University. The fieldwork commenced August 30, 1990, and was completed May 10, 1991. Peer review was performed by the Arizona State Historical Office, the University of Cincinnati, the University of Arizona, the National Park Service regional archeological staff in Denver and San Francisco, and affected Native American tribes.
- The River of Neverending Life: Navajo History and Cultural Resources of the Grand Canyon and the Colorado River. Navajo Nation Historic Preservation Department. August 9, 1995. A draft version of the report as well as basic research were used in preparing the EIS. The fieldwork for

this report was begun in May 1992. We did not obtain information on a peer review of the report.

- Surficial Geology, Geomorphology, and Erosion of Archaeologic Sites along the Colorado River, Eastern Grand Canyon, Grand Canyon National Park, Arizona. U.S. Geological Survey, Open-File Report 93-517, prepared in cooperation with the Bureau of Reclamation-Glen Canyon Environmental Studies. This report, released in 1993, acknowledges a number of individuals for critical review and comments.
- Zuni and the Grand Canyon: A Glen Canyon Environmental Studies Report, July 21, 1995, Zuni GCES Ethnohistorical Report prepared by the Institute of the North American West. The research data on which this report is based were used in the EIS. The research was initiated in 1993. We did not obtain information on a peer review of the report.

In addition to these studies, which dealt specifically with cultural resources, we examined other relevant documents to determine the significance of cultural resource concerns expressed or addressed prior to the preparation of the EIS. These other documents included the following:

- Final Analysis Report on Scoping Comments, prepared by Bear West Consulting Team, March 12-May 4, 1990, and
- Preliminary Research Findings, Glen Canyon Environmental Studies, presented to the Bureau of Reclamation and Western Area Power Administration in Denver by Duncan Patten and David Wegner, September 11, 1992.

Officials Interviewed

To assess the procedures followed and obtain views on the quality of the data used in preparing the cultural resource issues, we interviewed the four members of the cultural resource writing team. We asked the team leader for the cultural resources workgroup to review our description of the resource impact determination process for factual accuracy. She agreed that the information presented is a good summary of the process, methodology, and scientific basis used to determine the impacts on the cultural resources from the Glen Canyon Dam's operations. We also contacted representatives of several cooperating agencies, primarily Native American tribes, to obtain their perspectives on and concerns about the archeological/cultural resources addressed in the EIS. The following officials were contacted.

Roger Anyon, Pueblo of Zuni
Janet Balsom, National Park Service - Grand Canyon

Clay Bravo, Hualapai Tribe
Angelita Bulletts, Southern Paiute Consortium
Gary Cantley, Bureau of Indian Affairs
Kurt Dongoske, Hopi Tribe
Alan Downer, Navajo Nation
Loretta Jackson, Hualapai Tribe
Leigh Jenkins, Hopi Tribe
Signa Larralde, Bureau of Reclamation
Johnny Lehi, San Juan Southern Paiute Tribe
Alexa Roberts, Navajo Nation
John Thomas, Navajo Nation
Michael Yeats, Hopi Tribe

Also, members of the following cooperating agencies were involved in the analysis and development of the cultural resource issues addressed in the EIS: Bureau of Indian Affairs, National Park Service, Hopi Tribe, Hualapai Tribe, Navajo Nation, Pueblo of Zuni, San Juan Southern Paiute Tribe, and Southern Paiute Consortium.

Endangered Species

The historic operations of the Glen Canyon Dam have negatively affected some wildlife resources while enhancing others. Among the wildlife that inhabit the Glen and Grand canyon river corridor, there are seven nonfish endangered species.[6] The impacts of the various flow alternatives on these endangered species are mostly indirect and were analyzed through linkages to other resources, such as fish and vegetation. The U.S. Fish and Wildlife Service (FWS) determined that the proposed operation of the Glen Canyon Dam under the Modified Low Fluctuating Flow preferred alternative, is not likely to jeopardize the continued existence of the bald eagle, Kanab ambersnail, or peregrine falcon. The FWS addressed only species that were listed as endangered by the federal government. When the final EIS was issued, the southwestern willow flycatcher was only a candidate for listing. It has subsequently been listed as an endangered species. In addition, the bald eagle has been reclassified from endangered to threatened. The belted kingfisher, osprey, and southwestern river otter are Arizona species of concern. Therefore, they were addressed in the EIS but not by the FWS. In general, nonfish endangered species issues were not controversial in the preparation of the Glen Canyon Dam's EIS, and few concerns exist about the process used or the data relied upon for making the endangered species impact determinations.

Description of the Resource

Wildlife is diverse and abundant along the river corridor through the Glen and the Grand canyons. Riparian (near water) vegetation, which developed along the river after the construction of the Glen Canyon Dam, plays an important role as habitat to support this diversity and abundance. The variety of animals present in the river corridor, their habitats, and how they use their habitats form a complex system that is difficult to evaluate in detail. However, like other resources, this system is linked to the river and ultimately to the operations of the Glen Canyon Dam.

Both aquatic and terrestrial endangered species occupy or use the river corridor. The seven nonfish endangered species considered in this appendix include five birds, one terrestrial snail, and one mammal now presumed extinct. Specifically, these species are the bald eagle, peregrine falcon, southwestern willow flycatcher, belted kingfisher, osprey, Kanab ambersnail, and southwestern river otter. A brief description of each of these species follows.

[6]In this appendix, the term "endangered species" is used for all special-status species addressed in the final EIS, including endangered species, candidate species, and Arizona species of concern. In the final EIS, Reclamation revised the fish section to include the discussion of endangered fish species. This appendix follows the same approach. That is, only nonfish endangered species are discussed in this appendix. Endangered fish species are discussed in app. IV.

Bald Eagle

The bald eagle was listed as endangered in 1978 but has since been reclassified as threatened. The Colorado River corridor through the Grand Canyon is used by migrating bald eagles in the winter. While eagles are capable of taking fish from a river system with characteristics identical to those of the Colorado River before the construction of the Glen Canyon Dam, they were not often observed in the Grand Canyon until after the rainbow trout fishery was established.

The bald eagle's use of the river corridor is opportunistic and currently concentrated around Nankoweap Creek, where they use winter-spawning trout as a food source. The use of the river by eagles may increase and eventually expand to other locations. For example, bald eagles are regularly located along the river corridor above the Little Colorado River and occur around Lake Powell.

Peregrine Falcon

Peregrine falcons were listed as endangered in 1970 but have generally increased nationwide since the prohibition on the use of certain pesticides. The Grand Canyon and the surrounding areas support the largest known breeding population of peregrine falcons in the contiguous United States. The birds using the Grand Canyon appear to be part of an increasing peregrine falcon population on the Colorado Plateau.

Although relationships are still under investigation, it is assumed that the peregrine falcon's success in the area is at least partially due to the abundance of birds and bats. These prey species are plentiful because of large insect populations produced in the clear river water. The relationships between aquatic productivity, insects, prey species, and peregrine falcons are largely speculative. No specific data are available that refute or confirm the above relationships, and no data are available on the activities of peregrine falcons in the Grand Canyon before the construction of the Glen Canyon Dam.

Southwestern Willow Flycatcher

The southwestern willow flycatcher is a riparian bird found in Arizona, New Mexico, and southern California. At the time the final EIS was released, this species was a candidate for listing. It has since been listed as an endangered species.

Southwestern willow flycatchers have always occupied the river corridor. Nesting pairs of this species increased in the Grand Canyon following the completion of the Glen Canyon Dam. Researchers attribute this response to increases in riparian vegetation following reduced flood discharges. However, a 1991 survey found only two pairs of nesting birds. The most probable reason for this apparent decline is the brown-headed cowbird. These birds lay their eggs in other species' nests, usually at the expense of their hosts' young.

One researcher speculated that a possible reason for the decline in the numbers of this species is habitat fragmentation caused by floods and fluctuating river flows. Fluctuating flows contribute to the erosion of terrestrial habitats, resulting in a decrease in the size of contiguous vegetation patches. However, the required patch size for nesting southwestern willow flycatchers is not known. Although the southwestern willow flycatcher has traditionally been associated with willows and other native vegetation, all of the nests located in the Grand Canyon have been located in tamarisk, even though native vegetation was available.

Belted Kingfisher

The belted kingfisher is considered a candidate species for listing by the state of Arizona. This bird is found in low numbers year-round in the Grand Canyon and its tributaries. This species is restricted to habitats with permanent, fish-inhabited waters.

Osprey

The osprey is a fall, spring, or accidental transient in the Grand Canyon and is listed by the state of Arizona as a "state threatened" bird species. Osprey are primarily found in coniferous forests around lakes, and it is assumed that they use the river as a travel lane to other habitat.

Kanab Ambersnail

Only three populations of this snail are known to exist—two near Kanab, Utah, and one in the Grand Canyon. Since the listing of this species as endangered in 1992, one of the Utah populations is now believed to be extirpated (extinct in that area). The Grand Canyon population was discovered in 1991 by researchers surveying mollusks in conjunction with the Glen Canyon Environmental Studies program.

Although officially a terrestrial animal, the Kanab ambersnail is really an amphibious creature found in wet or moist environments, such as marshes and seeps located at the bases of sandstone cliffs. Vegetation cover is necessary for this mollusk. The vegetation in the Grand Canyon associated with the Kanab ambersnail is the cardinal monkey flower and water cress. The availability of the cardinal monkey flower and other vegetation near the river in the Grand Canyon, as well as the presence of rock ledges, influence the distribution of the Kanab ambersnail. Since the implementation of the interim flows for the Glen Canyon Dam in 1991, the Kanab ambersnail's habitat has become available at lower elevations, closer to the river.

Southwestern River Otter

The southwestern river otter is considered an endangered species by the state of Arizona. River otters have always been considered rare in the Grand Canyon; the last sighting was reported in 1983. Unconfirmed reports of their presence continue to be received from several localities, but extensive surveys have not resulted in sightings. The species is generally believed to be extinct.

Effects of Pre- and Postdam Conditions on Endangered Species

The Grand Canyon ecosystem originally developed in a sediment-laden, seasonally fluctuating environment. The construction of Glen Canyon Dam altered the natural dynamics of the Colorado River. The interruption in riverflow and the regulated releases of lake water now support aquatic and terrestrial systems that did not exist before the Glen Canyon Dam. The historic operations of the dam negatively affected some wildlife resources while enhancing others. The impacts of the dam's operations on the various endangered species also vary.

Issue

As defined in the final EIS, the issue for endangered species is how do dam operations affect the populations of endangered and other special-status species throughout the Glen and the Grand canyons?

Indicators

Because the seven nonfish endangered species that inhabit the river corridor occupy diverse niches in the Grand Canyon ecosystem, no single resource could be used as an indicator of impacts for endangered species as a whole. Therefore, the EIS team utilized an analytical approach which considered linkages among resources. The team identified the following indicators for individual species:

- for the bald eagle: trout and the aquatic food base;
- for the belted kingfisher: the aquatic food base;
- for the southwestern willow flycatcher: the area of woody plants; and
- for the Kanab ambersnail: maximum river flow.

Methodology Used to Make Impact Determinations

EIS team members told us that the EIS was developed through a dynamic process involving three main groups—the EIS team, Glen Canyon Environmental Studies officials and researchers, and representatives of the cooperating agencies. The EIS team was responsible for the technical development of alternatives and impact determinations, while the cooperating agency group was a policy-level review body.

The nonfish endangered species impacts and issues were primarily developed by two EIS team members assigned to that task on the basis of their areas of expertise. Unlike the groups formed to address economic issues, no formal endangered species workgroup existed and no formal reports were produced.

These two team members developed their sections of the EIS through an iterative process of drafting, discussions, and formal and informal presentations to, and review by, the EIS team, as well as through input from key researchers and colleagues with whom they shared their work and from whom they solicited feedback. Additionally, the team members presented impact assessments to the cooperating agency group.

Decisions on endangered species issues were handled through voting; the goal was to obtain consensus on the results of the work. The formal minutes of the EIS team meetings were kept as a record of key decisions.

Reclamation received approximately 33,000 public comments on the draft EIS, 1,826 of which related to endangered species. However, only 31 comments specifically focused on nonfish endangered species. On the basis of new scientific information, the public comments, and the comments received from internal reviews, the EIS team as a whole made changes to the endangered species section of the EIS. These changes included the addition of a new indicator for the impact analysis related to the Kanab ambersnail, changes to the text, and modifications to the endangered species impact matrix. Both minor and major changes were made. An example of a minor modification is the change of status in the matrix for the southwestern river otter from presumed “extirpated” to presumed “extinct.” A more major addition/modification pertains to the inclusion of updated information on, and an expanded treatment of, the Kanab ambersnail in the final EIS.

According to the principal author of the revised endangered species section, new information received after the release of the draft EIS indicated that the Kanab ambersnail responded to interim flows at the dam by moving into lower elevations than it had inhabited under the dam's historic operations. Kanab ambersnails residing in these locations would be affected by flows higher than 20,000 cubic feet per second (cfs) and the associated habitat maintenance and beach/habitat-building flows.

Because this population survived the 1983-86 floodflows of about 90,000 cfs, the EIS team assumed that infrequent flows of about 45,000 cfs would not jeopardize the continued existence of the population. However, some unavoidable mortality, or "incidental take," would occur. As a result of this information, changes were made to the discussion in the text of the Kanab ambersnail, and the impact determinations in the associated matrix were modified from "no effect" to "some incidental take."

Data Used for Making Impact Determinations

The research studies used to support the impact determinations on endangered species are listed in the final EIS bibliography. Because of linkages to the fish and vegetation resource areas, the studies done in these fields are pertinent to endangered species. The studies include Glen Canyon Environmental Studies phase I and phase II research, as well as research developed by various state and federal agencies involved in endangered species work. Those studies deemed most useful by a key member of the EIS team who worked on endangered species issues are noted later in this appendix.

Effects of Flow Alternatives on Endangered Species

Details of the anticipated impacts of the nine flow alternatives on endangered species are found in the final EIS. However, the following general statements can be made about these impacts:

- The Kanab ambersnail is the only species expected to be adversely affected by any of the flow alternatives. Some mortality, or "incidental take," would occur under all alternatives, although the continued existence of the population would not be jeopardized.
- Three species will be unaffected by changes in the dam's operations—the peregrine falcon, the osprey, and the southwestern river otter (which is presumed extinct).
- Habitat conditions for the bald eagle and belted kingfisher would remain stable or potentially improve under all alternatives.
- The southwestern willow flycatcher would experience an "undetermined increase" in habitat under all alternatives except the No-Action and Maximum Powerplant Capacity alternatives.

U.S. Fish and Wildlife Service's Final Biological Opinion

The U.S. Fish and Wildlife Service's 1994 final biological opinion found that the proposed operation of the Glen Canyon Dam under the preferred alternative is not likely to jeopardize the continued existence of the bald eagle, the peregrine falcon, or the Kanab ambersnail. Few of the researchers and EIS team members we spoke with commented on the biological opinion as it related to nonfish endangered species. When asked about this, two EIS team members said that the "no jeopardy" finding was key to the lack of controversy on endangered species issues in team discussions. Another EIS team member added that the no jeopardy finding probably did allow the team to target their discussions and efforts on those endangered fish which had a jeopardy finding. Still, another team member told us that the team was not surprised by FWS' no jeopardy finding and knew even before the opinion was released that fish would be the primary concern.

Assessment of Impact Determinations

Nonfish endangered species were not a controversial issue in the preparation of the Glen Canyon Dam's EIS. This is particularly true in comparison to fish, which generated a great deal of controversy and difference of opinion. When asked to comment on "endangered species," most researchers we spoke with talked only about endangered fish.

Several EIS team members pointed to the indirect impacts of the dam's operations on most endangered species as a key reason for this lack of controversy. A few EIS team members noted that nonfish species represent only a small percentage of the endangered species in the canyon and that concern about nonfish species was low compared to fish because of these small populations. One EIS team member used as an example of this the fact that only two nesting pairs of southwestern willow flycatchers are in the affected area. However, another EIS team member disputed the view that the smaller numbers of endangered species made them less controversial. This individual stressed that the smaller numbers actually made it even more crucial that these species be protected and taken very seriously in the EIS process. One researcher noted that there is a long history of fish research in the canyon but that there is no such research history for other species. This individual said that of the nonfish endangered species, most interest focused on the Kanab ambersnail and the southwestern willow flycatcher. Another researcher simply stated that "the fish drive the system" in the canyon and are more politically important than the other species. Furthermore, he said that the connection between fish and the dam's operations can be easily seen, while this connection is harder to see with terrestrial species.

Reasonableness of the Methodology

Few concerns exist among the experts we interviewed about the process used in making the endangered species impact determinations. Most EIS team members we interviewed were satisfied with the process of analyzing the linkages among resources in determining impacts. However, one EIS team member noted that analyzing linkages was only one way to look at impacts on endangered species. The member noted that while analyzing linkages was an acceptable and reasonable approach, it was not necessarily the best or the worst way to proceed.

EIS team members acknowledged that because some linkages were quite indirect, professional judgment was important in this process. They stressed, however, that professional judgment was supported by the best available data.

One researcher expressed some dissatisfaction with this process. This individual said that, on the basis of his experience in the canyon observing the connections among bird species and other terrestrial resources, the connections are more direct than they were represented in the final EIS. He felt that although the team claimed to have looked at linkages, they did not do as thorough a job as they say and looked more at the impacts that could be directly ascribed.

Opinions on Data Used for Impact Determinations

Individuals we interviewed had few concerns about the data used in making the impact determinations for nonfish endangered species. One EIS team member told us that with the possible exception of the Kanab ambersnail and the southwestern willow flycatcher, endangered species were not controversial in terms of the data or the process used in making the impact determinations. In fact, one researcher with whom we spoke characterized the terrestrial and bird-related research used as a basis for these determinations as “top notch.” Nevertheless, one EIS team member said that the data used for endangered species were even less solid than they were for fish.

A researcher who was also a member of the EIS team told us that while professional judgment played a role in their decision-making, the team worked hard to collect all of the information available. This person said that when necessary, to fill in data gaps, the team contacted researchers directly and asked them to provide information in the form of written communications that could then be cited as documentation.

Another member of the EIS team told us that, in his opinion, the data on the bald eagle were "adequate," data on the southwestern willow flycatcher were "on the cusp," and much of the new data on the Kanab ambersnail became available only after the EIS process was substantially complete. This individual went on to say, however, that the data available to the team on most species provided adequate information to make informed decisions. He stressed that complete information is never available in the process of scientific decision-making.

Response to the Issues Raised

The principal author of the endangered species section of the final EIS provided us with detailed comments on and responses to each of the issues noted above. He agreed with some statements or positions and disagreed with others. For example, he disagreed that the data available on which to base impact determinations were less solid than those for fish. He noted that because impacts based on linkages are difficult to quantify, they can give the impression that they are less solid. However, he stressed that linkages are a legitimate and useful scientific approach and that they yield useful information. Moreover, he agreed that the data available on the various species produced reasonable results that were adequate for informed decision-making.

Scope and Methodology

To determine the data and process used in developing endangered species issues, we identified and reviewed the following documents: the draft EIS and associated appendixes; the preliminary final EIS; the final EIS; public comments on the draft EIS; Reclamation's analysis of and the EIS team's responses to these comments; copies of the minutes of the EIS team meetings; summaries of the meetings of the cooperating agencies; and Reclamation's newsletters on the EIS process. We also obtained and reviewed FWS' draft biological opinion and final biological opinion on the operation of Glen Canyon Dam, Reclamation's comments on the draft biological opinion and official response to the final biological opinion, and FWS' Fish and Wildlife Coordination Act report. (See below for a list of related documents and full citations.)

We obtained a copy of the final EIS bibliography from Reclamation, with titles sorted by each resource area. The endangered species bibliography contains 29 titles; however, most of these titles relate to endangered fish. The wildlife and habitat bibliography also contains 29 titles, several of which specifically relate to nonfish endangered species. We asked the EIS team member recommended to us, as a key initial contact on nonfish endangered species issues, to identify those studies which had been the most useful in developing the impact determinations. This individual was also one of the two individuals primarily responsible for writing the endangered species section of the final EIS.

To assess the procedures followed and obtain views on the quality of the data used in preparing the endangered species impact determinations, we interviewed the EIS team members who had primary responsibility for writing this section of the draft EIS, as well as several other members of the EIS team. We spoke with several scientists identified by team members and others as having done key research used by the team in developing the endangered species section of the EIS. We also interviewed other agency officials with information on the EIS and the Glen Canyon Environmental Studies processes.

Finally, we asked the principal author to review our description of the endangered species impact determination process for factual accuracy. He agreed that our description was generally accurate but made some suggestions for changes. We have incorporated these changes into our description of the process. We also presented him with our preliminary findings on endangered species in order to provide him an opportunity to comment on and respond to the various issues raised through our audit work. He generally agreed with the facts as presented.

Key Studies Identified

The following are key titles selected from the endangered species bibliography not related to fish.

"Biological Opinion of the Effects of Glen Canyon Dam on the Colorado River as It Affects Endangered Species." Memorandum from Regional Director, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, to Acting Regional Director Harl Noble, Bureau of Reclamation. Salt Lake City, Utah: U.S. Fish and Wildlife Service, 1978.

Clarke, A.H., "Kanab Amber Snail—Oxyloma Haydeni Kanabinsis, Pilsbry, 1948," Status Survey of Selected Land and Freshwater Gastropods in Utah. Denver, Colorado: Prepared by Ecosearch, Inc., Portland, Texas, for the U.S. Fish and Wildlife Service, 1991, pp. 23-36.

Handbook of Federally Endangered, Threatened, and Candidate Plants of Arizona, S. Rutman, compiler. Phoenix, Arizona: U.S. Fish and Wildlife Service, 1990a.

Influences of Glen Canyon Dam Fluctuating Flows on Spawning Rainbow Trout and Wintering Bald Eagles, With Observations on the Effects of Human-Bald Eagle Interactions on the Colorado River in Grand Canyon National Park. Final Report from Northern Arizona University to Grand Canyon National Park, National Park Service, 1992.

Unitt, P. "Empidonax Trailli Extimus: An Endangered Species," Western Birds, Vol. 18, No. 3, pp. 137-162, 1987.

The following titles were selected from the wildlife and habitat bibliography related to nonfish endangered species.

Brown, B.T. Abundance, Distribution, and Ecology of Nesting Peregrine Falcons in Grand Canyon National Park, Arizona. Final report submitted to Grand Canyon National Park, Grand Canyon, Arizona, 1991b.

Brown, B.T. "Monitoring Bird Population Densities Along the Colorado River in Grand Canyon," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.

Brown, B.T. "Status of Nesting Willow Flycatchers Along the Colorado River From Glen Canyon Dam to Cardenas Creek, Arizona," Endangered Species Report No. 20. Phoenix, Arizona: U.S. Fish and Wildlife Service, 1991a.

Brown, B.T., and R.R. Johnson. "The Effects of Fluctuating Flows on Breeding Birds," Glen Canyon Environmental Studies Executive Summaries of Technical Reports. Salt Lake City, Utah: Bureau of Reclamation, 1988.

Brown, B.T., and W.C. Leibfried. "The Effect of Fluctuating Flows from Glen Canyon Dam on Bald Eagles and Rainbow Trout at Nankoweap Creek in Grand Canyon National Park, Arizona," Glen Canyon Environmental Studies Phase II Draft Integrated Research Plan, Vol. 2. Salt Lake City, Utah: Bureau of Reclamation, 1990.

Brown, B.T., R. Mesta, L.E. Stevens, and J. Weisheit. "Changes in Winter Distribution of Bald Eagles Along the Colorado River in Grand Canyon, Arizona," Journal of Raptor Research, Vol. 23, No. 3, pp. 110-113, 1989.

Brown, B.T., G.S. Mills, R.L. Glinski, and S.W. Hoffman. "Density of Nesting Peregrine Falcons in Grand Canyon National Park, Arizona," Southwestern Naturalist, Vol. 37, No. 2, pp. 188-193, 1992.

Brown, B.T., and L.E. Stevens. Written communication, National Park Service, 1991.

Brown, B.T., and M.W. Trosset. "Nesting Habitat Relationships of Riparian Birds Along the Colorado River in Grand Canyon, Arizona," Southwestern Naturalist, Vol. 34, No. 2, pp. 20-270, 1989.

Spamer, E.E., and A.E. Bogan. "Mollusca of the Grand Canyon and Vicinity, Arizona: New and Revised Data on Diversity and Distributions, With Notes on Pleistocene-Holocene Mollusks of the Grand Canyon," Proceedings of the Academy of Natural Sciences in Philadelphia, Vol. 144, pp. 21-68, 1993.

Threatened Native Wildlife in Arizona. Phoenix, Arizona: Arizona Game and Fish Department, 1988.

In addition to the studies identified above from the final EIS bibliography, other documents are relevant to endangered species issues.

Carothers, S.W., and B.T. Brown. The Colorado River Through Grand Canyon: Natural History and Human Change. Tucson, Arizona: University of Arizona Press, 1991. The coauthors of this book were both key researchers identified in our work. Furthermore, Dr. Carothers was a member of the EIS team and the Aquatic Biology Team workgroup. Portions of this book address fish and endangered species issues, drawing from Glen Canyon Environmental Studies research.

Final Biological Opinion: Operation of Glen Canyon Dam as the Modified Low Fluctuating Flow Alternative of the Final Environmental Impact Statement, Operation of Glen Canyon Dam. (2-21-93-F-167) U.S. Fish and Wildlife Service, Dec. 21, 1994. The Final Biological Opinion and its related Reasonable and Prudent Alternative were developed by FWS in response to Reclamation's request for formal consultation under section 7 of the Endangered Species Act. The Final Biological Opinion states that the Modified Low Fluctuating Flow preferred alternative is likely to jeopardize the continued existence of the humpback chub and razorback sucker but is not likely to jeopardize the bald eagle, peregrine falcon, or Kanab ambersnail.

Glen Canyon Dam: Beach/Habitat-Building Test Flow, Final Environmental Assessment and Finding of No Significant Impact, Bureau of Reclamation, Feb. 1996. This report presents the findings of the required environmental assessment prepared prior to implementing the spring 1996 “spike” flow.

Operation of Glen Canyon Dam - Fish and Wildlife Coordination Act Report, U.S. Fish and Wildlife Service, June 28, 1994. In accordance with the Fish and Wildlife Coordination Act, FWS submitted this report to Reclamation with recommendations in connection with the Glen Canyon Dam’s operations. The act does not require Reclamation to accept the recommendations; however, reasonable and practicable recommendations will be implemented. The act ensures that fish and wildlife receive equal consideration during the planning and construction of federal water projects.

“Organisms and Biological Processes,” River Resource Management in the Grand Canyon, pp. 84-117. National Research Council, Committee to Review the Glen Canyon Environmental Studies, 1996. This is a chapter of a National Research Council committee report on the Glen Canyon Environmental Studies. The purpose of this report and the committee’s task was to review research that was done in connection with the Glen Canyon Environmental Studies and to comment on the application of science in the management program of the Colorado River.

“Response to the Final Biological Opinion on the Operations of Glen Canyon Dam,” Bureau of Reclamation, Apr. 6, 1995. This is Reclamation’s official response to, and addressing of, the issues presented in the Final Biological Opinion. In its response, Reclamation states that it does not agree with all the points made or positions taken by FWS but will take steps to comply with them.

Officials Interviewed

We interviewed the following individuals about endangered species and other related Glen Canyon Dam EIS issues.

Michael Armbruster, Bureau of Reclamation, principal author of the endangered species section of the EIS
Frank Baucom, U.S. Fish and Wildlife Service
Debra Bills, U.S. Fish and Wildlife Service
Byran Brown, SWCA, Inc.
Christine Karas, Bureau of Reclamation
Dennis Kubly, Arizona Game and Fish Department

William Leibfried, SWCA, Inc./Hualapai Tribe
Gordon Lind, Bureau of Reclamation
Margaret Matter, Western Area Power Administration
Debra McGuinn-Robbins, Arizona Game and Fish Department
Anthony Morton, Western Area Power Administration
Ronald Moulton, Western Area Power Administration
S. Clayton Palmer, Western Area Power Administration
Timothy Randle, Bureau of Reclamation
Lawrence Riley, Arizona Game and Fish Department
David Wegner, Bureau of Reclamation, Glen Canyon Environmental Studies

Fish

The construction of the Glen Canyon Dam altered the natural dynamics of the Colorado River, including the downstream aquatic system. The predam aquatic system supported an array of native and nonnative fish. The decline of the native fish in the Glen and Grand canyons is attributed to the presence of nonnative competitors and predators and to subsequent postdam river conditions that affected habitat and redefined the relationship between native and nonnative fishes. Scientific opinions differ about the potential impacts on fish resources of the flow alternatives addressed in the Glen Canyon Dam environmental impact statement.

The U.S. Fish and Wildlife Service's (FWS) final biological opinion expressed concern that the Modified Low Fluctuating Flow, the EIS's preferred alternative, would jeopardize the continued existence of two endangered fish species, the humpback chub and the razorback sucker. The biological opinion's reasonable and prudent alternative identified actions that would modify the preferred alternative with seasonally adjusted steady flows about 25 percent of the time. FWS and Reclamation agreed to categorize these flows as experimental, or research, flows so that studies could be conducted to verify an effective dam flow regime and to include those flows with another element of the reasonable and prudent alternative, "adaptive management." Reclamation intends to initiate a process of adaptive management that would provide for long-term monitoring and research to measure the actual effect of the selected dam-operating criteria. The results of this effort would form the basis for possible future modifications of the dam's operations and, with other conservation measures, may lead to the removal of the jeopardy opinion.

EIS team members and resource scientists express a variety of opinions about the process and data used in making the impact determinations for fish. Because of incomplete information, as stated in the final EIS, the impact of steady flows on fish is still uncertain.

Description of the Resource

Several elements comprise the aquatic ecosystem downstream of the Glen Canyon Dam. These elements include the aquatic food base, native fishes, and nonnative fishes. Nonnative fishes include warmwater, coolwater, and coldwater species. Due to the very limited data collected before the construction of the dam, the predam distribution and relative abundance of native and nonnative fish are largely unknown and subject to speculation.

In general, the ability of fish populations to persist and thrive depends on how well their life requirements are met. Life requirements include food supply, habitat, and the ability to avoid or minimize competition and predation.

Before the dam was closed, the aquatic food base for fish was founded on coarse organic material carried into the river from the drainage basin. Today, this coarse material is trapped above the dam in Lake Powell. Algae in the river (especially the filamentous green alga Cladophora glomerata) has now become an important part of the aquatic food base, along with associated diatoms (microscopic, single-celled, or colonial algae) and invertebrates (especially insects and the amphipod Gammarus lacustris).

The predam aquatic ecosystem contained eight native fish species and several introduced species such as the channel catfish and the carp. The eight native species were the humpback chub, razorback sucker, Colorado squawfish, bonytail chub, roundtail chub, flannelmouth sucker, bluehead sucker, and speckled dace. The Colorado squawfish, the roundtail chub, and the bonytail chub are considered extirpated (i.e., extinct in a given area) from the Grand Canyon, and the razorback sucker is very rare. The population of humpback chub in the Grand Canyon is the largest of five remaining populations and the only population of the species in the Lower Colorado River Basin.

Warmwater nonnative fish species began to be introduced into the river system possibly as early as the late 1800s. About the time that the dam was completed, warmwater nonnative fish found near the dam site included channel catfish, carp, fathead minnow, green sunfish, killifish, largemouth bass, mosquito fish, and red shiner. Coolwater nonnative fishes introduced into the river include striped bass, smallmouth bass, and walleye. In addition to these warmwater and coolwater nonnatives, coldwater nonnative trout species were introduced for sport purposes beginning in the 1920s. Rainbow trout make up the major part of the sport fishery, but brook trout, brown trout, and cutthroat trout also have been stocked in the river.

The variety of native and nonnative fish present in the system leads to the issue of "interactions" among them. Interaction in the form of competition from, and predation by, nonnative fish has been cited along with habitat modification as causes of the decline of native fish in the Colorado River system. Potential competitors for habitat with native fish include carp, fathead minnow, killifish, rainbow trout, and red shiner. Species cited as predators on native fish include striped bass, channel catfish, brown trout, and possibly rainbow trout. Because of limited data, opinions vary about interactions between native and nonnative fish and how operational changes would affect these interactions.

Effects of Pre- and Postdam Conditions on Fish

The aquatic ecosystem originally developed in a sediment-laden, seasonally fluctuating river environment. The construction of the Glen Canyon Dam altered the natural dynamics of the Colorado River. Today, the ecological resources of the Glen and Grand canyons depend on the water releases from the dam and the sediment that comes from tributaries below the dam. Lake Powell traps water, sediment, and the associated nutrients that previously traveled down the Colorado River.

The interruption of riverflow and regulated release of lake water now support aquatic and terrestrial systems that did not exist before the Glen Canyon Dam. The predam aquatic system supported an array of native and nonnative fish. Native fish evolved in a river that carried large amounts of sediment and was subject to extreme seasonal variability in flow and temperature. The construction of the dam created a relatively clear river with near constant year-round cold temperatures. These water temperatures limit the possibility of successful reproduction by warmwater fish, including the five native fish still present in this portion of the Colorado River system. The decline of the native fish in the Glen and Grand canyons is attributed to the presence of nonnative competitors and predators and to postdam river conditions. The tributaries of the Colorado River in the Grand Canyon are used by native fish species for spawning and rearing young.

Issue

As defined in the final EIS, the issue of concern for fish resources is how do dam operations affect fish—their food base, life cycles, habitat, and ability to spawn?

Indicators

The indicators for fish resources listed in the final EIS are the

- abundance of Cladophora and associated diatoms for the aquatic food base;
- reproduction, recruitment(survival to adulthood), and growth of native fish;

- reproduction, recruitment, and growth of nonnative warmwater and coolwater fish; and
- level of interactions between native and nonnative fish.

Both the biological productivity of the aquatic food base and the physical characteristics of the environment (temperature, reliable flow, turbidity, etc.) determine the limits of fish development. Therefore, the EIS team's assessments of impacts on fish included both of these areas. The analysis of impacts on the food base focused on Cladophora production and used changes in the length of wetted perimeter (the productive band of shoreline) to demonstrate the differences between the alternatives.

The analyses of the impacts of the alternatives on native and nonnative fish addressed (1) direct sources of mortality, (2) potential for reproduction and recruitment, and (3) potential for growth. The analysis factors included the temperature of the water in the mainstem and access to tributaries for reproduction, food base and stable nearshore and backwater environments for recruitment and growth, flood frequency reduction measures, and beach/habitat-building flows. The evaluation of native and nonnative interactions was qualitative and focused on the effects of each alternative on nearshore and backwater habitats used by native and nonnative fish.

Methodology Used to Make Impact Determinations

EIS team members told us that the EIS was developed through a dynamic process involving three main groups—the EIS team, Glen Canyon Environmental Studies officials and researchers, and representatives of the cooperating agencies. Researchers provided data to the EIS team that was responsible for the technical development of alternatives and impact determinations, while the cooperating agency group was a policy-level review body.

The initial impact determinations for fish and endangered fish were primarily developed by two EIS team members assigned to that task on the basis of their areas of expertise. These team members were from the Arizona Game and Fish Department and FWS. No formal fish subgroup or workgroup existed at that time and no formal reports were produced.

These two team members developed their sections of the EIS through an iterative process of drafting, discussions, and formal and informal presentations to, and review by, the whole EIS team, as well as through input from key researchers and colleagues with whom they shared their work and from whom they solicited feedback. Additionally, presentations of the impact assessments were made to the cooperating agency group.

The EIS team's decision-making on fish issues was handled through voting; the goal was a consensus-based product. Formal minutes of the EIS team meetings were kept as a record of key decisions.

After public comments were received on the draft EIS, the Aquatic Biology Team (ABT) workgroup was formed by Reclamation to respond to the comments and to reorganize and rewrite the fish and endangered species sections of the final EIS. This workgroup consisted of the two original individuals and five additional EIS team members representing Reclamation, the Hopi Tribe, the Hualapai Tribe, and the Arizona Game and Fish Department. The workgroup was formed because of the controversy and diametrically opposed positions of many of the comments pertaining to aquatic biology. All members of the workgroup participated in discussions and consensus decision-making on fish issues and revised impact determinations; however, two individuals were principally responsible for the rewrite of the sections under review, with assistance and input from other EIS team and ABT workgroup members. Of the 33,000 comments received on the draft EIS, 291 related to fish and 1,826 related to endangered species. However, the vast majority of endangered species comments focused on endangered fish.

The ABT did its work through an iterative process similar to that used by the EIS team as a whole. Individuals were given assignments, interactive discussions were held, and decisions were made through consensus. According to ABT workgroup members, no official documentation of the discussions and decisions of this group were kept. Rather, information was shared among members through personal communications, working meetings, and other collegial interactions. Some information relevant to fish resources is contained in the official minutes of the EIS team meetings.

On the basis of the comments received on the draft EIS and the internal review, the EIS team/ABT workgroup made several major changes to the fish section of the final EIS. Specifically:

- In order to make the document less confusing and to facilitate better integration of material, the fish section was substantially revised and reorganized to include new information and to integrate the extensive treatment of endangered fish previously covered in the endangered species section of the EIS.

- In response to the comments received and ongoing discussions, Reclamation and FWS jointly agreed to move the endangered fish research flows identified in FWS's reasonable and prudent alternative from the preferred alternative to the Adaptive Management Program. The EIS team implemented this change.
- In response to the comments and concerns about interactions between native and nonnative fish, information on competition and predation and the predam fish population was expanded in the final EIS. Information on nonnative fish and native/nonnative interactions was added to the summary table of impacts.
- In order to more explicitly recognize the uncertainty and disagreement that exist among resource scientists about the responses of fish to steady flow alternatives, the final EIS describes those areas of uncertainty and includes reference to this uncertainty in the matrix of potential impacts.

Because final results were not available to the ABT from many of the phase II fish studies for the Glen Canyon Environmental Studies, professional judgment was an important factor in developing fish impact determinations for the final EIS. However, as one ABT member stressed, these impact determinations were criterion based, using important resource indicators as the basis for judgment. The ABT workgroup and EIS team thus used a combination of available data and professional judgment in developing the impact determinations for fish.

Data Used for Making Impact Determinations

The research studies used to support the impact determinations on fish resources are listed in the bibliography of the final EIS. These studies include Glen Canyon Environmental Studies research, as well as research developed by various state and federal agencies involved with fish resources. Those studies deemed most useful by several members of the EIS team who worked on fish issues are noted in the Key Studies Identified subsection of this appendix.

Effects of Flow Alternatives on Fish

Details of the anticipated impacts of the nine flow alternatives on fish resources are found in the final EIS. However, the following general statements can be made about the impacts of restricted fluctuating flows versus steady flows on fish:

- Fluctuating releases may affect fishes' access to tributaries and backwater habitat and destabilize these backwaters by alternately draining and refilling them with cold water from the Colorado River mainstem.

- Daily fluctuations in water level and cold water temperatures would continue to suppress reproduction and recruitment of nonnative warmwater fishes in the mainstem.
- Fluctuations may increase turbidity (cloudiness) of the water, which may provide cover for native fish and a degree of protection from predation. Increased turbidity could also provide foraging opportunities for the adult chub.
- Steady flows would allow for increased warming of backwaters, which would benefit young native fish. However, such improved habitat conditions for native species might also benefit nonnative species that are competitors or predators of these native endangered fish. The potential for increased interaction between native fish and their competitors and predators is greatest under steady flows.
- Steady flows might adversely affect maintenance of backwaters, allowing them to become isolated and filled with sediment.
- Steady flows could reduce the availability of fish forage and slow its transport downstream.

The final EIS points out that any change in the dam's daily operations or other management actions that result in improved habitat conditions for native fish also would improve conditions for nonnative warmwater and coolwater fish. Resource scientists are not in agreement about what improving habitat conditions means in terms of interactions between native and nonnative fish.

U.S. Fish and Wildlife Service's Final Biological Opinion

The U.S. Fish and Wildlife Service conditioned its support of the preferred alternative in the Glen Canyon Dam's EIS on the basis that Reclamation would agree to additional research on the impact of steady flows on fish as part of the Adaptive Management Program. In December 1994, FWS issued its final biological opinion on the operations of the Glen Canyon Dam, as required by section 7 of the Endangered Species Act. In its final opinion, FWS supports a flow regime that includes steady flows, and especially the Seasonally Adjusted Steady Flow alternative, on the basis of the supposed benefits for native fish. The final biological opinion concludes that the Modified Low Fluctuating Flow preferred alternative is likely to jeopardize the continued existence of the humpback chub and the razorback sucker. Therefore, FWS issued a "jeopardy opinion" concerning the EIS preferred alternative for those fish species.

In support of its 1994 opinion and findings, FWS states that "the preferred alternative (without a selective withdrawal structure) does not remove the issue of coldwater temperatures on reproductive success in the mainstem...." Furthermore, FWS asserts that

> "fluctuating flows limit solar warming of backwaters, flush organisms and nutrients important as food resources, and force earlier life stages of endangered and other native fishes out of quiet protected waters into unfavorable mainstem conditions. These conditions might include increased exposure to predation and debilitating effects of cold water and increased velocities."

Regulations implementing section 7 of the Endangered Species Act state that a "reasonable and prudent alternative" to the recommended action can be identified during the formal consultation process. For the Glen Canyon Dam's EIS, FWS' reasonable and prudent alternative recommends further studies of the effects of steady flows on endangered and native fish, otherwise known as endangered fish research flows. When implemented, these research flows would require as many as 5 low release years (annual water releases at or near 8.23 million acre-feet). Because low water release years are expected to occur only about half the time, it is uncertain how many total years it would take to complete the research program. However, it is likely that research flows could be completed within 10 years.

Endangered fish research flows would likely be between 8,000 cfs and 20,000 cfs with a spring through fall pattern and monthly releases similar to the Seasonally Adjusted Steady Flow alternative. The results from the research program would be monitored, and corrective action would be taken if adverse effects on endangered species were identified. Upon completion of the research flows and analysis of the data, Reclamation is to implement, through the Adaptive Management Program, any necessary changes in dam-operating criteria necessary to comply with the Endangered Species Act. Reclamation and FWS are to meet at least annually to coordinate reasonable and prudent alternative activities and ensure that sufficient progress is being made to remove the jeopardy opinion for the endangered species that are affected by the operation of the Glen Canyon Dam. FWS agreed to support the preferred alternative as modified by the reasonable and prudent alternative.

Reclamation does not agree with FWS' jeopardy opinion on the preferred alternative. In its comments on a draft version of the biological opinion, Reclamation presented its concerns about FWS' support of steady flows by noting that "scientific experts on native fishes in the Colorado River system who were convened to discuss the merits and detriments of flow alternatives on March 2, 1994, were not totally supportive that the draft biological opinion flow scenario will provide quantifiable benefit to native fish without additional temperature modification." Furthermore, Reclamation was also concerned that

"the logic for identifying the effects of steady flows as related to the Colorado River system in the Grand Canyon is not well supported. Data coming from the GCES program and in other research programs on Southwestern ecosystems consistently point to the importance of disturbance in maintaining the native species assemblages. The statement that the ecology of the Grand Canyon will be supported by steady flows is not supported in the document or in the literature."

Nevertheless, Reclamation has agreed to implement elements of FWS' reasonable and prudent alternative, including continued study of the effects of steady flows on fish.

Assessment of Impact Determinations

EIS team and ABT workgroup members told us that they were pleased with the process used in developing the EIS, believed that this process was "reasonable," and were satisfied with their product. Several noted the professional and open-minded approach brought to the work by most of the team members. FWS representatives to the team also said that they were pleased with the process up to the point where the draft EIS and the draft biological opinion were released. However, with the formation of the ABT workgroup, they said, the focus shifted to a concern for supporting the preferred alternative and "discrediting" the Seasonally Adjusted Steady Flow alternative. Other EIS team/ABT workgroup members took exception to this assertion, with one member stating that the preferred alternative was not forced upon FWS. Another team member stated that when it comes to the operations of the Glen Canyon Dam, NEPA (the EIS) and the Endangered Species Act (the reasonable and prudent alternative) did not complement each other very well.

Reasonableness of the Methodology

We received a variety of comments on the implementation of the fish impact determination methodology. For example, many interviewees expressed regret about the lack of coordinated time frames between the completion of Glen Canyon Environmental Studies research and the EIS development schedule, because the timing problem led to the use of incomplete data for the fish resources.

One of the ABT workgroup's tasks was to explicitly deal with the uncertain impacts of steady flows on fish resources. The leader of the ABT workgroup told us that there were significant disagreements among team members about how to handle this uncertainty, and that the FWS representatives held a different opinion from other members of the ABT. As with other decisions, this disagreement was handled through open discussion with the goal of establishing consensus. Many interviewees expressed the belief that the final EIS' increased, explicit acknowledgement of uncertainty about flow impacts on the fish resources was an important improvement in the document. Some of these individuals told us that this change to the fish resource section accurately reflects the disagreements and uncertainties within the scientific community.

EIS team members told us that an important component of the process of developing the impact determinations was the team's contacts with Glen Canyon Environmental Studies officials for updates on research results and the team's interactive relationship with key researchers. However, while some of the key researchers with whom we talked acknowledged that they had worked with EIS team members in this way, others told us that the EIS team's contact with them had been minimal or even nonexistent.

Some interviewees expressed the belief that private consultants should not have been included on the EIS team because their loyalty may be to present or future clients rather than to objective science. On the other hand, one consultant was also mentioned by several interviewees as one of the most knowledgeable individuals on fish and other resource issues in the canyon. Furthermore, several individuals expressed high regard for the work done by another consultant on some of the key Glen Canyon Environmental Studies research on the humpback chub.

Some EIS team members were also researchers whose work was being reviewed for the EIS. One EIS team member expressed the belief that this dual role was beneficial to the team because of their knowledge about the latest scientific findings as they developed. Two researchers, however, told us that they were troubled by this dual role for EIS team members. One suggested that it constituted a conflict of interest; the other was concerned that having individuals reviewing their own work might have affected the objectivity with which the research was examined.

Opinions on Data Used for Impact Determinations

Limited data permit opinions to vary among members of the scientific community on a number of issues related to fish. Some of these differences occur because of disagreements over scientific interpretations and viewpoints; others reflect personal, institutional, and academic affiliations and rivalries. Differences of opinion also exist on the issues related to the development of the impact determinations on fish for the final EIS.

A number of the individuals we talked with both inside and outside of the EIS preparation process expressed frustration that the final results from many of the Glen Canyon Environmental Studies phase II fish studies were not available to the EIS team and the ABT workgroup for the development of the impact determinations in the final EIS. According to several interviewees, this lack of final results—or "hard data," as one EIS team member not on the ABT called it—inevitably lead to an increased reliance on professional judgment in developing impact determinations related to fish.

Opinions varied as to whether the lack of final results from some phase II studies constituted a "limitation" on or simply a "hindrance" to the development of the impact determinations. Some interviewees told us that while it was unfortunate that final results from phase II were not in, this was not a limitation on the usefulness of the available data or the conclusions drawn from them. They believed that if the final data had been available, the team's determinations might have been more refined or supported, but their conclusions (and the preferred alternative) would have remained the same. Others believed that the lack of final results represented a significant limitation on the impact determinations. Some of these even suggested that the determinations or decisions might have changed on the basis of these final research results or that if the EIS team had used all the science available to them, "they would have come up with a different alternative."

Despite these differences, most of those who expressed an opinion to us said that the EIS team had used the "best available data" in determining the impacts on fish. One said that the best available data were used, although these data were not complete. Another told us that while the best available data were used, other, better data might have been available had the EIS time frames been changed to accommodate the completion of the Glen Canyon Environmental Studies. This individual further stated that the EIS team had developed "reasonable interpretations from unreasonable data." Even some of those individuals critical of the overall process agreed that the "best available data" had been utilized.

Peer Review of Studies

Reclamation and Glen Canyon Environmental Studies officials and researchers told us that a three-tiered review process was developed for all Glen Canyon Environmental Studies, regardless of resource area. This process included (1) internal agency/organizational review by the research entity, (2) Glen Canyon Environmental Studies office review, and (3) external peer review under the auspices of the Senior Scientist. However, a number of the researchers that we interviewed were critical of the actual review process. Furthermore, the individual responsible for overseeing this process told us that only about 30 to 35 out of approximately 140 anticipated Glen Canyon Environmental Studies had actually undergone the complete three-step review.

Results of the Process

As to the results of the process, the views on the preferred alternative varied among interviewees. Several supported the preferred alternative, especially when combined with the beach/habitat-building "spike" flow. Others supported flow regimes that include the Seasonally Adjusted Steady Flow alternative favored by FWS. Some interviewees told us that they were originally inclined to support steady flows but changed their views in favor of fluctuating flows on the basis of the developing data. Two interviewees endorsed a flow regime that closely resembles the "natural hydrograph," including floods and low flows. Some researchers told us that they had not read or reviewed the final EIS and were unfamiliar with the specifics of the flow alternatives.

ABT Workgroup Leader's Responses to the Issues Raised

The leader of the ABT workgroup provided us with detailed comments on and responses to each of the issues noted above. He agreed with some statements or positions and disagreed with others. For example, he agreed that the lack of final results from the fish research studies was frustrating and that the limited data allow differences of opinion on and scientific interpretation of the impacts on fish resources. However, he disagreed with the statement that had final results been available, the impact determinations might have been different. Rather, he said the final data would have refined the EIS team's understanding of the issues and supported their conclusions but would not have changed the impact determinations or the preferred alternative.

His overall position, taking into consideration the various perspectives and opinions expressed, was that

- the process used in making the impact determinations on fish resources was reasonable,
- the methodologies employed in this process were appropriate,
- the data used were the best available, and
- the results of the impact determinations are reasonable.

Scope and Methodology

To determine the data and process used in developing the impacts on fish resources, we identified and reviewed the following documents: the draft EIS and associated appendixes; the preliminary final EIS; the final EIS; the public comments on the draft EIS; Reclamation's analysis of and the EIS team's responses to these comments; copies of minutes of the EIS team meetings; summaries of the meetings of the cooperating agencies; and Reclamation's newsletters on the EIS process. We also obtained and reviewed FWS' draft biological opinion and final biological opinion on the operation of the Glen Canyon Dam, Reclamation's comments on the draft biological opinion and official response to the final biological opinion, and FWS' Fish and Wildlife Coordination Act report (see list of related documents below for full citations).

We obtained a copy of the final EIS bibliography from Reclamation, with titles sorted by each resource area. The fish bibliography contained 57 titles, while the endangered species bibliography contained 29 titles. We asked three EIS team members recommended to us as key initial contacts on fish and endangered species issues to review the titles related to these resources and to point out those studies they believed had been most useful in developing the impact determinations.

To assess the procedures followed and obtain views on the quality of data used in preparing fish issues, we interviewed the EIS team members who had primary responsibility for writing the fish and endangered species section of the draft EIS, as well as all other members of the ABT workgroup, which was formed to revise and reorganize these two sections following the receipt of public comments on the draft EIS. Additionally, we met with several other members of the EIS team, including two EIS team members not on the ABT workgroup who requested the opportunity to discuss fish and endangered species issues with us. We spoke with several scientists identified by team members and others as having done key research used by the workgroup and the full EIS team in developing the fish impact determinations. We interviewed other agency officials with information about the EIS and Glen Canyon Environmental Studies processes.

Finally, we asked the leader of the ABT workgroup to review the factual accuracy of our description of the process for developing the impact determinations for fish resources. He agreed that our description was generally accurate but made some suggestions for changes. We have incorporated these changes into our description of the process. We also presented him with our preliminary findings on fish resources in order to provide him with an opportunity to comment on and respond to the various issues raised through our audit work.

Key Studies Identified

The following are titles from the fish bibliography selected by at least two of the three key initial contacts recommended to us.

Angradi, T.R., R.W. Clarkson, D.A. Kinsolving, D.M. Kubly, and S.A. Morgensen. "Glen Canyon Dam and the Colorado River: Responses of the Aquatic Biota to Dam Operations," Glen Canyon Environmental Studies Technical Report. Phoenix, Arizona: Arizona Game and Fish Department, 1992.

Glen Canyon Environmental Studies Phase II 1992 Annual Report. Prepared for the Bureau of Reclamation, Glen Canyon Environmental Studies. Phoenix, Arizona: Arizona Game and Fish Department, 1993.

Gorman, O.T., S.T. Leon, and O.E. Maughan. "Habitat Use by Humpback Chub, Gila Cypha, in the Little Colorado River and Other Tributaries of the Colorado River in the Grand Canyon," Glen Canyon Environmental Studies Phase II Annual Report. Prepared for the Bureau of Reclamation by the U.S. Fish and Wildlife Service, Pinetop, Arizona, and the Arizona Cooperative Fish and Wildlife Research Unit, Tucson, Arizona, 1993.

Leibfried, W.C. "Utilization of Cladophora Glomerata and Epiphytic Diatoms as a Food Resource by Rainbow Trout in the Colorado River Below Glen Canyon Dam in Arizona," Masters Thesis. Flagstaff, Arizona: Northern Arizona University, 1988.

Leibfried, W.C., and D.W. Blinn. "The Effects of Steady Versus Fluctuating Flows on Aquatic Macroinvertebrates in the Colorado River below Glen Canyon Dam, Arizona," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.

Maddux, H.R., D.M. Kubly, J.C. DeVos, Jr., W.R. Persons, R. Staedicke, and R.L. Wright. "Effects of Varied Flow Regimes on Aquatic Resources of

Glen and Grand Canyons," Glen Canyon Environmental Studies Technical Report. Phoenix, Arizona: Arizona Game and Fish Department, 1987.

McGuinn-Robbins, D.K., Comparison of the Number and Area of Backwaters Associated With the Colorado River in Glen and Grand Canyons, Arizona. Phoenix, Arizona: Arizona Game and Fish Department, 1994.

Suttkus, R.D., G.H. Clemmer, C. Jones, and C.R. Shoop. Survey of Fishes, Mammals and Herpetofauna of the Colorado River in Grand Canyon. National Park Service, Colorado River Research Series Contribution no. 34, 1976.

Usher, H.D., D.W. Blinn, G.C. Hardwick, and W.C. Leibfried. Cladophora Glomerata and Its Diatom Epiphytes in the Colorado River Through Glen and Grand Canyons: Distribution and Desiccation Tolerance. National Technical Information Service No. PB88-183454/AS, 1986.

Weiss, J. "The Relationship Between Flow and Backwater Fish Habitat of the Colorado River in Grand Canyon" (draft report), Glen Canyon Environmental Studies Technical Report. Flagstaff, Arizona: Bureau of Reclamation, 1993.

Weiss, S.J. Spawning, Movement, and Population Structure of Flannelmouth Sucker in the Paria River. Masters Thesis. Tucson, Arizona: University of Arizona, 1993.

Titles related to fish selected from the endangered species bibliography by at least two of these contacts were as follows.

Kubly, D.M., The Endangered Humpback Chub (Gila Cypha) in Arizona: A Review of Past Studies and Suggestions for Future Research (draft report). Salt Lake City, Utah: Prepared by the Arizona Game and Fish Department for the Bureau of Reclamation, 1990.

Tyus, H.M., and C.A. Karp. "Habitat Use and Streamflow Needs of Rare and Endangered Fishes, Yampa River, Colorado," Fish and Wildlife Service Biological Report, vol. 89, no. 14. Vernal, Utah: 1989.

Valdez, R.A. Life History and Ecology of the Humpback Chub in Grand Canyon. Logan, Utah: BIO/WEST, 1994.

Valdez, R.A., and M. Hugentobler (editors). Characterization of the Life History and Ecology of the Humpback Chub (Gila Cypha) in the Grand Canyon. Annual Report 1992 to Bureau of Reclamation. Logan, Utah: BIO/WEST Report No. TR-250-06, 1993.

Valdez, R.A., W.J. Masslich, and W. Leibfried. Characterization of the Life History and Ecology of the Humpback Chub (Gila Cypha) in the Grand Canyon. Annual Report to the Bureau of Reclamation. Logan, Utah: BIO/WEST Report no. TR 250-04, 1992.

Valdez, R.A., A. Wasowicz, and W. Leibfried. Characterization of the Life History and Ecology of the Humpback Chub (Gila Cypha) in the Grand Canyon. Logan, Utah: BIO/WEST Trip Report no. 7-1992, 1992.

In addition to the studies identified above from the final EIS bibliography, other documents are relevant to fish issues. These documents include the following.

Carothers, S.W., and B.T. Brown. The Colorado River Through Grand Canyon: Natural History and Human Change. Tucson, Arizona: University of Arizona Press, 1991. The coauthors of this book were both key researchers identified in our work. Furthermore, Dr. Carothers was a member of the EIS team and the Aquatic Biology Team workgroup. Portions of this book address fish and endangered species issues, drawing from GCES research.

Clarkson, R.W., O.T. Gorman, D.M. Kubly, P.C. Marsh, and R.A. Valdez. “Management of Discharge, Temperature, and Sediment in Grand Canyon for Native Fishes.” Mar. 1994. A “white paper” provided to the EIS team, written by a number of key fish researchers from various agencies/organizations. In it, the researchers present their thoughts on native fish management issues. This document was mentioned by EIS team members as influential in their early discussions on fish issues. However, it does not appear in the final EIS bibliography.

Colorado River Endangered Fishes Critical Habitat Draft Biological Support Document. U.S. Fish and Wildlife Service, Sept. 3, 1993. Critical habitat must be designated for endangered species. This document was mentioned by one researcher with whom we spoke as an example of how agencies should handle scientific data in environmental policy papers.

Draft Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Sept. 3, 1993. This document is not directly related to activities at the Glen Canyon Dam but contains information about the recovery of endangered fish in the Colorado River Basin.

Final Biological Opinion: Operation of Glen Canyon Dam as the Modified Low Fluctuating Flow Alternative of the Final Environmental Impact Statement (2-21-93-F-167). U.S. Fish and Wildlife Service, Dec. 21, 1994. The final biological opinion and its related reasonable and prudent alternative were developed by FWS in response to Reclamation's request for formal consultation under section 7 of the Endangered Species Act. The final biological opinion states that the preferred alternative is likely to jeopardize the continued existence of the humpback chub and razorback sucker and is likely to destroy or adversely modify designated critical habitat. FWS' position is that the Seasonally Adjusted Steady Flow alternative may be more beneficial for these endangered native fish.

Glen Canyon Dam: Beach/Habitat-Building Test Flow, Final Environmental Assessment and Finding of No Significant Impact. Bureau of Reclamation, Feb. 1996. This report presents the findings of the required environmental assessment prepared prior to implementing the spring 1996 "spike" flow.

Glen Canyon Dam Discharge Temperature Control Draft Appraisal Report. Bureau of Reclamation, June 14, 1994. This draft report discusses options for studying and implementing temperature controls at the Glen Canyon Dam, including building a selective withdrawal structure.

Minckley, W.L. "Native Fishes of the Grand Canyon Region: An Obituary?" Colorado River Ecology and Dam Management. Proceedings of a Symposium, May 24-25, 1990, Santa Fe, New Mexico, pp. 124-177. Washington, D.C.: National Academy Press, 1991. This paper is listed in the final EIS bibliography. It is a part of the book developed from a symposium sponsored by the National Research Council's Committee to Review the Glen Canyon Environmental Studies. This paper is an overview of native fish issues by a recognized expert in the field.

Operation of Glen Canyon Dam - Fish and Wildlife Coordination Act Report. U.S. Fish and Wildlife Service, June 28, 1994. In accordance with the Fish and Wildlife Coordination Act, FWS submitted this report to Reclamation with recommendations in connection with the dam's operations. The Fish and Wildlife Coordination Act does not require

Reclamation to accept the recommendations; however, Reclamation has agreed that reasonable and practicable recommendations will be implemented. The Fish and Wildlife Coordination Act ensures that fish and wildlife receive equal consideration during the planning and construction of federal water projects.

"Organisms and Biological Processes," River Resource Management in the Grand Canyon, pp. 84-117. National Research Council Committee to Review the Glen Canyon Environmental Studies, 1996. This is a chapter of a National Research Council Committee report on GCES. The purpose of this report and the committee's task was to review research that was done in connection with the GCES and to comment on the application of science in the management program of the Colorado River.

Response to the Final Biological Opinion on the Operations of Glen Canyon Dam. Bureau of Reclamation, Apr. 6, 1995. This is Reclamation's official response to, and addressing of, the issues presented in the final biological opinion. In it, Reclamation states that it does not agree with all the points made or positions taken by FWS but will take steps to comply with them.

Threatened Native Wildlife in Arizona. Phoenix, Arizona: Arizona Game and Fish Department, 1988. This publication presents information on a variety of species and subspecies including fish, amphibians, reptiles, birds, and mammals.

Officials Interviewed

We interviewed the following individuals about the fish impact determinations and the related Glen Canyon Dam EIS issues.

Michael Armbruster, Bureau of Reclamation
Frank Baucom, U.S. Fish and Wildlife Service
Debra Bills, U.S. Fish and Wildlife Service
Bryan Brown, SWCA, Inc.
Steven Carothers, SWCA, Inc., Hopi Tribe
Michael Douglas, Arizona State University
Owen Gorman, U.S. Fish and Wildlife Service
David Harpman, Bureau of Reclamation
Christine Karas, Bureau of Reclamation
Dennis Kubly, Arizona Game and Fish Department
William Leibfried, SWCA, Inc., Hualapai Tribe
Gordon Lind, Bureau of Reclamation

Paul Marsh, Arizona State University, Center for Environmental Studies
Margaret Matter, Western Area Power Administration
Debra McGuinn-Robbins, Arizona Game and Fish Department
Wendell Minckley, Arizona State University
Anthony Morton, Western Area Power Administration
Ronald Moulton, Western Area Power Administration
Clayton Palmer, Western Area Power Administration
Timothy Randle, Bureau of Reclamation
Lawrence Riley, Arizona Game and Fish Department
John Thomas, SWCA, Inc., Navajo Nation
Harold Tyus, University of Colorado, Boulder
Richard Valdez, BIO/WEST, Inc.
David Wegner, Bureau of Reclamation, Glen Canyon Environmental Studies
Judy Weiss, Former Glen Canyon Environmental Studies Researcher (currently not active in the research community)

Hydropower

The purpose of this appendix is to review the methodology and key assumptions that the Bureau of Reclamation used to estimate the economic impact on hydropower of alternative water releases at the Glen Canyon Dam. The Glen Canyon Dam, which began producing power in 1964, is part of the Colorado River Storage Project, a federal project for water development in the Upper Colorado River Basin. Reclamation's purpose in analyzing hydropower issues in the EIS was to determine the impacts on the power system of potential changes in the Glen Canyon power plant operations. We found that Reclamation's methodology for estimating the economic cost of changing the dam's operations is reasonable and that Reclamation used the best available information at the time of the study.

Reclamation has estimated that the annual economic cost of changing the operations at the dam could range from –$1.5 million under the Maximum Powerplant alternative to $123.5 million under the Seasonally Adjusted Steady Flow alternative (in 1991 dollars, relative to the No-Action alternative). We found shortcomings in several of the assumptions Reclamation used in the power analysis, inconsistencies in some results, and two phase III computational errors, which suggest that the estimated economic impacts may be either overstated or understated. Because future events are inherently uncertain and because the actual cost of changing the dam's operations could also depend on factors yet to be determined, such as whether or not an Endangered Fish Research Program is implemented and the pace of deregulation in the electric utility industry, the actual economic impacts on power users may differ from those estimated. However, because the shortcomings we identified generally affect the estimates for all of the alternatives, we do not believe that addressing the shortcomings would alter the relative ranking of the fluctuating and steady flow alternatives. Furthermore, Reclamation and representatives of the power industry believe that the results of the hydropower analysis presented in the final EIS are reasonable and usable. As a result, we believe that Reclamation's estimated economic impacts can be used to compare in a general way the economic trade-offs that are associated with the various flow alternatives.

Introduction

The Glen Canyon Dam is owned, operated, and maintained by the Bureau of Reclamation. The Western Area Power Administration (WAPA)—a power-marketing administration established in the Department of Energy Organization Act of 1977—markets and transmits the power produced at the dam (that is, power in excess of that used by projects involving irrigation and flood control). WAPA, in compliance with the Colorado River Storage Project (CRSP) Act of 1956, is obligated to provide first priority to the power needs of CRSP Participating Projects (for example, Reclamation's irrigation projects). Power that is surplus to this "project use" requirement is then marketed by WAPA to wholesale firm-power customers entitled to preference allocations (for example, municipal and county utilities, rural electric cooperatives, and other nonprofit organizations financed under the Rural Electrification Act of 1936). WAPA generally enters into long-term contracts with its preference customers to sell firm power (that is, long-term capacity and energy) at a rate that is limited to the recovery of its costs and all costs assigned to power for repayment, including that portion of irrigation costs beyond the ability of the user to repay per the CRSP Act (this rate is referred to as the Salt Lake City Area/Integrated Projects—SLCA/IP—rate). If its customers require additional energy and additional energy is available, WAPA may sell short-term power to them at a price ranging from the SLCA/IP rate to the spot market rate, depending on market conditions. If WAPA's generation exceeds the needs of Reclamation's project use requirements and of the SLCA/IP's firm-power customers, energy may be exchanged with other suppliers or may be sold on the spot market. On the other hand, if WAPA's generation is less than the long-term firm-power commitments, WAPA must purchase replacement power on the spot market, make short-term contractual purchases, or exchange energy from other suppliers to make up the deficit.

Historically, maximum power production at the dam has been limited to 1,300 megawatts, which corresponds to a water release of 31,500 cubic feet per second. Power production (that is, instantaneous output, measured in watts) is a function of reservoir head, flow, and the generating capacity of the dam's turbines. The dam has eight electric generators that were originally installed when the dam was constructed and "uprated" to 1,356 megawatts during the 1980s. Energy production (that is, power produced over time, measured in watt-hours) is a function of capacity over time or the amount of water released over time. During a typical year, water releases average about 10 million acre-feet, corresponding to an average annual energy production of about 5 million kilowatt hours.[1]

Currently, WAPA markets power from the Glen Canyon Dam to approximately 180 preference customers located mainly in Colorado, New

[1]A kilowatt hour is the amount of electrical energy involved in a demand or requirement for 1 kilowatt over a period of 1 hour.

Mexico, Arizona, Utah, Nevada, and Wyoming. These customers sell electricity to about 1.7 million residential, commercial, industrial, and agricultural customers. Since November 1, 1991, the Department of the Interior has operated the dam under an interim flow regime, whereby water releases are generally limited to a maximum of 20,000 cubic feet per second (cfs).

Reclamation's purpose in preparing the Glen Canyon Dam's environmental impact statement was to determine specific options that could be implemented to minimize the adverse impacts on the downstream resources and Native American interests in the Glen and Grand canyons. In connection with hydropower production, the key EIS issue was to determine the impacts on the power system of potential changes in the Glen Canyon power plant's operations. Reclamation was responsible for evaluating the economic, project repayment, and rate impacts of changing the magnitude and timing of water releases from the Glen Canyon Dam. To make its assessment, Reclamation identified power operations flexibility (for example, the ability of WAPA to provide services to its customers) and power-marketing resources (for example, capacity and energy), costs, and rates as EIS indicators. Reclamation examined the effect that nine different alternative flow regimes could have on the EIS indicators. However, only the impact on the power-marketing indicator was quantified; the impact on power operations flexibility was assessed qualitatively.

Under each of the nine alternative flow regimes, the total volume of water released annually would be the same and would depend on a number of factors, including long-range operating criteria, such as an annual minimum flow of 8.23 million acre-feet and balanced storage between Lake Powell and Lake Mead (formed by the Hoover Dam). However, the nine alternatives would differ in terms of their daily, monthly, and seasonal flows.

The nine alternative flow regimes can be grouped into three main categories: (1) unrestricted fluctuating flows, (2) restricted fluctuating flows, and (3) steady flows. The unrestricted fluctuating flow alternatives include the No-Action and Maximum Powerplant regimes. The No-Action alternative, which reflects pre-1991 historic operations, would allow daily fluctuations up to 30,500 cfs, depending on the season. The Maximum Powerplant alternative would allow daily fluctuations up to 32,200 cfs, also depending on the season.

The restricted flow alternatives include the high, moderate, modified low, and interim low fluctuating flow regimes. In general, the restricted fluctuating flow alternatives would restrict ramping (increases or decreases in cfs per hour) and daily fluctuations (cfs per 24 hours) and increase the daily minimum release. In general, maximum releases would be no greater than 31,500 cfs for the high and moderate flow alternatives, 25,000 cfs for the modified low flow alternative, and 20,000 cfs for the interim low flow alternative.

The steady flow alternatives include the existing monthly volume, seasonally adjusted, and year-round steady flow regimes. In general, the steady flow alternatives would restrict daily fluctuations to plus or minus 1,000 cfs, providing steady flows on either a monthly, seasonal, or year-round basis. Under the seasonally adjusted flow alternative, the highest releases (that is, no greater than 18,000 cfs) would occur in May and June, and the lowest releases would occur between August and December.

Under habitat maintenance flows, however, releases could be greater than 31,500 cfs under the Moderate Fluctuating Flow alternative, greater than 25,000 under the Modified Fluctuating Flow alternative, and greater than 18,000 cfs under the Seasonally Adjusted Steady Flow alternative.

One of the key attributes of hydropower is that it can be turned on and off relatively quickly, allowing operators to respond to daily, hourly, or instantaneous fluctuations in the demand for electricity. Demand is typically highest during on-peak periods (for example, Monday through Saturday, 7 a.m. to 11 p.m.) and lowest during off-peak periods. Operationally, hydropower generators can respond to changes in load more easily than most other types of generation, which makes hydropower operationally more valuable any time load following (power generation that instantaneously rises and falls in response to the demand for electricity) is required. As a result of the operating constraints under the restricted and steady flow regimes, the maximum flows would generally be lower during on-peak periods, reducing on-peak energy production. Consequently, in general, the flexibility of power operations would be reduced under the restricted and steady flow alternatives. In addition, capacity (that is, instantaneous output) would be lower, generally speaking, under the restricted and steady flow alternatives, leading utilities to seek alternative and potentially higher-cost sources of peaking capacity. However, the total energy produced at the Glen Canyon Dam would not change—energy production would simply be shifted from the on-peak demand periods when it is most valuable to off-peak periods when it is less valuable. The additional energy produced during the off-peak periods would be available for sale in regional and other electricity markets.

Reclamation's Power Impacts Methodology Is Generally Reasonable

We found that Reclamation's methodology for estimating the economic impact of alternative water releases at the dam is generally reasonable. For example, a strength of Reclamation's power analysis is that it was conducted by a committee of specialists from the federal government, the utility industry, and the environmental community, and as a result, the analysis reflects a broad range of views. Other key features of the power analysis that we found appropriate include the use of a detailed analysis to determine the impact of alternative flows on hydropower production at the dam, a national perspective to estimate economic impacts, utility-specific data to determine the economic impact to the regional power system, and a sensitivity analysis to test the impact of key assumptions. Finally, Reclamation was responsive to the comments received on the draft EIS and partially revised the power analysis for the final EIS.

Power Resources Committee Conducted Power Study

To draw on expertise from the federal government, the utility industry, and the environmental community, Reclamation created a Power Resources Committee (the Committee) in 1989 to study the impacts of the various flow alternatives on the power system. Under Reclamation's lead, the Committee's responsibility was to define the scope of analysis, select modeling techniques, make basic assumptions, review preliminary analyses, and report findings. The Committee included representatives from the Colorado River Energy Distributors Association, the Environmental Defense Fund, and WAPA. In addition, Reclamation's primary contractor—HBRS, Inc. (now Hagler Bailly Consulting)—subcontracted with Stone & Webster Management Consultants, Inc., to serve as technical advisor to the Committee, collect data, run simulation models, synthesize findings, and write and prepare the Committee's reports. Another subcontractor, EDS Management Consulting Services, Inc., was involved in later phases of the power analysis. We found that the Committee conducted a comprehensive analysis of the impacts on the power system.

Using federal principles and guidelines for water resource projects and the professional judgments of its members, the Committee conducted an extensive analysis of the potential impacts on the power system from alternative water releases at the dam. For example, the Committee analyzed the impact on the regional power market that receives power from the dam, involving utilities in Arizona, New Mexico, Nevada, Utah, Colorado, and Wyoming. In addition, using historic operations as a base case or "No-Action" alternative, the Committee estimated the economic impacts of several different alternative flow regimes on the dam's power output and the regional power system over a 50-year period beginning in 1991.

Power Resources Committee Conducted Detailed Analysis of Impacts on Power Production

The Committee conducted a detailed analysis to determine the potential impact of the alternative water releases on the dam's power production. For example, the Committee used future projections of hydrologic conditions at the dam, two different marketing approaches, and standard microeconomic principles to estimate the amount of power that would be available for sale under each alternative flow regime over the 50-year analysis period.

To develop long-term monthly projections of water releases and power and energy production at the dam, the Committee used Reclamation's Colorado River Simulation System. This system projects future water conditions at the dam on the basis of historic water conditions. In addition, the Committee used two marketing approaches to estimate the power and energy that could be marketed over the analysis period. One marketing approach—the Contract Rate of Delivery (CROD)—is based on the current marketing practices used by WAPA to market the dam's power and assumes that a fixed amount of power would be available for marketing. The other approach—the Hydrology approach—assumes that a variable amount of power would be available for marketing, depending on the actual hydrologic conditions at the dam. In general, the Committee found that more capacity is forgone under the CROD approach than under the Hydrology approach in moving from the No-Action alternative to the fluctuating and steady flow alternatives.

Under the CROD approach, the power available under each alternative flow regime would be fixed at an amount that could be expected to be available roughly 9 years out of 10.[2] During periods when less power is available, WAPA is responsible for purchasing the replacement power needed to meet its contract commitments.

[2]The CROD level is based on WAPA's desire to reduce the risk of not being able to provide a reliable level of power and energy.

By contrast, the Hydrology marketing approach assumes that the power and energy available for marketing would depend on the actual hydrologic conditions at the dam, which could vary monthly, daily, or hourly, depending on streamflow and reservoir storage conditions. WAPA's customers would be responsible for purchasing additional power during periods when the dam's production is insufficient to meet their needs.

The Committee used two different methods to estimate the capacity and energy that would be available under the CROD and Hydrology marketing approaches for the fluctuating flow alternatives. The geometric method was used to estimate the power and energy available under the CROD. The peak-shaving algorithm was used to estimate the capacity and energy available under the Hydrology marketing approach. The geometric method uses geometric principles to approximate hourly operational constraints and calculate the amount of capacity and energy available on a daily basis. By contrast, the peak-shaving algorithm uses load projections, which vary hourly, daily, and seasonally, and operational constraints to optimally allocate water releases during periods of peak demand. The resulting estimates of capacity and energy represent the amount that would be available for each marketing arrangement for each of the alternatives.[3]

In general, less capacity is available for the No-Action alternative under the Hydrology approach than under the CROD approach. For example, the Committee found that the marketable capacity during the winter under the CROD would be about 1,058 megawatts compared to an average of 923 megawatts under Hydrology.

Power Resources Committee Used National Perspective to Estimate Economic Impacts

The Committee followed federal principles and guidelines for water resources planning where applicable in developing the analysis of the impacts to the power system. For example, consistent with the federal principles and guidelines, the Committee used a "federal economic analysis" approach to estimate the economic costs to society from changing water releases at the federally owned Glen Canyon Dam. The Committee also analyzed the financial impacts on individual utilities using a "utility economic analysis" approach, and the impact on the retail rates of selected end-users.

[3]Both the geometric method and the peak-shaving algorithm have limitations. The geometric method assumes load does not vary on a daily basis, and thus may not accurately capture daily changes in load, and the peak-shaving algorithm assumes perfect knowledge of future hourly demand, and thus may overoptimize the hydro dispatch.

Federal principles and guidelines state that the federal objective of water and related land resources planning is to contribute to the national economic development consistent with protecting the environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements.[4] The principles and guidelines further state that contributions to national economic development are increases in the net value of the national output of goods and services, expressed in monetary units. Consistent with this guidance, the Committee included in its economic analysis only those costs associated with constructing and operating new generating resources and operating those existing generating resources that would be needed to replace forgone power at the dam. The Committee excluded other costs—referred to as "transfer payments"—from the economic analysis. Transfer payments, including the fixed capital costs of currently operating powerplants, reflect a redistribution of income from one group in society to another and, as a result, do not reflect a net cost to society. For example, when a utility purchases power from another utility to replace forgone power at the dam, the appropriate measure of costs for the national economic perspective is the marginal cost of production. The fixed capital cost of the existing powerplant is considered a "sunk" cost. Because the decision to build the existing powerplant was made before the decision to change the dam's operations, the fixed costs of the existing plant are not an economic impact of changes in the dam's operations.

Because the regional power system currently has excess generating capacity, the economic impacts of the alternative flow regimes are lower during the early years of the 50-year analysis period. Economic costs rise over time, however, as the region's excess capacity is used up and new resources are constructed to replace forgone capacity at the dam.

In addition to the federal economic analysis, the Committee also measured the financial cost to individual utilities in a utility economic analysis. In estimating the financial impact on utilities, the Committee included transfer payments that incorporate such costs as the fixed costs of existing powerplants. In general, the financial impacts are substantially higher than the economic impacts because they include transfer payments between utilities. The Committee also examined the impact of higher financial costs on the retail rates of some end-use customers.

[4] Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, U.S. Water Resources Council, Mar. 10, 1983.

Power Resources Committee Conducted Detailed Analysis of Impacts on Large Utilities

The Committee conducted a detailed analysis of the impact of alternative flows on seven utilities from the regional power market.[5] In addition, the Committee used state-of-the-art and industry-standard simulation models to project the power resource additions and the production costs that the large utilities would incur to replace forgone power at the dam. In addition to the large-utility analysis, the Committee also estimated the impact of the alternative flow regimes on about 100 smaller utilities, using a spreadsheet model.

The Committee divided the regional power market into two basic groups: (1) seven large utilities, which own generating resources and sell power to other utilities and which represent about one-half of the regional power market, and (2) about 100 small utilities, which rely primarily on other utilities to generate their power needs.

From the large utilities, the Committee collected detailed data such as load and peak demand forecasts, the capacity and the operating costs and operating life of each generating unit, firm load purchases and sales, and the current and projected demand-side management programs.[6] In addition, the Committee developed assumptions about future prices for natural gas, oil, coal, and nuclear power and the future costs of adding new generating resources.

On the basis of the utility-specific data and using the Electric Generation Expansion Analysis System (EGEAS), the Committee calculated for the base case and each alternative flow regime each large utility's future expansion plan. The expansion plans represent the least-cost combination of new generating resources (or demand-side management programs) and purchased power that each utility would need to meet future demand for electricity.[7] In addition to the EGEAS model, the Committee used the Electric Utility Financial and Production Cost Model (Elfin) to cross-check the production cost estimates. The Committee used a 20-year planning period, beginning in 1991, to develop the expansion plans; a 30-year extension period was added on to complete the 50-year analysis period. Under the extension period, load was held constant but costs were allowed to escalate.

[5]One of the seven large utilities is no longer in existence.

[6]Demand-side management programs are used by utilities to promote more efficient energy use and include, for example, rebating or subsidizing the purchase of more efficient home appliances.

[7]The expansion plans were determined on the basis of the impacts of each alternative for the CROD marketing approach. The Committee used the expansion plans developed for the CROD approach to analyze the impacts of each alternative under the Hydrology marketing approach.

To model the large utilities in an integrated way, the Committee used several interconnected utility systems—consisting of a large utility and other utilities that sell or purchase power from the large utilities—to determine the effect of resource coordination on the selection of future generating resources by the large utilities. The large utilities were modeled to use their own generation resources to meet load demand. However, a utility was allowed to meet deficits or surpluses by purchasing energy from or selling it to its interconnected system.

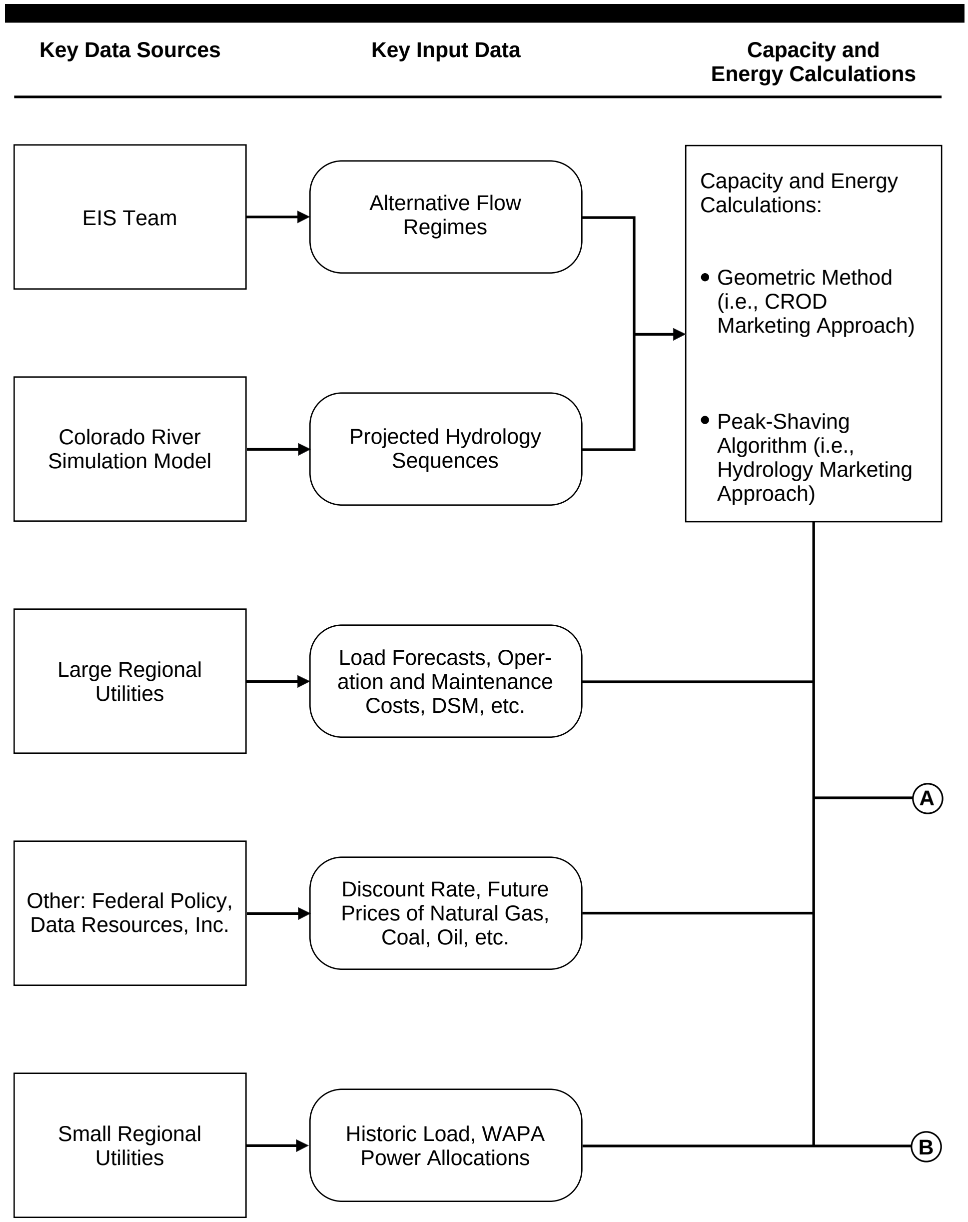
Because most of the modeled small utilities rely on other utilities to generate their power needs, the Committee used historic load data from the small utilities, replacement costs from the large-utility analysis, and a spreadsheet model to estimate the economic impact on small utilities over the analysis period. For example, the cost to a small utility of replacing forgone capacity was calculated as the increase in capacity and/or production costs incurred by the small utility's alternate supplier (that is, large utility). Unlike the large-utility analysis, however, the estimated costs for small utilities may not necessarily reflect the least-cost approach for replacing forgone power. For example, demand-side management programs were not considered as an option that small utilities could use to replace forgone power.

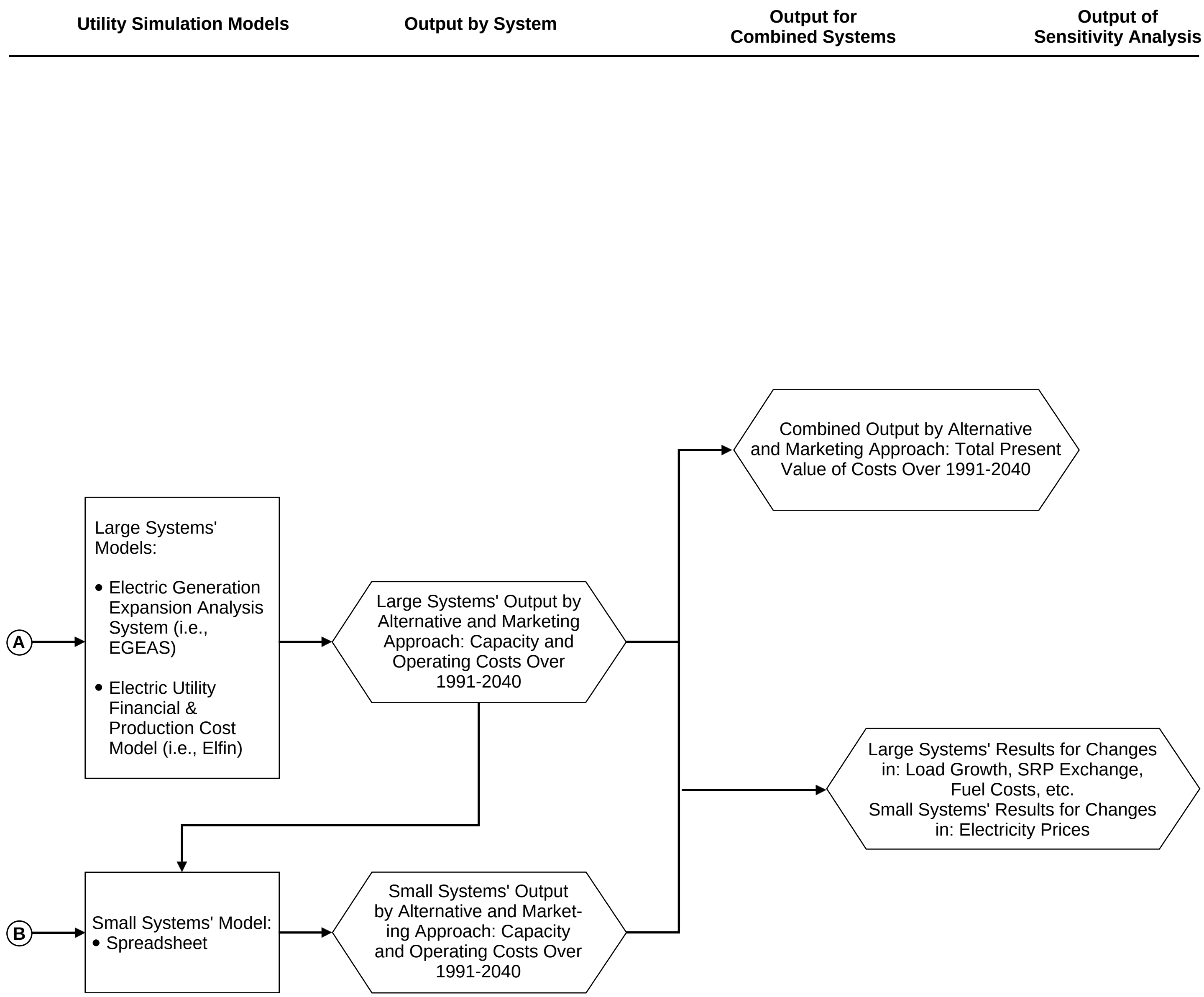
For both large and small utilities, the Committee calculated the economic costs for the base case and each alternative flow regime, under both the CROD and Hydrology marketing approaches. A discount rate of 8.5 percent was used to convert the annual stream of future economic costs to 1991 present valued dollars.[8] The Committee also "levelized" the total present-value cost estimate over the 50-year period to determine the annual levelized costs.

The difference between the base case and each alternative flow regime reflects, essentially, the cost of adding new generating capacity to replace forgone peaking power, and the cost of operating new and existing generating units to replace the energy shifted from on-peak periods to off-peak periods. A simplified representation of the Committee's methodology is shown in figure V.1.

[8]The Committee measured costs in nominal terms (that is, including inflation) partly because the federal discount rate policy for water resources planning requires the use of a nominal discount rate. The Committee also conducted a separate analysis using inflation-adjusted dollars and the nominal rate; however, this analysis is inconsistent because it uses a nominal rate to discount inflation-adjusted dollars.

Figure V.1: Simplified Representation of the Power Resource Committee's Power Systems Economic Impact Methodology





GAO presentation of the Bureau of Reclamation's data.

Power Resources Committee Used Sensitivity Analysis to Test Impact of Key Assumptions

The Committee assessed the impact of changes in several key assumptions on the estimated economic costs. For example, for the large-utility analysis, the Committee assessed the impact of changes in assumptions about load growth, capital costs, fuel costs and escalation rates, environmental costs, hydrologic conditions, demand-side management program costs, and the potential for a curtailment in electricity transmission between WAPA and the Salt River Project (Salt River) in Phoenix, Arizona. WAPA and Salt River currently have an agreement for the exchange of surplus Glen Canyon Dam generation.

In addition to the large-utility analysis, the Committee also assessed the impact on the small systems of changes in the assumptions about escalation rates for electricity prices paid by the small utility to their alternate supplier.[9] The sensitivity analysis for the large utilities indicated that in particular the results for the Hydrology marketing approach are very sensitive to changes in load growth and in the level of curtailment in the WAPA-Salt River exchange agreement.

To conduct the sensitivity analysis, the Committee selected several variables that were the most influential in determining economic impacts. In addition, the Committee evaluated the effect of changes in these variables on the No-Action, Low Fluctuating Flow, and Seasonally Adjusted Steady Flow alternatives. For each variable, the Committee assumed low and high values. For example, zero annual growth was used for the low load-growth scenario, and double the medium load growth (medium annual growth was assumed to average 1.5 percent) was used for the high load-growth scenario.

To examine the effect of alternative curtailment levels on the Salt River exchange agreement with WAPA, the Committee assumed that a curtailment in the transmission of electricity between Salt River and WAPA would occur more or less frequently than the base case, depending on the scenario. Salt River entered into an agreement with the United States in 1962 to exchange surplus Glen Canyon Dam generation. Under the agreement, and when generation at federally owned facilities is sufficient, WAPA exchanges surplus Glen Canyon generation with Salt River for thermal generation at three units in which Salt River owns shares.[10] In addition, under certain

[9]Because the sensitivity analysis was conducted separately for the large and small systems using different sensitivity variables, the analysis does not fully capture the potential impact of changes in the key variables.

[10]Salt River has generation rights at Craig (29 percent of Units 1 and 2) and Hayden (50 percent of Unit 2) in Northern Colorado, and Four Corners (10 percent of Units 4 and 5) in New Mexico.

conditions, WAPA wheels power generated at Salt River's units to its main customer base in Arizona. However, because power generation would be reduced at Glen Canyon Dam under many of the flow alternatives, WAPA may be unable to continue to meet its load commitments and also continue to exchange generation with Salt River. To approximate the potential for a curtailment in the exchange of electricity between WAPA and Salt River, the Committee assumed that Salt River's generation shares in the three generating units would undergo periodic nonscheduled shutdowns. In the sensitivity analysis, the Committee increased the probability of a shutdown for a high forced-outage-rate scenario and decreased the probability of a shutdown for a low forced-outage-rate scenario, relative to the base case.

The sensitivity analyses indicated that alternative assumptions in load growth and in transmission curtailment can have a large impact on the estimated economic impacts, depending on the alternative and the marketing approach. For example, the Committee found that under a high-load growth forecast, on average, the 50-year economic cost of the Low Fluctuating Flow alternative using the Hydrology marketing approach would be higher by about $1.5 billion, compared to the No-Action alternative. Similarly, under a high probability of curtailment in the WAPA-Salt River exchange agreement in the Seasonally Adjusted Steady Flow alternative under the CROD marketing approach, on average, the 50-year economic cost would be higher by about $620 million, relative to the No-Action alternative.[11]

Power Resources Committee Partially Revised Power Analysis for Final EIS

The Committee's initial analysis of the impacts on the power system, published in October 1993 and referred to as the phase II study, was included in the draft EIS. Reclamation received numerous comments on the draft EIS' power analysis. In addition, the Committee solicited additional review from three external energy experts, and Reclamation partially modified the draft EIS' preferred alternative. As a result, the Committee partially revised the power analysis in a phase III study, which was published in July 1995. For example, the Committee updated the projected costs of building gas-combustion powerplants, conducted additional

[11]The Committee's transmission exchange analysis is based on an assumption that WAPA would continue to market load at 1991 levels even though less Glen Canyon Dam capacity would be available for marketing under most of the alternatives. Because WAPA's load requirements would be lower than assumed, the likelihood and subsequent cost of a curtailment would be less, all else being the same.

sensitivity analyses, and revised the retail rate analysis.[12] However, because of Reclamation-imposed funding constraints, the Committee was able to revise the economic impacts only for the No-Action and the Modified Low Fluctuating Flow (preferred alternative) alternatives.

Furthermore, before the release of the draft EIS, but too late for inclusion in the phase II power analysis, Reclamation modified the characteristics of the Moderate Fluctuating Flow and Seasonally Adjusted Steady Flow alternatives to include beach-building flows and habitat maintenance flows. To include the impact of these modifications in the final EIS, the Committee used phase II cost and capacity data and a regression model to project the annual economic impacts of the two alternatives.

In addition, to develop comparable results between the phase II alternatives and the revised preferred alternative, the Committee also used the regression approach and phase II data to estimate the annual economic impact of implementing the preferred alternative. Before the release of the final EIS, Reclamation modified the preferred alternative to include a higher maximum release, a greater allowable daily increase in releases from the dam, and beach-building and habitat maintenance flows. Because this revised preferred alternative was not analyzed in the phase II study, comparable results with the other phase II alternatives were not available. As a result, the Committee used the regression approach to derive the economic impacts for the preferred alternative.

Consequently, the economic impacts for all nine alternatives shown in table IV-26 in Reclamation's final EIS (see page 300) are based on the phase II analysis and are generally comparable. The revised phase III power analysis for the preferred alternative is discussed separately on page 312 in the EIS under the description of the preferred alternative. Because the phase III results reflect a revised methodology and updated data, they are not comparable with the phase II results.

Although the phase III analysis reflects an improvement in methodology and in some data, it is of limited use in assessing the economic trade-offs between alternatives because only the No-Action and Modified Low Fluctuating Flow alternatives were modeled. Consequently, to show the impacts across alternatives, we display in table V.1 the estimated marketable resource and the comparable phase II economic results (that is, the point estimates) for the No-Action, High Fluctuating Flow, Modified

[12]In the phase III sensitivity analysis, the Committee tested the impact of changing the base year to 1995. The 1995 base year results indicated that the economic impact would be higher than the 1991 base year results, due partly to lower amounts of excess generating capacity.

Low Fluctuating Flow, and Seasonally Adjusted Steady Flow alternatives under the CROD marketing approach.

Table V.1: Projected Impacts of Operational Changes at Glen Canyon Dam on Hydropower Over the Period 1991-2041

Glen Canyon Dam hydropower[a]	No Action	High Fluctuating Flow	Modified Low Fluctuating Flow	Seasonally Adjusted Steady Flow
Annual energy (gigawatt-hours)	6,010	6,010	6,018	6,123
Winter capacity (megawatts)	1,407	1,383	965	640
Summer capacity (megawatts)	1,315	1,272	845	498
Change in annual economic costs (1991 nominal $), compared to No-Action alternative	$0	$2,500,000	$44,200,000	$123,500,000

Source: Bureau of Reclamation.

[a]Energy and capacity estimates are for WAPA's Salt Lake City Area/Integrated Projects facilities in total, including Glen Canyon Dam, which represents about 72 percent of WAPA's Salt Lake City Area/Integrated Projects generating resources. The change in annual economic costs are only for the operation of the Glen Canyon Dam.

Estimated Impacts on the Power System Could Be Over- or Understated

We found shortcomings in certain phase II and phase III assumptions, inconsistencies in some phase II results, and computational errors made by Reclamation during the phase III analysis. For example, the Committee did not explicitly consider in either the phase II or phase III analysis the effect that higher electricity prices would have in reducing the demand for electricity and the need to replace forgone power at the dam. In addition, the Committee's escalation rates for future natural gas prices are relatively high, potentially increasing the cost of replacing forgone power. These shortcomings would suggest that the estimated economic impacts may be overstated. However, we also found that in the phase III analysis the Committee did not incorporate the possibility of a curtailment in the Salt River exchange agreement with WAPA. This factor (all else being the same) would tend to understate the estimated economic costs to hydropower because a curtailment in the exchange agreement might require Salt River to purchase additional higher-cost capacity. Because of the time and expense that would be required to recompute the results with revised methodology and data, we did not determine the net effect of these factors on the estimated economic impacts.

Shortcomings in the Committee's Assumptions

Price elasticity effects were not explicitly incorporated into either the phase II or phase III analysis.[13] The Committee assumed that both load demand and electricity price would continue to rise over the planning period. However, the rise in electricity price would likely induce some electricity consumers (wholesale and end-use) to consume less electricity or switch to cheaper alternative suppliers. Consequently, fewer resources would be needed to replace forgone power at the dam, and the subsequent economic impacts would be lower than estimated (all else being the same). The Committee attempted to approximate the effects of price elasticity by using a low load-growth scenario in the sensitivity analysis. However, the inclusion of price elasticity effects in the base-case assumptions would give a more accurate picture of the potential economic impact of the alternative flow regimes.

Relatedly, demand-side management programs were not included as an option available to small utilities for replacing forgone power. The Committee assumed that the small systems would replace forgone power by purchasing power from their alternative supplier (that is, a large utility). Because this approach limits the choices that small utilities have in replacing forgone power, it may not reflect the least-cost option of replacing forgone power at the dam. Small utilities, for example, could also implement demand-side management programs as a way to mitigate the impact of forgone power, possibly at a lower cost.

We also found that the estimated economic impact of the preferred alternative in the phase III analysis does not incorporate the possibility of a curtailment in the Salt River exchange agreement with WAPA. During the phase III study, the Committee initially assumed that the preferred alternative (that is, the Modified Low Fluctuating Flow) would not affect the transmission exchange agreement between WAPA and Salt River, on the basis of the phase II analysis conducted for the draft EIS. However, some Committee members later revised their original assessment after Reclamation modified the preferred alternative to incorporate an increase in the maximum release and upramp rates and the beach-building and habitat maintenance flows. Implementation of beach-building and habitat maintenance flows could negatively affect the exchange agreement by effectively reducing water releases and subsequent power production during the summer months, when the demand for electricity is fairly high and when Salt River's system is at its peak. As a result, the economic

[13]The price elasticity of demand is a measure of the percentage change in the quantity demanded resulting from a percentage change in price. For example, assuming an estimated price elasticity of demand for electricity of –0.4, if the price of electricity rose by 1 percent, the quantity demanded for electricity would be expected to fall by 0.4 percent.

impact could be greater because a curtailment in the exchange could require Salt River to add additional higher-cost capacity. The key consultant who directed the power analysis told us that if curtailments increase in the summer months the impact on economic costs would be significant. According to some Committee members, a lack of time prevented the contractor from including these potential impacts in the phase III analysis.

In addition, the Committee's escalation rates, used to project future natural gas prices in the phase II and phase III analyses, are relatively high. The Committee used the escalation rates from DRI/McGraw-Hill's fourth-quarter 1991 forecast to project gas prices for the western states over the 50-year analysis period (the same escalation rates were used for the base case and the alternative cases). DRI has since revised downward its price forecast for natural gas. Despite comments from several reviewers that these escalation rates were too high, the Committee did not revise its analysis. For example, using DRI's 1991 forecast for Arizona and New Mexico, the Committee assumed that the average gas price would increase annually by 8 percent from 1991 through 2010. By contrast, DRI's 1994 forecast projected that gas prices would increase by about 6 percent annually from 1991 through 2010. Its 1995 forecast assumes that prices will rise by only 5 percent annually over the forecast period. Similar to hydropower, some gas-powered resources can be ideal as peaking resources because they can be turned on and off relatively quickly to meet fluctuations in demand. The higher escalation rates could affect the power analysis in two ways: (1) gas resources are selected later than they would be if fuel were cheaper and (2) gas resources are more expensive to operate than they would be under a lower gas-price trend. The Committee tested the impact of lower escalation rates in the phase II sensitivity analysis. However, the inclusion of the lower gas-price trend in the base-case assumptions would give a more accurate picture of the potential economic impact of the alternative flow regimes.

Finally, the Committee did not give full credit to the value of off-peak energy in mitigating the on-peak demand and energy costs in the small-utilities analysis in the phase II analysis. In general, the alternatives shift energy production from the on-peak period to the off-peak period. Even though less energy is produced during on-peak periods when it is more valuable, additional energy production during the off-peak period may help offset the cost of the forgone energy during the on-peak period. In the phase II analysis, however, the Committee essentially assigned a value of zero to some of the off-peak energy in the small-utilities analysis.

In a separate exercise, the Committee estimated that the value of the off-peak energy could reduce annual economic costs by as much as $19 million, depending on the alternative and the unit price of the energy.[14]

Inconsistencies in the Committee's Results

We found two inconsistencies in the Committee's results. First, the economic results for the large utilities and the fluctuating flow alternatives under the Hydrology marketing approach are inconsistent in the phase II analysis. For example, in the phase II analysis the Committee found that on average less capacity is lost under the Hydrology marketing approach than under the CROD approach. However, the economic impacts are higher for the fluctuating flow alternatives under the Hydrology approach than for the fluctuating flow alternatives under the CROD approach. The key consultant who directed the power analysis told us that the inconsistency is due to the Committee's use of the CROD-based utility expansion plans to represent expansion plans in the Hydrology marketing approach. However, even though the expansion plans are least-cost under a CROD marketing approach, they may not reflect least-cost conditions under a Hydrology approach.

In addition, some of the phase II sensitivity analysis results are inconsistent. For example, the Committee found that under a wide range of possible expansion plans, the economic impact of the Low Fluctuating Flow alternative versus the No-Action alternative would be approximately $173,923,000 under the "all medium" scenario (all variables held at expected values) and about $143,170,000 under the "high-load forecast" scenario. This result is inconsistent because we would expect that the impact of the Low Fluctuating Flow alternative versus the No-Action alternative would be greater under a future scenario of high-load growth than a future scenario in which all variables were held at their expected values. The key consultant who directed the power analysis agreed that this result is inconsistent and stated that the most likely explanation is that more inefficient generation is replaced in the high-load forecast scenario.

Computational Errors in the Committee's Analysis

Computational errors were made by the Reclamation staff during the phase III analysis. The Committee acknowledged these errors in its phase III report and stated that the errors affected the results in opposite ways. For example, in revising the monthly hydrologic release volumes,

[14]Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations, Final Report (phase II) (Oct. 1993), page ES-17.

Reclamation incorrectly assumed that the beach-building flows would occur every year rather than every so many years, as is planned. As a result, more water was projected to flow through the spillways and less capacity and energy would be available for marketing purposes. The Committee stated that this error may have overstated the economic and financial impact of the preferred alternative. In another case, instead of using the average hydrological sequence (that is, the average of dry and wet years) to calculate future hydrological conditions and the impact on power production at the dam, the Committee used a different hydrological sequence. The Committee stated that this error may have understated the economic impact of the preferred alternative under the Hydrology marketing approach. The Committee was unable to correct these errors because of time and resource constraints and, consequently, was unable to determine the effect of the errors on the estimated economic and financial impacts.

Power Results Can Be Useful Despite Limitations

Because future events are inherently uncertain and the actual cost of changing the dam's operations could also depend on factors yet to be determined, such as whether or not an Endangered Fish Research Program is implemented and the pace of deregulation in the electric utility industry, the actual economic impacts on power users may differ from those estimated. Often a point-estimate forecast is used to represent the most likely or expected outcome. In the case of the Committee's hydropower analysis, however, the limitations we have identified indicate that the point estimates lack precision. As a result, it should not be anticipated that the actual impacts will equal the estimated impacts. However, because the shortcomings we identified generally affect the point estimates for all of the alternatives, we do not believe that addressing the shortcomings would alter the relative ranking of the fluctuating and steady flow alternatives. In addition, we do not believe that addressing the inconsistency in the Hydrology marketing analysis (for example, using Hydrology-based expansion plans in the expansion analysis) would alter the relative ranking of the fluctuating and steady flow alternatives. Moreover, the inconsistency noted in the sensitivity analysis does not affect the phase II point estimates. Because the phase III analysis was limited to an assessment of the impacts of the No-Action and preferred alternative, the computational errors have no impact on the relative ranking of the phase II alternatives. Furthermore, Reclamation and representatives of the power industry believe that the results of the hydropower analysis presented in the final EIS are reasonable and usable. As a result, we believe that the estimated economic impacts can be used to compare in a general way the economic trade-offs that are associated with the various flow alternatives.

Consequently, we believe that Reclamation’s estimated economic impacts are useful for comparing the economic trade-offs that may be associated with the fluctuating and steady flow alternatives. The Committee’s analysis indicates that the estimated impacts are robust across alternatives; that is, the relative ranking of the fluctuating and steady flow alternatives is consistent even when taking into account changes in key assumptions such as load growth. Thus, in making a determination about the future operational plan for the dam, a decision maker can anticipate that, for example, a Seasonally Adjusted Steady Flow alternative would cost substantially more than a Modified Low Fluctuating Flow alternative. Furthermore, officials from Reclamation and the electric utility industry believe that the results are reasonable and usable. The Reclamation economist who served on the Power Resources Committee stated that he generally agreed with our observations but believed the methodology and the results are reasonable and should be useful in comparing economic trade-offs between alternatives. Similarly, an official from a regional utility who also served on the Committee said that the methodology and results are reasonable. Although the association that represents the affected power utilities maintained throughout the power studies process that the costs to the power system are understated, the association does not believe that Reclamation’s cost estimate is understated by a large magnitude. The Salt River Project has also maintained that the estimated costs do not fully account for the higher costs that Salt River could incur as a result of a curtailment in the exchange agreement. However, the Salt River Project did not provide us with documentation supporting its position.

As indicated by the Committee’s sensitivity analysis, changes in variables such as load growth can have a substantial impact on the estimated impacts. Economic impacts could also be affected by other factors yet to be determined, including whether or not an Endangered Fish Research Program (fish research) is implemented, and the pace of deregulation in the electric utility industry. For example, fish research could require higher-than-average water releases in the spring and summer months periodically to enable scientists to conduct fish research. As a result, water releases and power production during the other half of the year—between September and February—will be lower than average. Consequently, WAPA and its customers may have to seek alternative power supplies during certain periods, possibly at higher cost. In addition, the impact of fish research on Salt River could be substantial, because the decrease in the capacity available in the summer could limit the Salt River-WAPA electricity exchange agreement when the Salt River system peaks. As indicated by the Committee's sensitivity analysis, the economic costs of changes in the dam's operations increase substantially under assumptions of a greater probability of a curtailment in the Salt River-WAPA exchange agreement. According to the draft EIS, the economic impact of implementing fish research would fall within the range of impacts identified for the Modified Low Fluctuating Flow alternative and the Seasonally Adjusted Steady Flow alternative. The former alternative does not include the potential impact of fish research, and thus it represents the minimum potential impact. On the other hand, the latter alternative would involve flows similar to fish research flows but on a seasonal and annual basis; thus, it represents the maximum potential impact.

Finally, partly as a result of the Energy Policy Act of 1992, more opportunities for producing and delivering low-cost power to customers could emerge in the regional power market, which could help mitigate some of the economic burden that some small utilities in particular may bear as a result of changes in the dam's operations. For example, under the act, electricity generators (utilities, alternative energy producers) can use a competitor's transmission grid to wheel power directly to other utilities. As a result, small utilities may have access to alternative power sources that may be cheaper than their traditional suppliers.

Scope and Methodology

To gain an understanding of the Bureau of Reclamation's power methodology, key economic assumptions, and results, we reviewed documentation that describes the methodology, economic assumptions, and results, including reports by the Power Resources Committee, entitled Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations, Final Report (phase II) (Oct. 1993), and Power System Impacts of Potential Changes in Glen Canyon Power Plant Operations, Phase III Final Report (July 1995). Also, we interviewed members of the Power Resources Committee, including the Reclamation officials who served as Chairman and economist; representatives from the Western Area Power Administration, the Colorado River Energy Distributors Association, and the Environmental Defense Fund; and representatives from the primary contractor, HBRS, Inc., and subcontractor Stone & Webster Management Consultants, Inc. We also interviewed Ms. Leslie Buttorff who directed the power analysis for Stone and Webster.

To assess the reasonableness of the power methodology, economic assumptions, and results, we reviewed federal guidance on water resource projects entitled Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council, Mar. 10, 1983); public comments on the draft and final EIS; and comments by three energy consultants retained by HBRS, Inc., to review the power analysis. Also, we reviewed comments by the National Research Council on the power analyses in the draft and final environmental impact statements. In addition, we interviewed members of the Power Resources Committee, including representatives from Reclamation, the Western Area Power Administration, the Environmental Defense Fund, the Salt River Project, and the Platte River Power Authority, as well as officials from the Colorado River Energy Distributors Association, HBRS, Inc., Stone & Webster Management Consultants, Inc., the National Research Council's EIS review team, and several regional utilities. Finally, we used standard microeconomic principles to assess the reasonableness of the Power Resource Committee's methodology, analytical framework, economic assumptions, and results.

Our assessment of the reasonableness of Reclamation's methodology was limited to a review of the general analytical framework and an assessment of the reasonableness of key assumptions and data. We did not evaluate the Committee's calibration of the EGEAS and Elfin power simulation models or the small systems spreadsheet model, nor did we verify the accuracy of data inputs.

The organizations and individuals we contacted include those in the following list.

Arizona Public Service Company, Phoenix, Arizona
Bureau of Reclamation, Denver, Colorado
Buttorff, Leslie, A.T. Kearney, Inc., Englewood, Colorado
Colorado River Energy Distributors Association, Salt Lake City, Utah
Environmental Defense Fund, Oakland, California
Goodman, Ian, The Goodman Group, Boston, Massachusetts
HBRS, Inc., Madison, Wisconsin
Marcus, David, Berkeley, California
National Research Council, Washington, D.C.
Plains Electric Generation and Transmission Cooperative, Inc., Albuquerque, New Mexico
Platte River Power Authority, Fort Collins, Colorado

Salt River Project, Phoenix, Arizona
Stone & Webster Management Consultants, Inc., Englewood, Colorado
Tucson Electric Power Company, Tucson, Arizona
Western Area Power Administration, Salt Lake City, Utah

Non-Use Value

The construction and operation of the Glen Canyon Dam changed river flows and the environment along the Colorado River, affecting, among other things, fish populations, beach and wildlife conditions, and sites of archeological significance in and near the Glen and the Grand canyons. The values that people may receive from the knowledge that such things as, for example, rare plants, animals, and unspoiled natural environments exist, even if people do not consume or use these goods directly, have been defined as "non-use values." The non-use value concept, which is generally attributed to economist John Krutilla,[1] can be relevant in natural resource and environmental policy settings that focus on proposals to develop the natural environment or to mitigate prior resource damage. In the context of the Glen Canyon Dam's EIS, individuals suffered losses in non-use values to the extent they valued the natural resources that were affected negatively by the changes in river flows after the construction of the dam. Conversely, the changes in the operation of the Glen Canyon Dam that are currently under consideration could result in environmental improvements in downstream riparian resources and hence gains in non-use values. At the urging of the National Research Council, an entity of the National Academy of Sciences, Reclamation undertook the non-use value study as part of the Glen Canyon Dam's EIS to provide estimates of the non-use values placed on changes in environmental quality that may be expected to result from particular operating changes at the Glen Canyon Dam.

The purpose of this appendix is to review the methodology and economic assumptions that Reclamation used to estimate non-use values and the reasonableness of the results. A key aspect of Reclamation's non-use value study[2] is its use of the "contingent valuation" method (CVM) to estimate economic impacts. While CVM is currently the only known method of estimating non-use values empirically, some prominent economists question the usefulness of the estimates of non-use values produced by contingent valuation studies. We are not taking a position on the appropriateness of contingent valuation generally.

[1]"Conservation Reconsidered," American Economic Review, vol. 57, Sept. 1967, pp. 777-786.

[2]The term non-use value applies to the value an individual places on a resource without directly or indirectly using that resource. The term total value applies to the value an individual places on a resource, including non-use and use components. According to Reclamation's non-use value study, the study actually measures total values. That is, a respondent to the non-use value survey could have been motivated by an experience of direct use (such as rafting or fishing) or indirect use of the natural resources in the study area, and thus the estimates may include values associated with recreation. Reclamation states, however, that the estimated total values are likely to consist primarily of non-use values.

The Glen Canyon Dam's EIS non-use value study was carried out in a manner consistent with contingent valuation and survey research guidance developed to produce high-quality contingent valuation studies. Non-use values were estimated for the level of change associated with each examined alternative compared to the no-action base case. As such, no estimate for the level of non-use values associated with the No-Action Flow alternative is provided. The study produced results that suggest that there are substantial non-use values associated with each of the examined alternatives to current operations at the Glen Canyon Dam. However, the results of the non-use value study were not available at the time the Glen Canyon Dam's final EIS was issued; therefore, the study did not receive public comment. Reclamation noted that although the non-use study did not go through the public comment process, the study team was comprised of interests that will be affected by changes to the Glen Canyon Dam, such as power groups and environmental groups. Furthermore, Reclamation stated that the study team received peer review at various key decision points in the process and that the final results received a positive review by the National Research Council.[3]

Reclamation Used the Contingent Valuation Method as Basis for Estimating Economic Impacts

While economists have traditionally preferred to rely on information on what people do rather than on what they say they would do, economists and survey researchers working in the natural resource and environmental areas have developed the theory and practice of contingent valuation to estimate non-use values.[4] Non-use values are typically expressed in terms of willingness to pay by individuals or households for a specified environmental improvement. Typically, economists are more accustomed to calculating willingness-to-pay measurements for marketed goods because, in markets, information on how consumers value goods can be determined by their purchases of goods and services. Because by its definition a non-use good is not used, information from market transactions in which consumers reveal information about how much they are willing to pay for the good is not available. Contingent valuation methods currently offer the only known method of estimating non-use values empirically.

[3]River Resource Management in the Grand Canyon, Committee to Review the Glen Canyon Environmental Studies, National Research Council, Washington, D.C.: National Academy Press, 1996, p. 135.

[4]See, for example, Using Surveys to Value Public Goods: The Contingent Valuation Method, by Robert Cameron Mitchell and Richard T. Carson, Resources for the Future, 1989.

Contingent valuation studies rely on surveys to elicit information from consumers to estimate how much they would be willing to pay for a non-use good. In an overview of contingent valuation practice, a leading resource economist described three general features typically contained in contingent valuation studies.[5] First, a contingent valuation study contains descriptions of the policy or program at issue and the likely environmental effects so that respondents can understand the good they are valuing. Second, a contingent valuation study contains a framework or mechanism for eliciting willingness to pay. Several mechanisms have been used in contingent valuation studies, such as open-ended questions (How much would you be willing to pay?) and referendum formats (Would you vote for the described proposal if your taxes increase by $10?). Third, a contingent valuation study gathers information on socioeconomic variables and attitudes about the environment. This information is used in estimating willingness-to-pay functions using econometric techniques.

Some prominent economists have voiced strong criticisms of contingent valuation methods.[6] One of the main concerns about contingent valuation methods is the ability of survey research and statistical techniques to adequately capture true estimates of willingness to pay. Particularly with respect to non-use values, critics argue that it can be very difficult for individuals to comprehend a particular environmental or resource valuation issue, or to distinguish what researchers envision as a well-defined specific issue from a more general “warm glow” effect. Furthermore, some critics argue that the statistical estimation process by which willingness-to-pay estimates are produced from survey responses can be very imprecise.[7] Nonetheless, the contingent valuation method has become a standard tool for analyzing many natural resource issues.

[5]Paul R. Portney, “The Contingent Valuation Debate: Why Economists Should Care,” Journal of Economic Perspectives, 8(4), Fall 1994, pp. 3-17.

[6]A collection of studies critical of contingent valuation can be found in Jerry A. Hausman, Contingent Valuation: A Critical Assessment. Amsterdam: North Holland Press, 1993; and also Peter A. Diamond and Jerry A. Hausman, “Contingent Valuation: Is Some Number Better Than No Number?,” Journal of Economic Perspectives, 8(4), Fall 1994, pp.45-64.

[7]Daniel McFadden, “Contingent Valuation and Social Choice,” American Journal of Agricultural Economics, 76(4), Nov. 1994, pp. 689-708.

Developing Criteria to Examine Reclamation's Non-Use Value Study

To evaluate Reclamation's Glen Canyon non-use value study, we made use of some general guidelines that focus on the quality of a contingent valuation study and on the underlying survey research. Specifically, we relied on (1) the statement of a panel of prominent researchers convened by the National Oceanic and Atmospheric Administration (NOAA) to develop some general guidelines applicable to conducting contingent valuation studies[8] and (2) the total design method for conducting mail surveys developed by Dillman.[9]

NOAA Panel Developed General Guidelines

As part of a process by which it developed regulations related to oil spill damages,[10] NOAA convened an advisory panel to address such issues as whether the contingent valuation method was capable of providing reliable estimates of non-use values for use in resource damage assessments.[11] The panel stated that contingent valuation "can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use (non-use) values," listed some guidelines for producing credible studies, and noted concerns about some past studies.

The panel suggested (1) using probability sampling and appropriate statistical sampling procedures, (2) subjecting the survey instruments to pretesting, and (3) taking steps to reduce nonresponse rates. Additionally, the panel suggested that contingent valuation studies disclose information on the sample selection process and provide information on survey instruments and responses. The panel also suggested that the use of the referendum format, as opposed to open-ended elicitation, was desirable.

The panel suggested that respondents be provided with a reminder that paying for the non-use good at issue would result in a smaller budget to spend on other goods and services and that they be told of any available substitutes. In this way, the decisions made by the respondents may more

[8]The panel's report was published in the Federal Register. See 58 Fed. R. 4601, Jan. 15, 1993.

[9]The most widely accepted written standards for mail questionnaires are presented by Don A. Dillman in Mail and Telephone Surveys, the Total Design Method (1978).

[10]The Oil Pollution Act of 1990, Pub. L. No. 101-380, 104 Stat. 484, required NOAA, within the Department of Commerce, to develop regulations for use by natural resource trustees in assessing damages due to oil spills.

[11]The panel was composed of Kenneth Arrow, Robert Solow (co-chairs), Edward Leamer, Roy Radner, Howard Schuman, and Paul Portney. Schuman is a prominent survey researcher, and the others are economists. Arrow and Solow are Nobel laureates.

closely resemble market transactions in which consumers make choices in the face of budget constraints.

The panel stated a preference for the use of in-person surveys as superior to telephone or mail surveys. The panel's report stated that it is "unlikely that reliable estimates of values could be elicited with mail surveys." This guideline in particular has been criticized by some contingent valuation practitioners, who argue that the use of large-scale, in-person surveys can dramatically increase the cost of conducting contingent valuation studies.

The NOAA panel echoed the concern that estimated willingness-to-pay figures be consistent with common notions of rationality. One aspect of rationality is that, generally speaking, people are willing to pay more for greater amounts of a good. The panel was troubled by evidence presented in one contingent valuation study finding that estimated willingness to pay "for the cleanup of all lakes in Ontario was only slightly more than willingness to pay for cleaning up lakes in just one region" and in another study that "willingness to pay to take measures to prevent 2,000 migratory birds (not endangered species) from dying in oil-filled ponds was as great as that for preventing 20,000 or 200,000 birds from dying." The sensitivity of a study to these so-called scope effects can be important in evaluating its credibility.

Dillman's Standards Reflect a Total Survey Design Method

While the usefulness of contingent valuation methodology has been debated, survey research, a key component of contingent valuation studies, is itself a mature discipline with an accepted set of standards. For example, Dillman's "total design method" has become an accepted standard in survey research for maximizing the quality and quantity of responses to mail questionnaires.

By maximizing the quality of responses, researchers can have greater confidence in the validity of their work; that is, they can be surer that they are measuring what they intend to measure. By maximizing the quantity of responses they can have greater confidence in the reliability of their work; that is, repeated investigations will come up with similar results. Dillman's method provides a comprehensive approach that spans the design and implementation of mail questionnaires. From the wording of the questions to the pretest regimen to the design of the survey package and, finally, to the timetables for mailing and following up on the mailing, Dillman has a proven set of techniques that have been embraced by the survey research community.

Reclamation's Non-Use Value Study Finds Substantial Non-Use Values Associated With Changes in Operations at Glen Canyon Dam

Using a contingent valuation study, Reclamation estimated non-use values for the environmental improvements associated with changing the operations at Glen Canyon Dam. These estimates, which ranged from less than $15 per household annually to almost $30 per household annually, depending on, among other things, the specific dam-operating alternative under consideration, indicate the large non-use values associated with environmental improvements and are consistent with the idea that some change in the dam's operations will lead to these improvements. Furthermore, although the EIS included a discussion of non-use values, the results of the non-use value study were not formally included as part of the EIS and thus were not subject to the same set of formal comments from interested parties.

An Overview of the Glen Canyon Non-Use Value Study

The Glen Canyon non-use value study was one of the economic studies Reclamation carried out as part of the Glen Canyon Environmental Studies.[12] As part of the study process, a non-use value committee, including representatives from the power industry, environmental groups, Native American tribes, and federal agencies, met to consider interim results and to provide input to the research team. Additionally, the study team received peer review at various key decision points.

The researchers addressed some important preliminary issues in a qualitative research phase designed to establish whether a contingent valuation study would be likely to produce meaningful results. First, the researchers determined that representative individuals were able to distinguish the Colorado River environment in the Grand Canyon from the Grand Canyon itself. This was important because changes in the Glen Canyon Dam's operations would not affect the existence of the Grand Canyon itself. Rather, they would change aspects of the riparian environment along the Colorado River in and around the Grand Canyon. Importantly, if people were unable to distinguish changes to aspects of the riparian environment from broad changes to the Grand Canyon itself, then it would be impossible to provide meaningful estimates of non-use values related to operational changes at the Glen Canyon Dam. The researchers were convinced that people were able to make these distinctions and, moreover, were likely to care about, or to place meaningful values on, these resources.

The researchers also determined that people living far away from the Glen Canyon Dam were likely to care about the affected resources. This is

[12]The study was performed by Hagler Bailly Consulting under contract to Reclamation.

important in estimating aggregate non-use value because an average willingness-to-pay estimate is multiplied by the number of individuals or households believed to have non-use values. Because there are close to 100 million households in the United States, an average household's willingness to pay estimated to be $5 per year yields an aggregate non-use value of $500 million annually.

A pilot test phase was initiated in early 1994. A key research objective of this phase was to investigate whether willingness-to-pay estimates were sensitive to the various flow regimes under consideration, that is, whether non-use values were likely to increase in measurable ways related to the different river flows resulting from the different dam-operating alternatives. The pilot test included a series of nine versions of survey questionnaires given to separate samples of 250 respondents. Three of these versions were sent to national samples of households, with each version describing one river flow alternative and its likely effects on the affected resources. The three versions were the moderate fluctuating flow; the low fluctuating flow; and the seasonally adjusted steady flow. In general, the moderate fluctuating flow version describes the smallest improvement in environmental conditions, and the seasonally adjusted steady flow describes the biggest improvement. The surveys also describe adverse impacts on power customers, with more severe effects described in the seasonally adjusted steady flow version. Two versions, one describing the moderate fluctuating flow and one describing the seasonally adjusted steady flow, were sent to marketing area households.[13] The other four survey versions were sent to national samples and were used to address other methodological issues.

The qualitative research and pilot study phases included a thorough development and pretesting strategy, as well as peer and other reviews. During the qualitative research phase, researchers held 15 focus groups in which various methodological issues were investigated. In particular, focus groups were held in New York, Tennessee, and Nebraska to examine the geographic extent to which people living at some distance from the study area were likely to care about these resources.

The final phase of the non-use value study, built upon the knowledge developed during earlier phases, was designed to estimate non-use values. The researchers selected two samples—a national sample and a marketing area sample—and developed seven versions of a mail questionnaire.

[13]The marketing area refers to the geographic area in which individuals are served by utilities receiving power produced at Glen Canyon Dam.

Multiple versions of the instrument permitted the researchers to investigate the differences in non-use values associated with the differences in river flow conditions. While the overall Glen Canyon Environmental Studies examined nine alternatives, three flow alternatives were considered in the non-use study: moderate fluctuating flow; low fluctuating flow; and seasonally adjusted steady flow. According to the non-use study, these alternatives "covered most of the range of alternative dam operations being studied and were considered to include the set of alternatives most likely to contain the eventual preferred alternative."

Estimates of Willingness to Pay for Environmental Improvements Associated With Changes in the Operation of Glen Canyon Dam

Non-use values were based on estimates of willingness to pay for the described flow alternatives. Respondents were provided with background information on a proposal to change the dam's operations and the likely downstream environmental effects and were asked how they would vote on the proposal if it were to cost them nothing. If they indicated they would vote yes, they were then asked another voting question, but this time the proposal was tied to a specified annual dollar amount and to a specified "payment vehicle." This form of contingent valuation study is known as the referendum format. The payment vehicle for respondents in the national sample was a tax increase, and the payment vehicle for respondents in the marketing area sample was a utility bill increase. Each respondent was assigned one of the following eight dollar amounts: $5, $15, $30, $60, $90, $120, $150, and $200.

Willingness to pay was then estimated using a logistic regression based on the resulting "yes or no" answers to the voting question. A variable, referred to here as BID, is defined as the specific dollar amount associated with the cost of the referendum proposal presented to the respondent. A variety of other explanatory variables were derived from the survey responses. For example, four variables describing the respondent's environmental attitudes were constructed using factor analysis of a variety of environmental attitude questions provided in the questionnaire. Also, a score variable was calculated from a portion of the survey used to test how well the respondent understood the proposal.

The form of the logistic cumulative density function is:

$$\text{probability(yes vote)}=1/(1 + \exp((-\Sigma\, \beta_i{*}X_i) - \beta_{BID}{*}BID)), \qquad (1)$$

where the β_i are the coefficients for the explanatory variables and β_{BID} is the coefficient on the BID variable specifically. An expression for mean willingness to pay (WTP) is derived from the following formula suggested by Hanemann[14]:

$$WTP = \ln (1 + \exp \Sigma \beta_i{*}X_i) / -\beta_{BID}. \qquad (2)$$

The samples were split to focus on the different operating alternatives under consideration. The national sample was split four ways, examining two versions of the seasonally adjusted steady flow alternative along with the moderate and low fluctuating flow alternatives—and the marketing area sample was split three ways. For analytical purposes, a set of 0-1 dummy variables were included to indicate the different versions.[15]

The non-use questionnaires did not ask a binary "yes or no" vote question but used a scale which included "definitely yes" and "probably yes." The researchers investigated two definitions of yes votes for use in the logistic regressions: using "definitely yes" as the definition of yes, and alternatively with "definitely/ probably yes" as the definition of yes. "Definitely yes" models generated mean willingness-to-pay values in the $20 to $38 range across all flow alternatives and for both the national and marketing area samples. "Definitely/Probably yes" models generated mean willingness-to-pay values of $100 to about $130. The researchers believe that the "definitely yes" definition provides better estimates than the use of binary "yes or no" definition. They also believe the "definitely yes" definition yielded lower willingness-to-pay estimates.

To generate population willingness to pay, the researchers had to address additional issues. The regression-derived mean willingness-to-pay values apply to those respondents who voted for the specified proposal when it was presented to them with the condition that they would not have to pay for it. However, some people did not respond to the survey, some respondents did not vote on the referendum question, and some respondents did not vote for the proposal at zero cost. In this study, the respondents who did not vote and those who voted no were both assigned a willingness to pay of $0. The researchers gathered information on

[14]W. Michael Hanemann, "Welfare Evaluations in Contingent Valuation Experiments With Discrete Responses," American Journal of Agricultural Economics, vol. 66, Aug. 1984, pp. 332-341.

[15]In other words, the explanatory variables (the X_i) include a set of intercept dummies which permits different willingness-to-pay amounts to be determined for the different dam operation alternatives. β_{BID} is estimated for the whole sample, but the $\Sigma \beta_i{*}X_i$ component in expression (2) above will be different depending on which flow alternative (survey version) is being considered.

nonrespondents using follow-up telephone interviews.[16,17] The assumed or estimated values for each of the groups were averaged together on the basis of their proportion of the sample. Table VI.1 presents the resulting willingness-to-pay values for the "definitely yes" version (dollars per household per year).

Table VI.1: Population Average Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents (1991 Nominal Dollars per Household per Year)

Riverflow	National sample	Marketing area sample
Moderate fluctuating	$13.65	$22.06
Low fluctuating	$20.15	$21.45
Seasonally adjusted steady	$20.55	$28.87
Seasonally adjusted steady (but describing lower power cost effects)	$23.79	•

In general, the results indicate that individuals have a significant willingness to pay for the environmental improvements associated with a change from the no-action alternative to each of the other flow alternatives (i.e., the moderate fluctuating, low fluctuating, and seasonally adjusted steady flow alternatives). In addition, the national sample results indicate that individuals are willing to pay more for the environmental improvements associated with the seasonally adjusted steady flow alternative, compared to the moderate fluctuating flow alternative, and that the difference is statistically significant. The results also indicate that individuals are willing to pay more for the environmental improvements associated with the low fluctuating flow alternative, compared to the moderate flow alternative; however, this difference is not statistically significant. Consequently, we have less confidence in the precision of the estimate for the low fluctuating flow alternative.

Researchers provided ranges around the average willingness-to-pay values to reflect the statistical uncertainty surrounding the estimates. These ranges were calculated using repeated sampling from the estimated distributions of the parameters generated by the logistic regressions. In essence, the researchers calculated 3,000 estimates of mean willingness-to-pay for each alternative, arrayed them from lowest to highest, and reported the values as the lower and upper limits associated with a 95-percent confidence interval. Table VI.2 presents these results for

[16]The follow-up information was used to estimate willingness to pay on the basis of the characteristics derived through this process in conjunction with the results of a model using the mail survey respondents to predict the likelihood of voting for the proposal at zero cost.

[17]Estimates were provided for population average willingness to pay calculated with the assumption that nonrespondents had zero willingness to pay. These estimates were in the range of 15 to 20 percent less than the corresponding estimates with imputed values for nonrespondents.

the national sample and table VI.3 presents these results for the marketing area sample.

Table VI.2: Population Weighted Average Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents and the Associated 95-Percent Confidence Interval, National Sample (1991 Nominal Dollars per Household per Year)

Riverflow	Population weighted average	95-percent confidence interval: Lower limit	95-percent confidence interval: Upper limit
Moderate fluctuating	$13.65	$9.27	$20.39
Low fluctuating	$20.15	$14.22	$29.29
Seasonally adjusted steady	$20.55	$14.57	$29.84
Seasonally adjusted steady (but describing lower power cost effects)	$23.79	$17.17	$33.39

Table VI.3: Population Weighted Average Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents and the Associated 95-Percent Confidence Interval, Marketing Area Sample (1991 Nominal Dollars per Household per Year)

Riverflow	Population weighted average	95-percent confidence interval: Lower limit	95-percent confidence interval: Upper limit
Moderate fluctuating	$22.06	$16.68	$29.39
Low fluctuating	$21.45	$15.84	$29.28
Seasonally adjusted steady	$28.87	$22.50	$37.24

Researchers calculated aggregate willingness-to-pay values on the basis of the population averages. This involved gathering estimates of the number of households in the United States and in the marketing area as well as population growth rates nationally and for a set of states to approximate future growth in the marketing area.[18] A 50-year period (1991-2040) was used. Levelized annual aggregate willingness-to-pay values were calculated using a discount rate of 8.5 percent. The results are presented in table VI.4.

Table VI.4: Annual Aggregate Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents (Millions of 1991 Nominal Dollars)

Riverflow	National sample	Marketing area sample
Moderate fluctuating	$2,286.4	$62.2
Low fluctuating	$3,375.2	$60.5
Seasonally adjusted steady	$3,442.2	$81.4
Seasonally adjusted steady (but describing lower power cost effects)	$3,984.8	•

A range of annual aggregate values calculated using the lower and upper limits of the 95-percent confidence intervals for the population weighted

[18]These states were Wyoming, Utah, Colorado, New Mexico, Arizona, and Nevada.

averages are provided in table VI.5 for the national sample and in table VI.6 for the marketing area sample.

Table VI.5: Range of Values for Annual Aggregate Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents, National Sample (Millions of 1991 Nominal Dollars)

	Annual aggregate willingness to pay on the basis of		
Riverflow	**Population weighted average**	**Lower limit**	**Upper limit**
Moderate fluctuating	$2,286.4	$1,552.7	$3,415.4
Low fluctuating	$3,375.2	$2,381.9	$4,906.2
Seasonally adjusted steady	$3,442.2	$2,750.3	$4,998.4
Seasonally adjusted steady (but describing lower power cost effects)	$3,984.8	$2,875.8	$5,592.7

Note: Lower and upper limits refer to the lower and upper limits of the 95-percent confidence interval for the population weighted average.

Table VI.6: Range of Values for Annual Aggregate Willingness to Pay, Definitely Yes Model With Imputed Values for Nonrespondents, Marketing Area Sample (Millions of 1991 Nominal Dollars)

	Annual aggregate willingness to pay on the basis of		
Riverflow	**Population weighted average**	**Lower limit**	**Upper limit**
Moderate fluctuating	$62.2	$47.0	$82.9
Low fluctuating	$60.5	$44.7	$82.6
Seasonally adjusted steady	$81.4	$63.4	$105.0

Note: Lower and upper limits refer to the lower and upper limits of the 95-percent confidence interval for the population weighted average.

Evaluating the Non-Use Value Study Using the NOAA Panel and Dillman's Findings

We evaluated Reclamation's non-use study on the basis of issues considered by the NOAA panel and Dillman's total design methods as described above.[19] Most of the NOAA panel's suggested practices were part of the design and implementation of the Glen Canyon non-use value study, including those related to the sampling, pretesting, and reporting of results. Samples were based on commercially available sampling frames and were augmented with motor vehicle and postal service address update information. The researchers took random samples proportionate to the number of households in each state for the national sample and

[19]The NOAA panel's findings have no bearing on the Glen Canyon non-use study, and indeed were not published until after the Glen Canyon study was well under way. We refer to them because we believe that the NOAA panel's deliberations represent valuable critical and impartial thinking related to contingent valuation.

proportionate to the number of households in zip codes for the marketing area sample.[20] Respondents to the national survey had higher average levels of educational attainment and household income than the underlying population. It is likely that these characteristics are positively associated with willingness to pay for environmental improvements and thus increase non-use values. However, the magnitude of the effect is uncertain. During the qualitative research phase, draft questionnaires were pretested with six focus groups and six in-depth personal interviews. The questionnaires were reproduced in the report, along with responses to the various questions.

The study used the referendum format in preference to open-ended elicitation, and questionnaires emphasized the consumer's budget constraint, consistent with suggestions by the NOAA panel.[21] The study also provided a test on a respondent's level of understanding of the issue at hand.

A notable exception to the NOAA panel's suggested practices is that the Glen Canyon non-use value study used mail surveys. The panel strongly favored the use of in-person surveys. The Glen Canyon researchers maintain that well-designed mail surveys are capable of producing reliable results.

With respect to the design and implementation of the mail survey, we found that, except for one component, the researchers followed the total design method to the letter. Everything from the size and shape of the documents to the timing and amount of follow-up material was as Dillman suggested, and in general, the questionnaires were designed and implemented with extremely high standards. The researchers made a great effort to ensure that the questions both met the needs of the research design and were easily understood by the respondents.

Only the length of the instrument exceeded the maximum suggested by Dillman. The questionnaires were 18 pages, and according to Dillman, 10

[20]The national sample size was 3,400 individuals, and the marketing area sample size was 2,550. Each of the seven survey versions was administered to 850 individuals. In the national sample, two versions pertained to the Seasonally Adjusted Steady Flow alternative and differed not in their descriptions of environmental impacts but in their descriptions of possible electricity price impacts on users of Glen Canyon power.

[21]Respondents in the national sample were asked to answer the following question: "If this proposal passes and you had to pay $xxx every year for the foreseeable future, on what sorts of things would you spend less money in order to pay for the cost of this proposal?" In the marketing area survey, respondents were asked a similar question about monthly increases in utility bills. The next question then provided an opportunity for the respondent to change his or her vote. (Emphasis is contained in the questionnaires.)

to 12 pages is the maximum length for a questionnaire if a researcher does not want reduced response rates. Nonetheless, the average of 74 percent of the usable sample responding to the mail surveys and an average of 83 percent responding to the mail and follow-up telephone surveys is commendable given the nature of general public surveys. Although a shorter instrument may have led to higher response rates, the researchers faced a trade-off between the amount of background information and environmental attitude questions on the one hand and response rates on the other.

Evaluating Scope Effects in the Glen Canyon Non-Use Value Study

Scope effects were of concern to the NOAA panel. Scope effects, broadly interpreted to mean that changes in estimated willingness to pay vary in ways that seem consistent with the changes in the degree of environmental improvement, are at the center of the Glen Canyon non-use value study because willingness to pay for the environmental effects of different river flows should differ to the extent that the effects differ. The researchers investigated scope effects in their discussion of the "construct validity" of the non-use value study.[22]

Scope tests can be considered a form of theoretical construct validity, in which hypotheses based on economic theory are addressed. For instance, one potentially important construct validity test is whether income is positively related to measured willingness to pay. In their summary of various construct validity issues, the researchers stated that they believed the national sample results provided the highest level of credibility, but that the marketing area sample results were a little less credible.

Scope issues were examined using both the pilot and final versions of the survey. Compared to the pilot version, the final survey's descriptions of the environmental effects differed less sharply across the various flow alternatives because, over time, scientific assessments carried out in the Glen Canyon Environmental Studies did not support such sharp distinctions.[23] Thus, the pilot test language permitted a somewhat cleaner

[22]Drawing on methods developed by psychologists, contingent valuation researchers often examine three issues relevant to a study's reliability. These are content validity, construct validity, and criterion validity.

[23]For instance, the pilot survey proposal describing the Seasonally Adjusted Steady Flow alternative stated that "There would be a major improvement in conditions for native fish. Populations of most native fish, including one of the species in danger of extinction, would increase." The final survey proposal describing this flow alternative stated that "There would be a major improvement in conditions for fish. Native fish, including one of the endangered species, would most likely increase in numbers. However, competition from non-native fish may still limit the growth of native fish populations."

test of the general issue of whether respondents were able to distinguish among the various degrees of environmental improvement associated with the different flow alternatives. Additionally, some versions of the pilot survey used a multiple-bounded rather than a single-bounded referendum format. This permitted greater statistical precision in testing for scope effects.[24]

Some scope tests are provided by the voting behavior of those respondents who voted for the proposal facing them at zero cost. According to the study, "the portion of respondents who would support proposals if the cost to them were zero varied significantly across proposals in ways that were consistent with prior expectations." Generally, respondents appeared willing to pay more for the environmental improvement associated with the Seasonally Adjusted Steady Flow alternative than for that associated with the Moderate Fluctuating Flow alternative.[25]

Direct tests for scope effects are accomplished by examining the dummy variables indicating the various survey versions. In the regressions, each dummy variable can be interpreted as an additional willingness-to-pay contribution for the additional environmental improvement associated with that flow version over the environmental effects associated with the examined reference case, moderate fluctuating flow.[26] One complicating factor, however, is that the different versions can involve trade-offs. Specifically, the seasonally adjusted steady flow version describes a greater environmental improvement but a more serious adverse effect on

[24]Because the multiple-bounded approach was new, the researchers decided to use the more traditional single-bounded form in the final versions. Using an additional bound would allow a finer partition of the willingness-to-pay range. For instance, if a respondent indicates a willingness to pay $10 but an unwillingness to pay $20, the upper bound has been established. The concern with providing the respondent with another dollar amount is that it may provide a valuation cue to the respondent and thereby introduce a response bias.

[25]Additionally, in the national sample pilot test, survey versions were similar except that one mentioned improved conditions for fish while the other did not produce different willingness-to-pay estimates.

[26]In a regression, one of a set of mutually exclusive and exhaustive dummy variables is omitted as an explanatory variable. In this way, the "omitted" category can be thought of as the reference case. In the Glen Canyon study, the moderate fluctuation flow version is the reference case.

power customers.[27] To focus more clearly on willingness to pay for environmental improvement, researchers developed two versions of the seasonally adjusted steady flow survey, which differed only in the description of the adverse effects on power customers.[28] This permits some disentangling of an environmental improvement scope effect from the combined effect of environmental improvement and adverse power impacts.[29]

Because each survey version designated with a dummy variable offers greater environmental improvement compared to the moderate fluctuating flow version, expectations are that the parameter estimates for variables representing alternative flows should be positive. For the preferred "definitely yes" model, four of the five key parameter estimates are of the correct sign. However, only the coefficients for the two seasonally adjusted steady flow alternatives in the national sample are statistically significant (i.e., different from zero, using a one-tailed test at the 90-percent confidence level). The study acknowledges that the results of these scope tests are mixed but suggests that the totality of evidence (including pilot test versions and the "definitely and probably yes" models) are relevant for discussions of scope tests, and much of that evidence is stronger.

[27]In the national sample, the referendum proposal described effects on households and farmers using power generated at Glen Canyon Dam. The fluctuating flow versions contained the following language: "The average electric bill would increase by $3 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $9 per month for 3,600 households and a minimum of no increase for 800,000 households. On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 3%." The steady flow version stated: "The average electric bill would increase by $9 per month for 1.5 million households receiving power from Glen Canyon Dam. This average reflects a maximum increase of $21 per month for 3,600 households to a minimum of no increase for 300,000 households. On average, farm incomes would not change significantly. However, about 300 farmers in southern Utah would see their incomes drop by 6%."

[28]Specifically, the second version of the steady flow proposal included descriptions of the adverse effects on power customers and farmers that were identical to those used in the fluctuating flow versions.

[29]The use of two survey versions describing the seasonally adjusted steady flow also permits investigation into whether a description of the power impacts possibly provides a cue to respondents in answering the referendum question. For example, the value of the dummy with the higher power impacts would be greater in magnitude than the dummy with the lower power impacts if respondents interpreted the larger dollar impacts on power users as an indication of the magnitude of the environmental problem. Conversely, if respondents empathized with the plight of power users, the results would be the opposite.

Results of the Non-Use Value Study Could Be Significant in the Decision-Making Process

Non-use values represent the highest estimated economic impact from changing the Glen Canyon Dam's operations. Non-use values were based on estimates of the public's willingness to pay for downstream environmental improvement that would likely result from changes in the dam's operations. Willingness-to-pay estimates for the national sample ranged from less than $15 per household annually to about $20 per household annually. Because there are close to 100 million households in the United States, an average household's willingness to pay estimated to be $15 per year yields an aggregate non-use value of $1.5 billion annually, which is very large when compared to the estimated annual power costs.

Although the final EIS discusses non-use values and notes that they are positive and significant, the actual quantified results are not included in the final EIS. Reclamation did not include the non-use value study results in the final EIS because they were not available when the final EIS was published. Nonetheless, the non-use value study will be among the materials provided to the Secretary and, as a result, could be used in the final decision-making. In fact, the National Research Council in its 1996 report stated that the non-use value study results "deserve full attention as decisions are made regarding dam operations."[30]

Because the actual quantified results of the non-use value study were not in the draft or final EIS, they were not available to the general public to offer comments similar to other EIS results. While acknowledging the lack of formal public comment, Reclamation officials point out that the non-use value study was subjected to extensive peer review at key decision points in the process and that the final non-use value study received a positive review by the National Research Council. Reclamation also states that interests likely to be affected by the changes in the Glen Canyon Dam, such as power groups or environmental groups, were involved in the non-use value study process.

Scope and Methodology

To gain an understanding of Reclamation's non-use value study methodology and results, we reviewed the final report GCES Non-Use Value Study, September 8, 1995. We also reviewed the economics literature on non-use values and the contingent valuation method for estimating them. We interviewed the principal author of the report, a Senior Associate at Hagler Bailly Consulting. We examined reports prepared by peer reviewers

[30]River Resource Management in the Grand Canyon, Committee to Review the Glen Canyon Environmental Studies, National Research Council, Washington, D.C. National Academy Press, 1996, p. 135.

and we also discussed the study with some members of the non-use value committee.

The following is a list of individuals we contacted.

David Harpman, Natural Resource Economist, Bureau of Reclamation
Michael P. Welsh, Hagler Bailly Consulting
Bruce Brown, ECOPLAN Consultants

Recreation

The purpose of this appendix is to review (1) the methodology and key assumptions that the Bureau of Reclamation used to estimate the economic impact on recreation of alternative water releases at Glen Canyon Dam and (2) the reasonableness of the estimated impacts. The section of the Colorado River below the dam is used by a variety of recreationists, including anglers, boaters, day-rafters, campers, and hikers. We found that the methodology that Reclamation used to estimate the economic impact of alternative flows on recreational activities is generally reasonable. For example, recreationists were surveyed to assess the impact of changes in the dam's operations on recreation activities. In addition, modeling was used to estimate the economic benefits accruing to the national economy from recreational activities under the different flow regimes.

Reclamation has estimated that the economic impact on recreational activities of changing the operations at the dam could range from $0 under the Maximum Powerplant Capacity and High Fluctuating Flow alternatives to benefits of $4.8 million under the Seasonally Adjusted Steady Flow alternative (in 1991 nominal dollars, relative to a No-Action alternative). However, we found several limitations in Reclamation's recreation analysis that suggest that the estimated economic benefits could be over- or understated. For example, because the initial recreation study was completed in 1985 and some recreation conditions have changed since then, some of the study's data may not reflect more recent trends in recreational activities below the dam. Also, recreationists were surveyed during an unusually high water year, limiting the ability of the researchers to capture representative recreational experiences, and some of the survey instruments were not adequately pretested to minimize bias and confusion on the part of survey participants. In addition, anglers who fish within the Grand Canyon were not included in the survey. Because of the inherent uncertainty associated with future events, the actual economic impacts on recreation may differ from those estimated. Nonetheless, despite these limitations, we believe that the estimated impacts can be useful for generally assessing the impacts that may be associated with moving from a No-Action alternative to a fluctuating or steady flow alternative. Moreover, Reclamation and National Park Service officials told us that they were generally aware of the limitations in the recreation analysis but believe that revising the study would not change the basic conclusions of the EIS, the preferred alternative, or the ranking of alternatives. Furthermore, a reviewer of the recreation study for the National Research Council told us that the recreation analysis reflected current professional practices and was well done.

Introduction

Recreation is an important use of the Colorado River below the Glen Canyon Dam. The 15-mile segment of the river below the dam—located within the Glen Canyon National Recreational Area—is the last remaining riverine section of the 189-mile, river-carved channel that once was Glen Canyon. A variety of recreationists use this portion of the river, including anglers, boaters, day-rafters, campers, and hikers. Downstream from Glen Canyon, the Colorado River runs through Marble Canyon and Grand Canyon. This segment of the river is the longest stretch of river (278 miles) for recreational use that is entirely located within a national park. A large number of rapids, as well as the river's isolation within the Grand Canyon, enhance recreational activities along this portion of the river. After passing through the Grand Canyon, the Colorado River is impounded by the Hoover Dam and forms the largest reservoir in the Western United States—Lake Mead. According to Reclamation, about 100,000 boaters annually use this stretch of the Colorado River and Lake Mead for scenic boating, camping, fishing, and water-skiing.

Effects of Pre- and Postdam Conditions on Recreation

The Glen Canyon trout fishery has flourished since the construction of the dam. Water flows from the dam are colder, carry less silt, and are more stable on an annual basis than before the dam was constructed. According to the Department of the Interior, following the completion of the Glen Canyon Dam, the first 15 miles of flat water between the dam and Lees Ferry, once stocked with trout, became an excellent coldwater fishery. This section of the river is also used for half-day commercial raft trips, which, depending upon the flow level, depart either from a dock near the Glen Canyon Dam and float down to Lees Ferry or from Lees Ferry and motor part way upstream before floating back downstream.[1]

Before the early 1960s, and before the dam was completed, few visitors entered the canyon or ran the river. However, Reclamation's EIS indicates that white-water boating in the Grand Canyon is a major industry today, with 15,000 to 20,000 commercial and private boaters annually, paralleling an increasing trend nationwide in white-water boating. In order to help minimize impacts by recreationists, the National Park Service established a ceiling on the number of user days allowed each year along with stricter river-use regulations. Before the dam, riverflows were highly variable and ranged from low flows (frequently less than 3,000 cubic feet per second) to peak flows (occasionally in excess of 100,000 cfs) in spring and early summer. Now, riverflows are within a much narrower range—generally

[1]High discharges associated with flood flows preclude rafting trips from departing near the dam. The probability that such flows will occur is diminished by several features of the action alternatives described in Reclamation's EIS.

from 3,000 cfs to 31,500 cfs (20,000 cfs under the interim operating criteria)—and show less seasonal variation, reducing the high- and low-water risks associated with recreating on the river.

Before the construction of the Glen Canyon Dam, spring runoff carried sediment down the Colorado River to Lake Mead. After construction of the dam, sediment from side canyons and beaches continued to be transported down the river, but in smaller quantities. Over the years, these sediment deposits have built up to form broad mud flats at the upper end of Lake Mead. When the water level in Lake Mead falls below 1,180 feet, boat navigation is difficult because the river is too shallow at low flows and the channel changes with water fluctuations.

Issue

The major issue addressed by Reclamation in its EIS analysis of recreation was how do dam operations affect recreation in the study area? Specifically, Reclamation's assessment focused on how changes in the dam's operations would affect angling, day-rafting, and white-water boating along the Colorado River in the Glen and Grand canyons, as well as the recreationists using lakes Powell and Mead.

Indicators

Reclamation evaluated the impact of alternative flow regimes on a series of indicator activities. The indicators are:

- Fishing trip attributes, safety, and access.
- Day-rafting trip attributes and access.
- White-water boating trip attributes, camping beaches, safety, and wilderness values.
- Lake activities and facilities.
- Net economic value of recreation.

Effects of Flow Alternatives on Recreation

According to Reclamation's EIS, fishing in the Glen Canyon occurs mostly from boats, but some anglers wade in the area around Lees Ferry. The magnitude and rate of change in the river's stage increases the danger for anglers wading in the Glen Canyon reach. Therefore, fishing safety would improve under the Moderate, Modified Low and the Interim Low Fluctuating Flow alternatives, because fluctuations are reduced and the rate at which the river's stage rises is constrained. Upstream fishing access by boat under the Maximum Powerplant Capacity alternative is the same as under the No-Action alternative. Increased minimum flows under the

High Fluctuating Flow alternative would result in a negligible increase in the ease of upstream access by anglers. Because damage to boats and motors is more likely during the low-flow periods that typically occur in the morning before peak power generation occurs, increased minimums and changes in the magnitude of upramp and downramp rates (that is, changes in cfs per hour) would greatly improve upstream access under all other alternatives.

Reclamation's EIS states that the flood control measures included in the restricted fluctuating and steady flow alternatives would reduce the probability of flood events and the corresponding need to launch from Lees Ferry, thus improving the quality of the day-rafting experience in Glen Canyon. In addition, the risk of white-water boating accidents would be highest under the No-Action and Maximum Powerplant Capacity alternatives, slightly lower under the High Fluctuating Flow alternative, and lower under the remaining restricted fluctuating flow alternatives. All steady flow alternatives would decrease the risk of white-water boating accidents over the No-Action alternative.

According to the EIS, wilderness characteristics would improve as variations in riverflow are reduced. To the extent that habitat maintenance and beach/habitat-building flows maintain beaches and reduce the rate of vegetative encroachment, the alternatives with these flows would further enhance wilderness values.

In the short term, the greatest increase in available beach area would occur under the steady flow alternatives. In the long term, low steady flows would remove all of the system's natural variation. The absence of natural system cycles is likely to encourage vegetative growth and result in a net loss of camping beach area. The available beach area would be slightly increased under the Moderate, Modified Low, and Interim Low Fluctuating Flow alternatives in the short term. In the long term, habitat maintenance flows (included in the Moderate and Modified Low Fluctuating and Seasonally Adjusted Steady Flow alternatives) would help maintain the number of beaches and their camping areas.

Because riverflows and the magnitude and frequency of fluctuations differ under each alternative, the net economic value of recreation would also differ. The majority of recreational benefits are derived from commercial white-water rafting, which in general is positively related to average daily flows and negatively related to fluctuations. Those alternatives that increase average summer flows or eliminate daily fluctuations in excess of 10,000 cfs tend to increase recreational benefits.

Reclamation's Methodology for Making Impact Assessments

In assessing the effects on recreation of the different operating regimes for the Glen Canyon Dam, the final EIS gives numerical values where possible; otherwise, it gives qualitative assessments that are based on physical, biological, and economic research. There are three distinct and independent components to the recreational material presented in the EIS. The first is a quantitative assessment of the net economic value of river-based recreation associated with the different flow alternatives. The second component is a qualitative assessment performed by resource managers using the results of scientific studies of the impact of flow alternatives on individual resources. The third recreation component involves an analysis of the regional economic impacts of recreation. Regional economic impact refers to expenditures and their importance to the local economy in the study area. The first two components are based on a study of visitors' preferences conducted by Bishop et al (1987). This appendix will address only the specifics of the first component—the economic benefits associated with recreation.

Reclamation's Recreation Impact Methodology Is Generally Reasonable

We found that the methodology that Reclamation used to estimate the economic impact of alternative flows on recreation activities is generally reasonable. For example, to obtain information from river recreationists, the researchers used a two-stage research design. They conducted two sets of surveys to obtain information from white-water boaters, anglers, and day-rafters. In addition, the researchers analyzed the survey data using a "logit" regression model to determine the amount of money that recreationists would be willing to pay to experience recreational activities under different flow regimes. Also, they used a national economic perspective in the analysis to estimate the recreation benefits accruing to the national economy.

To design and conduct the recreation study, Reclamation contracted with a private consulting firm, HBRS, Inc. (now Hagler Bailly Consulting; hereinafter, the contractor or researchers). The contractor completed an initial study in 1987 and an updated study in 1993.[2] The updated study was used as the basis for the recreation benefits cited in the final EIS.

[2]Glen Canyon Dam Releases and Downstream Recreation: An Analysis of User Preferences and Economic Values, 1987; and Analysis of the Impact of GCDEIS Alternatives on Recreational Benefits Downstream From Glen Canyon, Madison, Wisconsin: HBRS, Inc., 1993.

A Two-Stage Research Design Was Used to Obtain Survey Data

The contractor used a two-stage research design to determine the potential impact of alternative flows at the Glen Canyon Dam on three groups of recreationists—white-water boaters, day-rafters, and anglers. Because riverflows during the period the research was carried out were predominately high and steady, there was no way to ensure that a representative sample drawn from the three groups would include recreationists who had experienced the full range of flows being evaluated. Therefore, the contractor asked the respondents to evaluate their actual trips as well as written descriptions (scenarios) of recreational experiences under a variety of flow levels that they may not have experienced.

During the first stage, the contractor surveyed each recreational group to identify the important characteristics (or attributes) of the recreational experience on the Colorado River and what effect, if any, riverflows would have on these experiences. The contractor also administered these attribute surveys to commercial white-water boating guides and private trip leaders to get a more informed view of how riverflows affect the experiences of boaters on the river. White-water boating participants in the attribute survey were selected from the National Park Service's records of trip launches for the 1982 and 1984 seasons. For anglers, the contractor attempted to survey anglers at Lees Ferry during selected days in November and December 1984. The researchers chose day-rafters from a concessionaire's list of individuals who took a Glen Canyon raft trip during the months of April through October 1985.

The contractor applied what had been learned from the attribute surveys to the design of the scenarios for the contingent valuation survey.[3] A contingent valuation survey attempts to measure the willingness of a group of people to pay for hypothetical projects or programs. The contractor used questionnaires to ask individuals about their dollar valuation of a series of specific hypothetical changes in Colorado River flows. Because the valuation is contingent on the specific hypothetical change identified, these values are called "contingent values" and the

[3]Another approach for measuring recreation impacts is the travel cost method. This method uses travel and related costs that are incurred during a recreational activity to approximate the market price for a recreation trip.

method of obtaining data is termed the "contingent valuation method," or CVM.[4]

The scenarios described white-water trips and angling trips at various flow levels in terms of identified flow-sensitive attributes.[5] The scenarios also distinguished between constant and fluctuating flows. A fluctuating flow primarily occurs when the dam is being operated for peak power production. Fluctuations in excess of 10,000 cfs within a 24-hour period constituted a fluctuating flow for the recreation study's purposes. The 10,000-cfs threshold was based on the results of the attribute surveys.

In the second stage, the contractor used the scenarios as the basis of the contingent valuation survey. Along with the actual trip experience and its total cost, the contractor used these hypothetical descriptions to quantify the effects of different flow regimes on the recreational experience. Specifically, the contractor described the change in the recreational experience and asked those surveyed whether they would still take such a trip if their expenses were to increase by a certain randomly assigned dollar amount over their trip's actual cost. The respondents were limited to "yes" and "no" answers. The researchers also provided the respondents with riverflow information corresponding to the date of their actual trip in order to gain information about the trip and establish a context for the responses to the scenarios. In addition to this information, the researchers asked the recreationists about the characteristics of their actual trip and reasons for taking the trip. Also included were questions about the respondent's income level and indicators of how well the respondents understood the survey and thought the results would affect the cost of future recreation.

A 1987 review by the National Research Council stated that the use of the contingent valuation technique to address the public's willingness to pay for angling and rafting opportunities through the Grand Canyon was "a bold application of this promising method. The researchers, who are well

[4]In our review of the contingent valuation survey, we relied on Dillman's total design method as well as on economic reasoning in assessing the reasonableness of Reclamation's application of the CVM approach. Dillman's method is an accepted standard in survey research for achieving the maximum quality and quantity of responses to mail questionnaires. By achieving the maximum quality of responses, for example, researchers can have greater confidence in the validity of the work; that is, they can be more sure of measuring what they intend to measure. By achieving the maximum quantity of responses, researchers can have greater confidence in the reliability of their work that repeated investigations will produce similar results. A more detailed discussion of the CVM approach is presented in app. VI of this report; the total design method is described in Dillman, Don A., Mail and Telephone Surveys: The Total Design Method, John Wiley & Sons, New York, 1978.

[5]Because the attribute survey found day-rafters insensitive to flows, no scenarios were presented to this sample group.

known for their development of the technique, have ably and creatively analyzed the satisfaction of recent recreationists."[6]

Economic Estimates Developed Using Federal Principles and Guidelines

We found that the contractor followed federal principles and guidelines for water resources planning where applicable in developing estimates of the recreation benefits. For example, federal principles and guidelines state that the federal objective of water and related land resources planning is to contribute to national economic development (consistent with protecting the environment).[7] In addition, the guidelines state that the benefits arising from recreational opportunities created by a project are measured in terms of willingness to pay. The contractor defined recreational benefits in terms of consumers' willingness to pay and calculated the net economic benefit, or "surplus value," associated with the recreational experiences under different flow conditions. Surplus value is the value that the recreationists placed on their recreational experience over and above what they actually paid for the recreational experience. Expenditures, such as the price of a Grand Canyon white-water boat trip, were excluded from the net economic benefit calculations because the expenditures represent a transfer payment to the local economy. Transfer payments simply redistribute income from one group in society to another, and therefore they do not reflect an economic benefit to the national economy.

Nonetheless, expenditures are important because they support local businesses and provide employment for local residents. For this reason, recreational expenditures were the focus of a separate analysis of regional economic activity that Reclamation performed.

Economic Benefits Were Estimated Using Econometric Model

The contractor used a now standard econometric approach to evaluate the contingent valuation response data. For example, surplus values were estimated using a "logit" model, that was based on the "yes" and "no" answers to the survey's valuation question. Using the logit model, the contractor estimated the probability that a respondent would be willing to pay a specific dollar amount (termed "offer amount") above his/her actual trip cost to recreate under the various flow regimes. This probability was assumed to be a function of several independent variables, including the

[6]River and Dam Management: A Review of the Bureau of Reclamation's Glen Canyon Environmental Studies, National Academy Press, Washington D.C., 1987, p. 63.

[7]Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, U.S. Water Resources Council, Mar. 10, 1983.

offer amount, the amount the recreationist spent to take an actual trip, and the number of days spent on the river.

To update the estimated values obtained during the 1985 survey, the contractor used the 1985 model with the hydrologic conditions for 1991 to generate surplus values for various alternatives by month and by recreational activity. The contractor then multiplied the surplus values by the observed 1991 monthly participation rates for each activity. The resulting estimates were then inflated to 1991 dollars. In addition, because the initial recreation study was completed before Reclamation developed the alternative flow regimes in the EIS, the contractor extrapolated from the flow regimes used in the contingent valuation survey to the EIS flow regimes using a combination of historical data on the dam's operations and projections of future hydrologic conditions over a 20-year planning period. The 20th year was repeated for 30 years to complete the 50-year analysis period. The Colorado River Simulation System model was used to develop the future hydrologic projections, which were identical to those used in the power analysis.

To determine the present value of future recreation benefits over the 50-year analysis period, the contractor discounted future annual benefits using the federal discount rate of 8.5 percent.[8] The present value was "levelized" over the 50-year analysis period to determine equivalent annual benefits. Table VII.1 shows the estimated net economic benefits for recreation associated with the nine alternatives discussed in the final EIS. The table reflects the net benefits associated with white-water boating and angling activities. The number of white-water boating and angler trips were held constant at 1991 levels over the 50-year analysis period. The researchers found that day-rafters are not sensitive to river stage and fluctuations; thus, the economic impact of changes in the dam's operations on day-rafters was estimated to be zero.

[8]The net recreation benefits in each year in the analysis period were inflated by the projected gross national product price deflator for that year. The same deflator and discount rate were also used in the hydropower analysis.

Table VII.1: Economic Benefits Associated With Recreation Activities, Relative to the No-Action Alternative (1991 Nominal Dollars in Millions)

EIS alternatives	Present value of net benefits over 50-year analysis period	Equivalent annual net benefits
No Action	$0	$0
Maximum Powerplant Capacity	$0	$0
High Fluctuating Flow	$0	$0
Moderate Fluctuating Flow	$4.6	$0.4
Modified Low Fluctuating Flow	$43.3	$3.7
Interim Low Fluctuating Flow	$45.6	$3.9
Existing Monthly Volume Steady Flow	$45.6	$3.9
Seasonally Adjusted Steady Flow	$55.0	$4.8
Year-Round Steady Flow	$23.5	$2.9

Source: Bureau of Reclamation.

Shortcomings in Recreation Analysis Suggest Economic Impacts Could Be Over- or Understated

Although the recreation methodology is generally reasonable, we found limitations in the analysis. For example, because the initial recreation study was completed in 1985 and some recreational conditions have changed since then, some of the study's data may not reflect more recent trends in the recreational activities below the dam. Also, the researchers gathered the survey data during an unusually high-water year, limiting the ability to capture representative recreational experiences, and they did not adequately pretest some of the survey instruments to minimize bias and confusion on the part of the participants. In addition, the contractor did not include Grand Canyon anglers in the survey. Finally, some of the econometric results are inconsistent with expectations based on conventional economic reasoning. These limitations indicate that the estimated recreation benefits could be over- or understated. Because of the time and expense that would be required to recompute the results with revised methodology and data, we did not determine the net effect of the limitations on the estimated economic impacts.

Recreation Conditions May Have Changed Since the Survey

We found that some of the data used to develop the economic benefits may be dated because of changes in the recreation environment since recreationists were surveyed in 1985. The contractor used 1985 surplus values and number of trips taken in 1991 to derive recreation benefits for alternative flows. However, because the estimated benefits were derived using 1985 surplus values, they may not account for more recent changes in recreational activities that could affect value.[9]

The years 1985 and 1991 combined for use in the model were different in terms of the number of recreational trips taken, especially for anglers. For example, according to study statistics, the actual number of fishing trips at Lees Ferry more than doubled between 1985 and 1991, from 6,064 to 12,902. In addition, the fishing regulations changed during this period, strictly limiting anglers to artificial lures and imposing new restrictions on the size and number of fish caught. Because of the substantial change in the number of fishing trips taken and a change in fishing regulations, it may not be reasonable to assume that the value per fishing trip, relative to other goods and services, would have remained unchanged between 1985 and 1991.

Survey Data Based on a Year With Unusually High Water

The researchers were not able to capture representative recreational experiences because of the river conditions present during the recreation study. The sample year—1985—used to develop the statistical relationship between flow rates and surplus values was an atypical year for the Colorado River, characterized by relatively high, constant flows and poor fishing. To address this data issue, the contractor used hypothetical scenarios (developed using the attribute survey information) to determine the effect of different flow regimes on recreational experiences. However, two potential problems with the use of the high-water year and scenario data are (1) the estimated surplus values depend heavily on the ability of the respondents to meaningfully interpret the scenarios using their high-water experience and (2) the surplus values generated from scenario data may differ from those based on actual experiences.

Ideally, the respondents should be asked about their willingness to pay for alternative flow regimes that they have actually experienced. At the time of the recreation survey in 1985, however, there had been already 2 consecutive years of high-water flows. In addition, according to Reclamation, it was not feasible to adjust the Glen Canyon Dam's operations to create alternative flow conditions for the recreation study. Therefore, the contractor constructed hypothetical scenarios to simulate recreational experiences under different flow conditions. The contractor then asked the recreationists to compare their actual trip experiences with the hypothetical trip experiences.

[9]Surplus values were adjusted for inflation between 1985 and 1991.

However, because 1985 and the preceding years were unusually high-water years characterized by constant flows, some recreationists may not have experienced a variety of flow conditions. For example, the researchers could not make inferences about the influence of fluctuating flows on white-water boaters using information from actual trips because only 12 percent of the respondents experienced these fluctuations. Similarly, because there was little variation in the actual trip experiences for anglers, the researchers were unable to make a direct link between the actual trip's surplus value and the flow levels experienced by the respondent. This condition is attributable to all anglers having experienced such small variation in flow conditions that substantially all of the respondents compared the scenarios with essentially the same limited actual flow experiences. Consequently, there was no way to determine whether recreationists who experienced other types of flows would have valued the scenarios differently. For example, a recreationist who had experienced low, fluctuating flows might value a medium flow more than a recreationist who experienced only a high constant flow.

Some Questionnaires Were Not Adequately Pretested

Although the researchers used Dillman's total design method for the implementation of the surveys and tested proposed questions to determine which wording options offered the highest response rates, they did not adequately pretest some survey instruments to detect defects in wording, construction, presentation, or other inadequacies. As a result, we cannot be completely confident that the surveys actually measured what they were intending to measure.

Reclamation's contractor used mail questionnaires to gather data on recreational attributes and contingent values. We found that the contractor generally followed Dillman's total design method in the design and implementation of these questionnaires. For example, the contractor met Dillman's standards for questionnaire design and mailing procedures, which helped to obtain response rates between 70 and 93 percent. These response rates allow the researchers to have greater confidence that they do not have a biased picture of the sample caused by differences between the respondents and nonrespondents.

However, we also found that the contractor did not follow Dillman's pretesting standards. For example, the attribute survey for anglers and the questionnaire used for white-water guides were pretested in person, while other questionnaires were pretested through the mail. According to Dillman, mail pretesting is "destined to be of very limited value." Only by having respondents fill out the draft in the presence of the researchers can they discover such information as: Is each question measuring what it is intended to measure? Are all the words understood? Are the questions interpreted similarly by all respondents? Is any part of the questionnaire biased? Because such pretesting was not done, neither we nor the contractor can be confident about the validity of the questions or the instruments as a whole.

An example of problems that may have resulted from inadequate pretesting can be seen in the interpretation of the water levels experienced by anglers. In the in-person interviews performed for the angler attribute questionnaire, the researchers found problems with the responses to questions that dealt with water levels experienced by the anglers. The authors of the recreation study noted that for the 2 years before the attribute survey, steady high water was the rule. However, some respondents who had fished at Lees Ferry only during 1984 and 1985 answered that they had experienced low, medium, or fluctuating flows. The authors conclude that some anglers may have answered the water-level experience question incorrectly. These responses are evidence of possible problems in the validity of the measures used. We do not know the extent of misunderstanding between the respondents and the contractor, but this example suggests that there was some. Adequate pretesting may have detected and corrected this misunderstanding.

Grand Canyon Anglers Were Excluded From Survey

The contractor assumed that fishing in locations other than Lees Ferry was an incidental activity and therefore did not include these anglers in the survey. As a result, the data for anglers are based solely on the recreational experiences of anglers at Lees Ferry. To the extent that other anglers who fish downstream in the Colorado River or its tributaries have surplus values that are different from the Lees Ferry anglers (but also positive), the estimated benefits may understate the total benefits to anglers resulting from alternative flow regimes.

The researchers defined the angling population to include those who access the river from Lees Ferry in Glen Canyon, which had the effect of excluding anglers in the Grand Canyon. According to the researchers and recreation subteam members, the Grand Canyon anglers were not included in the study for a variety of reasons. For example, they were thought to represent only a small percentage of fishing activity; they might be difficult to sample; and fishing itself was not considered to be the focus of a Grand Canyon recreational experience. Although little information exists on the extent of angling in the Grand Canyon or the characteristics of these anglers, the EIS makes reference to 15 sites in the Grand Canyon that are managed for anglers who want to catch "fish that are naturally reproduced in the wild." In addition, the National Park Service and Arizona Game and Fish Department officials we contacted indicated that some anglers fish in the vicinity of Marble Canyon to avoid the restrictions on natural bait enforced at Lees Ferry, and other anglers hike down into Phantom Ranch to fish in Bright Angel Creek. The difficulty or expense of reaching or staying at a location other than Lees Ferry, a preference for "wild" rather than hatchery fish, and reasons for going to the river other than fishing could mean that these groups of anglers have different opinions of the values of flows than those who were sampled.

Survey Data Do Not Precisely Correspond to EIS Flow Alternatives

Because the researchers designed and conducted the recreation contingent valuation survey well before the EIS operating regimes were proposed for the Glen Canyon Dam, the flow regimes used in the survey scenarios do not precisely correspond to the flow alternatives identified in the final EIS. As a result, there is some uncertainty as to whether the survey data reflect the same environmental changes proposed in the EIS alternatives.

An unusual aspect of the recreational modeling effort is that it is composed of two separate segments of work, several years apart, occurring within the framework of the Glen Canyon Environmental Studies. Reclamation's contractor began the initial study of recreational values in 1984, and the results were published in 1987. The 1987 study, however, predated the development of the preferred alternative.

In order to allocate the estimated recreation benefits to the alternative flow regimes in the EIS, the contractor converted the EIS alternatives into the same terms as those used in the original survey. This was done by translating the EIS alternatives into average flow terms and identifying fluctuations in flow using a mixture of theoretical data and data from the dam's actual operations. However, the recreation survey was based on broad groupings of flows, while the EIS flow alternatives are much more detailed in their characteristics. As a result of this sequencing, it is not clear that the aggregate recreational values captured in the 1987 study reflect the same environmental changes proposed in the EIS alternatives. The recreation analysis may not have captured the nuances that distinguish the individual EIS flow alternatives. For example, the scenarios used in the 1987 study used average flow figures (such as 13,000 cfs) to ask individuals about their dollar valuation of a hypothetical change in riverflows, while the EIS describes complex alternatives stated both in terms of minimum and maximum flows (for example, 1,000 cfs to 31,500 cfs) as well as the rate of change in flows per hour (that is, ramping up or down). Although ramping can affect the recreational experience, by using these averages, the recreation analysis was not able to assess the impact of ramping on recreational activities. For example, rapid changes in the upramp rate of the dam's operations can put wading anglers at risk of inundation, as well as affect the "naturalness" of a wilderness boating experience. Similarly, rapid changes in the downramp rate of the dam's operations can strand anglers in boats, as well as fish in backwaters.

A Reclamation official and the contract researchers acknowledge that there is no systematic linkage between the scenarios used in the contingent valuation surveys and the flow regimes in the final EIS. A Reclamation official told us that translating the EIS alternatives into the same terms used in the 1985 scenarios involved a great simplification. For example, the scenarios were based on a dichotomous approach: a single mean monthly flow rate and the presence or absence of fluctuations. If the flow levels varied by more than 10,000 cfs, they were considered fluctuating. If the flow levels varied by less than or were equal to 10,000 cfs, they were considered steady. By contrast, the EIS alternatives involve complex variables, including flow ranges and rates that change hourly. As a result of this simplification, the recreation model cannot distinguish between several alternatives. That is, the model predicted the same economic benefits for the No-Action, Maximum Powerplant Capacity, and High Fluctuating Flows, as well as for the Interim Low Fluctuating Flow and the Existing Monthly Volume Steady Flow.

Some Econometric Results Are Inconsistent With Conventional Economic Reasoning

Some of the econometric results indicate a positive and significant relationship between surplus value and the expenditure variable, which is inconsistent with conventional economic reasoning. For example, in the analysis of white-water boaters' and anglers' responses, the contractor found that the respondents' surplus values increased with the amounts they spent to take their actual trips. This result is inconsistent with conventional economic reasoning because we would expect that the more an individual spends on a trip, the lower would be his or her surplus value, all else being the same. Because this result may be symptomatic of a technical problem, such as a misspecification of the model, a measurement error, or an insufficient sample size, it suggests that the results lack precision.[10]

Some members of the contract research team acknowledged this inconsistency between the results of the model and conventional economic reasoning. One of the contractor's researchers told us that the positive relationship between surplus value and expenditure may be attributable to an omitted price variable. In his opinion, however, this omission does not affect the validity of the results incorporated into the EIS.

The EIS Team Used Estimated Recreation Benefits Only to Aid Decision-Making

Reclamation and National Park Service officials involved in the EIS process told us they were generally aware of the limitations of the recreation analysis but believe that addressing the limitations would not change the basic conclusions of the EIS, the choice of the preferred alternative, or the ranking of alternatives. No such changes would occur because the study results were used more as an adjunct in developing a preferred alternative, rather than a focal point.

A Reclamation official involved in the selection of the preferred alternative told us that the first criterion applied to the nine proposed alternatives was how the sediment balance in the canyon would be affected. Alternatives that negatively affected the amount and location of sediment were eliminated, leaving only three alternatives, none of which posed a safety threat to recreationists except at very low flows. Since two of the three remaining alternatives were identical except for a habitat maintenance flow, the EIS team had to choose between only two alternatives. In choosing between these two alternatives, the EIS team weighed the power costs associated with each, the recreational benefits, and unquantified ecological concerns, such as benefits to the aquatic food base. According to this official, the EIS team selected the Modified Low Fluctuating Flow as the preferred alternative because the loss of power revenues was roughly offset by the gains to the other resources.

National Park Service and Reclamation officials told us that Reclamation considered revising the recreation economic study after the EIS alternatives were developed to get better data on how respondents valued a wide variety of actual flow conditions and on anglers' participation in the Lees Ferry fishery. In particular, a researcher raised the prospect of

[10]Researchers were unable to calculate a standard error because the appropriate statistical techniques were not available at the time of the study. However, a Reclamation official told us that the estimates are subject to an error of about plus or minus 20 percent.

further investigating anglers' values to overcome the limitations of the original study. However, Reclamation decided not to spend additional resources on revising the recreational analysis in order to further study areas that were deemed more critical. A National Park Service representative told us that because most of the unanswered questions were in the areas of sediment, vegetation, and endangered fish, funds were directed to these "higher-priority data gaps."

Recreation Results Can Be Useful Despite Limitations

Because there is inherent uncertainty associated with projecting future impacts, the actual economic impacts on recreation may differ from those estimated. The limitations we have identified suggest that the estimated impacts could be over- or understated. Nonetheless, despite these limitations, we believe that the estimated impacts can be useful for generally assessing the impacts that may be associated with moving from a No-Action alternative to a restricted fluctuating or steady flow alternative. Moreover, a reviewer of the recreation study for the National Research Council indicated to us that the recreation modeling was conducted using current professional practices and was a state-of-the-art effort given the budget and time constraints. In addition, this reviewer indicated that the work on the economics of recreational use was well done and a good use of taxpayer money given the many other demands on the Glen Canyon Environmental Studies budget.

Reclamation's and the National Park Service's Response to the Recreation Issues Raised

We discussed our findings with a National Park Service and a Reclamation official who, as EIS team members, were responsible for incorporating recreation and the economics of recreational use into the EIS. These officials, a resource management specialist with the National Park Service and an economist with the Bureau of Reclamation, generally agreed with our statements concerning the strengths and weaknesses of the recreation analysis. Reclamation's economist acknowledged that recreational conditions may have changed since the study's survey was implemented in 1985. Both officials said that the methodology was reasonable and appropriate and the data were the best available at the time of the study. For these reasons, they told us that neither the ranking of alternatives nor the choice of a preferred alternative would change, even if the issues we identified as shortcomings were resolved.

Scope and Methodology

To gain an understanding of general recreational issues we reviewed studies on recreation use in the Glen and Grand canyons. To assess the reasonableness of the recreation methodology, assumptions, and results, we reviewed the documents that describe Reclamation's methodology, assumptions and data, and literature on the contingent valuation method, and we used standard economic principles. Our assessment was limited to a review of the general analytical framework and an assessment of the reasonableness of key assumptions and data. We did not validate data inputs.

The documents we reviewed include the following:

Analysis of the Impact of GCDEIS Alternatives on Recreational Benefits Downstream From Glen Canyon (draft report). Madison, Wisconsin: HBRS, Inc., 1993.

Bishop, R., C. Brown, M. Welsh, and K.J. Boyle. "Grand Canyon Recreation and Glen Canyon Dam Operations: An Economic Evaluation, W-133," Benefits and Costs in Natural Resource Planning: Interim Report 2. Edited by Kevin J. Boyle and Trish Heekin. Orono, Maine: Department of Agricultural and Resource Economics, University of Maine, 1989.

Bishop, R., K. Boyle, M. Welsh, R. Baumgartner, and P. Rathbun. Glen Canyon Dam Releases and Downstream Recreation. Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.

Boyle, K., M. Welsh, and R. Bishop. "The Role of Question Order and Respondent Experience in Contingent-Valuation Studies," Journal of Environmental Economics and Management, pp. 80-99, 1993.

Boyle, K., M. Welsh, R. Bishop, and R. Baumgartner. "Analyzing the Effects of Glen Canyon Dam Releases on Colorado River Recreation Using Scenarios of Unexperienced Flow Conditions, W-133," Benefits and Costs in Natural Resource Planning: Interim Report. Compiled by John B. Loomis. Davis, California: Department of Agricultural and Resource Economics, University of California, 1988.

Chestnut, L., R. Raucher, and R. Rowe. A Review of the Economic Studies Conducted in Phase I of the Glen Canyon Environmental Studies. Report to Mr. Dave Wegner, Bureau of Reclamation - Upper Colorado Region, Flagstaff, Arizona. Economic Studies for the Glen Canyon Environmental Studies, Phase II. RCG/Hagler, Bailly, Inc., 1991.

Cummings, R.G., D.S. Brookshire, and W.D. Schulze. Valuing Environmental Goods: An Assessment of the Contingent Valuation Method. Rowman & Littlefield Publishers, 1986.

Diamond, P.A., J. Hausman. "Contingent Valuation: Is Some Number Better than No Number?" Journal of Economic Perspectives, Vol. 8, No. 4, pp. 45-64, 1994.

Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, U.S. Water Resources Council, Mar. 10, 1983.

Final Report: Hualapai Recreation Studies. SWCA, Inc. Environmental Consultants. Feb. 1995.

Final 1993 Annual Report: Hualapai Recreation Studies. SWCA, Inc., Jan. 1994.

Glen Canyon Environmental Studies Final Report. Salt Lake City, Utah: Bureau of Reclamation, U.S. Department of the Interior, 1988.

Hanemann, W. M. "Valuing the Environment Through Contingent Valuation," Journal of Economic Perspectives, Vol. 8, No. 4, pp. 19-43, 1994.

HBRS, Inc. Glen Canyon Dam Releases and Downstream Recreation: An Analysis of User Preferences and Economic Values, 1987.

Jalbert, L. The Influence of Discharge on Recreational Values Including Crowding and Congestion and Safety in Grand Canyon National Park. Grand Canyon National Park Division of Resources Management, 1992.

Jalbert, L. Monitoring Visitor Distribution and Use Patterns Along the Colorado River Corridor: River Contact Survey and Attraction Site Monitoring (status report). Grand Canyon National Park Division of Resources Management and Planning, 1991.

Kearsley, L. Monitoring the Effects of Glen Canyon Dam Interim Flows on Campsite Size Along the Colorado River in Grand Canyon National Park (final report). Grand Canyon National Park Division of Resources Management, National Park Service, 1995.

Kearsley, L., J. Schmidt, and K. Warren. “Effects of Glen Canyon Dam on Colorado River Sand Deposits Used as Campsites in Grand Canyon National Park, USA,” Regulated Rivers: Research and Management, Vol. 9, pp. 137-149, 1994.

Kearsley, L., and K. Warren. River Campsites in Grand Canyon National Park: Inventory and Effects of Discharge on Campsite Size and Availability (final report). Grand Canyon National Park Division of Resource Management, National Park Service, 1993.

Operation of Glen Canyon Dam Final Environmental Impact Statement. Bureau of Reclamation, U.S. Department of the Interior, 1995.

Operation of Glen Canyon Dam Draft Environmental Impact Statement: Public Comments Analysis Report. Prepared by the Bear West Consulting Team for the Bureau of Reclamation, 1994.

Portney, P.R. “The Contingent Valuation Debate: Why Economists Should Care,” Journal of Economic Perspectives, Vol. 8, No. 4, pp. 3-17, 1994.

Reger, S., K. Tinning, and L. Piest. Colorado River Lee’s Ferry Fish Management Report, 1985-1988. Phoenix, Arizona: Arizona Game and Fish Department, 1989.

Richards, M., and D.B. Wood. “The Economic Value of Sportfishing at Lees Ferry, Arizona,” Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. Proceedings of the First North American Riparian Conference. Apr. 16-18, 1985. Tucson, Arizona. U.S.D.A. Forest Service General Technical Report RM 120. Ft. Collins, Colorado: Rocky Mountain Forest and Range Experiment Station.

River Resource Management in the Grand Canyon, Committee to Review the Glen Canyon Environmental Studies, National Research Council, Washington, D.C.: National Academy Press, 1996.

River and Dam Management: A Review of the Bureau of Reclamation’s Glen Canyon Environmental Studies, Committee to Review the Glen Canyon Environmental Studies, National Research Council. Washington, D.C.: National Academy Press, 1987.

Schulze, W., R. d'Arge, and D. Brookshire. "Valuing Environmental Commodities: Some Recent Experiments," Land Economics, Vol. 57, No. 2, pp. 151-172, 1981.

Shelby, B., T.C. Brown, and R. Baumgartner. "Effects of Streamflows on River Trips on the Colorado River in Grand Canyon, Arizona," Rivers, Vol. 3, No. 3, pp. 191-201, 1992.

Stevens, L., K. Buck, B. Brown, and N. Kline. Dam and Geomorphic Influences on Colorado River Waterbird Distribution, Grand Canyon, Arizona, USA, 1995 (unpublished original research).

We also interviewed researchers, members of the EIS and recreation teams, including Reclamation officials and their contractors, as well as representatives from the National Park Service and the Arizona Game and Fish Department. In addition, we spoke to academic experts in economics and members of the National Academy of Sciences Glen Canyon Dam EIS review team. A list of the researchers, officials, and experts follows.

Richard Bishop, Professor, University of Wisconsin
Kevin Boyle, Associate Professor, University of Maine
Curtis Brown, Social Psychologist, Bureau of Reclamation
Bonnie Colby, Associate Professor of Agricultural and Resource Economics, University of Arizona, Tucson
Galen Collins, Assistant Dean of Hotel and Restaurant Management, Northern Arizona University
Diane Dupont, Associate Professor of Economics, Brock University - Ontario, Canada
Marshall Flug, Water Resources Engineer and Research Hydrologist, National Biological Service and Colorado State University
Rusty Gattis, Acting Superintendent, Glen Canyon Dam, Bureau of Reclamation
Terry Gunn, Owner, Lees Ferry Angler's Guides and Fly Shop
W. Michael Hanemann, Professor of Agricultural and Resource Economics, University of California, Berkeley
Martha Hahn, Idaho State Director, Bureau of Land Management
David Harpman, Natural Resource Economist, Bureau of Reclamation
Amis Holm, Environmental Planner III, SWCA, Inc. Environmental Consultants
Brice Hoskins, Project Manager, SWCA, Inc. Environmental Consultants
Charles Howe, Professor of Economics, University of Colorado

Linda Jalbert, Biological Technician, National Park Service
Lisa Kearsley, former National Park Service employee and researcher
Mark Law, Colorado River Subdistrict Ranger, National Park Service
Jerry Mitchell, Chief, Cultural Resource Management, National Park Service
Mike O'Donnell, Supervisory Natural Resource Specialist, Bureau of Land Management
Timothy Randle, Hydraulic Engineer, Bureau of Reclamation
Larry Riley, Supervisor, Arizona Game and Fish Department
Michael Welsh, Senior Associate, Hagler Bailly Consulting

Sediment

Sediment is unconsolidated material that comes from the weathering of rock and is transported and deposited by water or wind. It is seen as a key indicator resource for the Grand Canyon ecosystem because nearly all of the canyon's resources are strongly linked to sediment. For example, sediment is critical for stabilizing archeological sites and camping beaches, for developing and maintaining backwater fish habitats, for transporting nutrients, and for supporting the vegetation that provides wildlife habitat. The amount of sediment transported through the Glen and the Grand canyons depends to a large degree on the volume of water released by the Glen Canyon Dam.

According to the EIS team members and sediment researchers that we interviewed, the data used in the preparation of the sediment section of the Glen Canyon Dam's EIS were the latest and best scientific information available at the time. Furthermore, they told us that the EIS is as good a document as can be done for reviewing and transferring technical information for use in public policy decision-making. While some sediment study results were based on data that were preliminary, draft, and/or unpublished at the time of the draft and final EIS, the researchers told us that no new or additional information has subsequently been obtained that would alter the information or conclusions presented in the final EIS. Also, for the most part, these researchers agree that the modeling tools used in the sediment impact determinations, while fairly crude in some respects, were the best available at the time and that their use resulted in appropriate conclusions.

Description of the Resource

Sediment currently entering the Colorado River comes from tributaries downstream from the Glen Canyon Dam, primarily the Little Colorado and Paria rivers. Through several complex processes, the sediment in the river is transported, deposited, and then eroded for further transport. The quantity of the sediment in motion at a given time and its location depend on the amount and particle size of the sediment available, the dimensions and slope of the channel, and the magnitude of the water's flow. Four general classes of sediment, by size, are found in the Glen and Grand canyons:

- silts and clays (finer than 0.062 millimeter),
- sand (0.062 to 2 millimeters),
- gravels and cobbles (2 to 256 millimeters), and
- boulders (greater than 256 millimeters).

The transport and deposition of sediment vary with the size of the particles. Silts and clays are easily transported and generally pass through the system in a relatively short time, although some may be deposited in the low-water-velocity areas on sandbars and in backwaters. Silt and clay-sized particles provide important nutrients for vegetation, and clay also provides cohesion. The most abundant class of sediment found along the river is sand. Many sandbars, frequently called "beaches," are used as campsites by boaters and rafters and are also important sites for riparian vegetation and wildlife habitats. Some sandbars also contain important cultural resource sites for Native American tribes. Gravel and cobblestones cover the bottom of some streambeds. Some fish species use shallow gravel beds for spawning. The larger boulders fall from the canyon walls or reach the river during flash floods in steep tributary canyons. Boulders create and modify most of the major river rapids and are an important factor in the creation of sandbars.

The river's capacity to transport sediment increases exponentially with the amount of water flowing in the river. The greater the river's flow, the greater the velocity and the greater the turbulence. The turbulence of flowing water is the uplifting force that causes sediment particles to be carried in suspension or roll along the streambed. Because sediment particles weigh more than water, they tend to settle to the bottom of the river channel. Small clay and silt particles can be carried in suspension by nearly all dam releases. Riverflows often are large enough to carry sand grains in suspension. The grains may be temporarily deposited in areas where the velocity of the water is insufficient to move them. Larger flows and velocities are needed to move gravel and cobbles, whereas the largest boulders may remain in place in the river channel for decades.

Effects of Pre- and Postdam Conditions on Sediment

The Colorado River historically carried large quantities of sediment from the states in the Upper Colorado River Basin. The Glen Canyon Dam has caused three major changes to the sediment resources in the canyon. First, the supply of sediment has been reduced. The construction of the Glen Canyon Dam caused virtually all of the high concentration of sediment from the upper basin to be trapped by the dam and deposited in Lake Powell. Second, by controlling the annual historical peak flows that had a tremendous capacity to transport sediment, the dam has reduced the capacity of the river to transport sand and other sediment. Third, the height of the annual deposition of sediment, which is responsible for the size of sandbars, has been reduced because the dam now controls flood flows.

Issue

As defined in the final EIS, the issue of concern for sediment resources is how the dam's operations affect sediment throughout the Glen and the Grand canyons.

Indicators

The indicators for the sediment resource listed in the final EIS are

- the probability of net gain in riverbed sand;
- the active width and height of sandbars;
- the erosion of high terraces (high sediment deposits having a relatively flat surface and steep slope facing the river);
- the constriction of debris fans (sloping masses of boulders, cobbles, gravel, sand, silt, and clay formed by debris flows at the mouth of a tributary) and rapids; and
- the elevation of lake deltas (sediment deposits formed where the Colorado River and other streams enter Lake Powell or Lake Mead).

Methodology Used to Make Impact Determinations

The EIS sediment team used a combination of historical riverflow and sediment discharge data, established computer modeling techniques, preliminary research results, and professional judgment to determine the potential impacts of the nine flow alternatives on the various types of sediment (especially riverbed sand). The long-term impacts on riverbed sand were estimated using empirical data and computer modeling, while the potential impacts on sandbars, high terraces, debris fans, and lake deltas were developed using preliminary research results, modeling, and professional judgment.

The sediment team was comprised of two individuals, a civil engineer with Reclamation and a hydrologist with the U.S. Geological Survey. In order to obtain the most recent scientific information, they obtained the preliminary results of the Glen Canyon Environmental Studies phase II research and attended the meetings of the phase II sediment researchers. The sediment team also attended a special session at an American Geophysical Union symposium to discuss the latest research on backwaters and also participated in several raft trips down the canyon with researchers in order to personally observe the sedimentation processes.

Other researchers involved in the sediment impact determinations included U.S. Geological Survey and National Park Service officials experienced in the sediment resource area. In addition, researchers from Utah State University, the University of Tucson, and the University of Northern Arizona were also active in various projects. All of the researchers were experienced in sedimentation data collection and analysis.

The data used in drafting the sediment section of the EIS were obtained from measurements and observations at selected canyon sites under various conditions, including during floods, historic powerplant operations and operations under the interim operating criteria, and also under specially designed research flows. The data collected underwent several different reviews.

The data obtained by the U.S. Geological Survey and used in the final EIS received additional reviews. Within the Geological Survey, each report was reviewed by at least two other researchers, plus an additional review at the regional level. External review was provided by the editors of outside publications or other professionals when the work was published in a U.S. Geological Survey professional paper.

In addition, the National Academy of Sciences, through its National Research Council, reviewed the preliminary draft EIS and provided official comments. The draft EIS was also made available for public review and comment. Over 470 public comments were received that related to sediment. The public comments reflected many differing and even contradictory views and opinions. For example, some commentors suggested that the dam's historical operations have damaged the beaches and increased erosion. Other commentors said that without the dam, there would be fewer beaches or that the increases in erosion are overstated. The effect of steady flows versus fluctuating flows on beach erosion was also argued on both sides. Some believed that steady flows would preserve beaches, while others said that they would destroy beaches. Other commentors expressed the belief that controlling fluctuation within certain parameters can control erosion, while others said that as long as there is a flow of any kind, erosion will occur.

The EIS team needed detailed analyses of the projected flow patterns for the various alternatives to evaluate different impacts. To develop these technical analyses, the EIS team used the Colorado River Simulation System (CRSS), a package of computer programs and databases designed to assist water resource managers in long-range planning and operations studies. The development of CRSS took place over a 10-year period and stemmed from the need for a comprehensive model of the Colorado River Basin that would incorporate all areas of interest, including legislative requirements. According to Reclamation and other experts, today, CRSS is the most comprehensive and detailed simulation of the Colorado River system that exists.

The CRSS database contains reconstructed natural flow data for the Colorado River between 1906 and 1990. The CRSS model can simulate the Colorado River's operations and the effects of changes to the Glen Canyon Dam's operations for the entire river basin. The modeling process begins with the assumption that previous natural flows in the river are indicative of future activity. Thus, the model uses the historical data to project future water availability. The CRSS can address many of the "what if" questions stemming from proposed changes in the Colorado River's operations, from proposed Colorado River basin development or from changes to present water use throughout the basin. The model's long-term estimates are widely accepted by water resource managers. The short-term estimates, between 5 and 10 years, are considered to be somewhat less precise.

The model produces data on a monthly basis, whereas the EIS team needed hourly projections in order to make their analyses for the fluctuating flow alternatives. The steady flow alternatives did not require this analysis because they provide for essentially steady monthly flows. To make the necessary adjustments for analyzing the fluctuating flows, a peak-shaving model was used to calculate the hourly distributions from the CRSS-projected monthly release volumes. (Peak shaving is the concept whereby hydroelectric powerplants are used to serve (shave) the highest electric load (peak) during a 24-hour period.) These hourly distributions were produced for the No-Action and Maximum Powerplant Capacity alternatives and for each of the restricted fluctuating flow alternatives.

The combined outputs of the CRSS model and the peak-shaving model were then used in the development of a sand-mass balance model. This model used 85 different hydrological scenarios (for 50 years each) to estimate the changes in riverbed sand due to differing flow alternatives from the Glen Canyon Dam. Using regression analysis, the sediment team calculated a sand-load discharge rating curve using the water flow rate as the independent variable and total sand load as the dependent variable. This curve shows the amount of sediment transported for any given discharge rate. The sand-load discharge rating curves were used as input into the 85 water release scenarios to determine the probability that a given flow alternative would result in higher amounts of sand in the riverbed over 20- and 50-year periods. EIS team members stated that the resulting numbers were reasonably accurate indicators of the relative differences between the nine flow alternatives considered in the EIS.

Effects of Flow Alternatives on Sediment

According to the final EIS, the type of water release pattern selected for the dam's operations will greatly affect sediment. The analysis of the impacts on sediment was limited to the Colorado River corridor from Glen Canyon Dam to Lake Mead and the deltas in Lake Powell and Lake Mead. The direct impacts on sediment will vary with the level and pattern of riverflow. The direct impacts include changes in riverbed sand storage, aggradation (the process of filling and raising the level of a streambed, flood plain, or sandbar by the deposition of sediment) and degradation (the process wherein the elevation of streambeds, flood plains, and sandbars is lowered by erosion) of sandbars, and changes in the capacity to move large boulders from rapids. Future levels of riverbed sand will vary depending on the amount of riverbed sand available and the water volume and release patterns of the alternative implemented.

On the basis of the results of computer models and the most recent scientific research, the EIS sediment team determined what the potential impacts of the various alternatives would be:

- The No-Action, Maximum Powerplant Capacity, and High Fluctuating Flow alternatives all had excessive sand transport capacity, which jeopardized the long-term storage of sediment.
- The Interim Low Fluctuating Flow, Existing Monthly Volume, and Year-Round Steady Flow alternatives all maximized long-term sand storage but provide limited ability to build sandbars. These alternatives would result in vegetation encroachment on sandbars and net erosion of sandbars above the normal river stage.
- The Seasonally Adjusted Steady Flow, the Moderate Fluctuating Flow, and the Modified Low Fluctuating Flow alternatives all provided long-term sand storage and system dynamics.

On the basis of this analysis, the sediment team focused on the Seasonally Adjusted Steady Flow, the Moderate Fluctuating Flow, and the Modified Low Fluctuating Flow alternatives as the ones that would provide preferable potential impacts on sediment.

Assessment of Impact Determinations

The EIS team members and sediment researchers whom we contacted provided us with comments on a variety of subjects, including the sand-mass balance model, the quality of the data used, the accuracy of the EIS in reflecting the research data, and whether other evidence existed that would change the impact determinations in the EIS. Generally, they agreed that the sand-mass balance model was the best modeling tool available at the time, although two researchers told us that more refined models are currently being developed by U.S. Geological Survey researchers. However, according to two Geological Survey researchers, none of the preliminary results from these newer models contradict the conclusions reached from the sand-mass balance model.

The researchers we spoke to generally complimented the way Reclamation interpreted and used their work in the impact determination process and said that the quality of the data used was the best available at the time. A limitation on the use of the more recent research results was that the data were preliminary (in draft form or unpublished) and the newer models were too complex to simulate multiple years of dam operations. In some cases, definitive information on the impacts of a specific flow alternative was not available. Therefore, the team had to extrapolate from the existing data using their professional judgment to estimate the potential impact of the alternative. However, they always verified the reasonableness of their conclusions and extrapolations with the researchers involved.

The officials we contacted also agreed with Reclamation's selection of a preferred alternative and could find no evidence to change the outcomes of the impact determinations for the sediment resource.

Specific comments made by some of those with whom we spoke included the following:

- Some commentors described the sand-mass balance model as simplistic or fairly crude. However, they agreed that it was the best and only tool available at the time. Also, they agreed that the impact determinations reached as a result of the model were correct. The leader of the sediment team agreed that the sand-mass balance model is simplistic, but he believed it produced reliable results for general, long-term information needs. He did not think that any other model now available would have been better. In fact, he stressed that the models available today cannot handle the amount and types of data that were required for the EIS process.

- Some commentors believed that the sediment information in the EIS was somewhat out of date in that it reflected the scientific data of 1992-93. However, there was a general belief that the EIS team did an excellent job of using the latest sediment research. While more is known about the sedimentation processes in the canyon today than was known when the EIS was written, the EIS does contain the best information available at the time. Also, they told us that even if the newer data had been available, the same decisions would have been reached. The discontinuity between the research and the administrative time frames was a limitation on the EIS process, but they said that the only impact would have been changes in some of the statements made in the EIS. For example, they said that the reasons for the selection of the preferred alternative would have been more clearly supported.
- Most of the researchers we contacted believed that their work was properly used and interpreted in the EIS. With only a few exceptions, discussions and communication between the EIS team and the researchers were frequent and thorough enough to ensure that the work was properly integrated into the EIS. Consequently, the researchers believe that the sediment team came up with the right conclusions. We found no examples that would contradict or change the impact determinations in the EIS or the selection of a preferred alternative. According to one researcher, the sediment team examined all of the existing professional papers and "followed up every lead, public or private, for additional work."

The sediment team leader's overall position, taking into consideration the various perspectives and opinions expressed, was that

- the process used in making the impact determinations for sediment was reasonable,
- the methodologies employed in this process were appropriate, and
- the data used were the best available.

Scope and Methodology

To determine the process used in developing the impacts on the sediment resource, we identified and reviewed the following documents: the draft and final Glen Canyon Dam environmental impact statements and associated appendixes, the public comments on the draft and final environmental impact statements, and Reclamation's responses to the comments on the draft. We obtained and reviewed copies of the minutes from the EIS team meetings and summaries of the cooperating agencies' meetings. We also reviewed the Colorado River Simulation System Overview, the Final Analysis Report on Scoping Comments, the Glen

Canyon Dam EIS Preliminary Alternatives Report, and the newsletters issued by the Colorado River Studies Office from June 1990 to February 1995. We also obtained and studied the Glen Canyon Dam: Beach/Habitat-Building Test Flow, Final Environmental Assessment and Finding of No Significant Impact, issued in February 1996.

In addition, we reviewed the paper entitled "Sediment Transport in the Colorado River Basin" by Edmund D. Andrews. This paper was published in Colorado River Ecology and Dam Management by the National Academy of Sciences. This book contains various papers presented in a 1990 symposium on the Grand Canyon.

We also reviewed Reclamation's paper entitled "Assessment of Changes to the Glen Canyon Dam Environmental Impact Statement Preferred Alternative From Draft to Final EIS." This paper explained the background and scientific basis for the changes to the preferred alternative between the draft and the final EIS.

To assess the procedures followed and obtain views on the quality of data used in developing the impact determinations, we interviewed the members of the sediment resource team and reviewers of the sediment section of the draft EIS. We also identified and interviewed several key Glen Canyon Environmental Studies principal investigators on sediment issues.

Finally, we asked a member of the sediment team to review our description of the impact determination process for factual accuracy. He agreed that our description was generally accurate but made some suggestions for changes. We have incorporated these changes into our description of the process. We also presented him with our summary of the resource process in order to provide him with an opportunity to comment on and respond to the various issues raised through our audit work.

Key Studies Identified

Beaus, S.S., and C.C. Avery (editors). The Influence of Variable Discharge Regimes on Colorado River Sand Bars Below Glen Canyon Dam. Flagstaff, Arizona: Northern Arizona University, 1992.

Budhu, M. "Mechanisms of Erosion and a Model to Predict Seepage-Driven Erosion due to Transient Flow," in The Influence of Variable Discharge Regimes on Colorado River Sand Bars Below Glen Canyon Dam, S.S.

Beaus and C.C. Avery, editors. Flagstaff, Arizona: Northern Arizona University, 1992.

Ferrari, R.L. 1986 Lake Powell Survey. Bureau of Reclamation, Report no. REC-ERC-88-6, 1988.

Hereford, R., H.C. Fairley, K.S. Thompson, and J.R. Balsom. Surficial Geology, Geomorphology, and Erosion of Archeological Sites Along the Colorado River, Eastern Grand Canyon, Grand Canyon National Park, Arizona. U.S. Geological Survey Open-File Report 93-517, 1993.

Leopold, L.B. "The Rapids and the Pools—Grand Canyon." U.S. Geological Survey Professional Paper 669-D, 1969.

Pemberton, E.L. "Sediment Data Collection and Analysis for Five Stations on the Colorado River from Lees Ferry to Diamond Creek," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.

Randle, T.J., and E.L. Pemberton. "Results and Analysis of STARS Modeling Efforts of the Colorado River in Grand Canyon," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.

Randle, T.J., R.I. Strand, and A. Streifel. "Engineering and Environmental Considerations of Grand Canyon Sediment Management," Engineering Solutions to Environmental Challenges: Thirteenth Annual USCOLD Lecture, Chattanooga, Tennessee. Denver, Colorado: U.S. Committee on Large Dams, 1993.

Schmidt, J.C. "Temporal and Spatial Changes in Sediment Storage in Grand Canyon," The Influence of Variable Discharge Regimes on Colorado River Sand Bars Below Glen Canyon Dam, S.S. Beaus and C.C. Avery, editors. Flagstaff, Arizona: Northern Arizona University, 1992.

Schmidt, J.C., and J.B. Graf. "Aggradation and Degradation of Alluvial Sand Deposits, 1965 to 1986, Colorado River, Grand Canyon National Park, Arizona." U.S. Geological Survey Professional Paper 1493, 1990.

Smillie, G.M., W.L. Jackson, and D. Tucker. "Colorado River Sand Budget: Lees Ferry to Little Colorado River." National Park Service Technical

Report NPS/NRWRD/NRTR-92/12. Fort Collins, Colorado: National Park Service, 1993.

Webb, R.H., P.T. Pringle, and G.R. Rink. “Debris Flows From Tributaries of the Colorado River, Grand Canyon National Park, Arizona.” U.S. Geological Survey Professional Paper 1492, 1989.

Officials Interviewed

We interviewed the following individuals about the sediment impact determination.

Edmund (Ned) Andrews, U.S. Geological Survey, Boulder, Colorado
Julia Graf, U.S. Geological Survey, Tucson, Arizona
Bill Jackson, National Park Service, Ft. Collins, Colorado
Dick Marzolf, U.S. Geological Survey, Boulder, Colorado
Margaret Matter, Western Area Power Administration, Denver, Colorado
Timothy Randle, Bureau of Reclamation, Denver, Colorado
Spreck Rosekrans, Environmental Defense Fund
Jack Schmidt, Utah State University
James Smith, U.S. Geological Survey, Boulder, Colorado
Robert Webb, U.S. Geological Survey, Tucson, Arizona
James Wilson, U.S. Geological Survey, Cheyenne, Wyoming

Vegetation and Wildlife/Habitat

The resources downstream from Glen Canyon Dam through the Grand Canyon are interrelated, or linked, since virtually all of them are associated with or are dependent on water and sediment. This link is true for vegetation and wildlife and their habitat. The complex Grand Canyon ecosystem contains a variety of native and nonnative plants and animal communities that began developing before the construction of the dam. However, since the dam was completed, the ecosystem immediately surrounding the Colorado River has been significantly influenced by the operations of the dam.

We have combined our analysis of the vegetation and the wildlife/habitat impact determinations in this appendix because (1) with the exception of the abundance of aquatic food base for wintering waterfowl, similar indicators were studied in making the impact determinations for these resources; (2) the riparian vegetation that developed along the Colorado River corridor plays an important role as habitat to support the diversity of wildlife within the Glen and the Grand canyons; and (3) the same EIS team member was responsible for the impact determinations for both resources.

There has been little controversy surrounding the results of the impact determinations as presented in the final EIS for the vegetation and wildlife/habitat resources. Generally, the team leader and other experts we interviewed believed that the processes used in making the impact determinations were reasonable, the methodologies employed in these processes were appropriate, and the data used were the best available.

Description of the Resource

The plant communities surrounding the Grand Canyon reflect the influences of desert conditions. These plants include barrel cactus, brittle bush, creosote bush, ocotilla, and cholla cactus. The Colorado River and the operations of the Glen Canyon Dam have little effect on these plants. However, the dam's operations, which modified the natural hydrology within the Colorado River corridor, do affect a narrow band of vegetation known as the riparian (near water) zone. The availability of water in the riparian zone supports plants that could not otherwise survive in a desert climate, and the types and abundance of vegetation that exists reflect the water regime that supports it. Among the plants found in areas of the riparian zone are netleaf hackberry, honey mesquite, catclaw acacia, seep-willow, arrowweed, desert broom, coyote willow, and tamarisk.

The riparian zone is the focus of both the vegetation and the wildlife/habitat studies for the EIS. The thick growth and variety of plant species as well as the several thousand species of invertebrates found there make the riparian zone some of the most important wildlife habitat in the Grand Canyon region. For example, riparian plants provide cover and food for 26 species of mammals. Also, of the 303 species of birds that have been documented in the Grand Canyon region, 250 species use the riparian zone within the Colorado River corridor. Over half of the bird species nesting along the river corridor nest in riparian vegetation. Furthermore, 27 species of reptiles and amphibians are supported by the resources found in the riparian zone. In some Colorado River corridor locations, lizard population densities are higher than anywhere else in the Southwest.

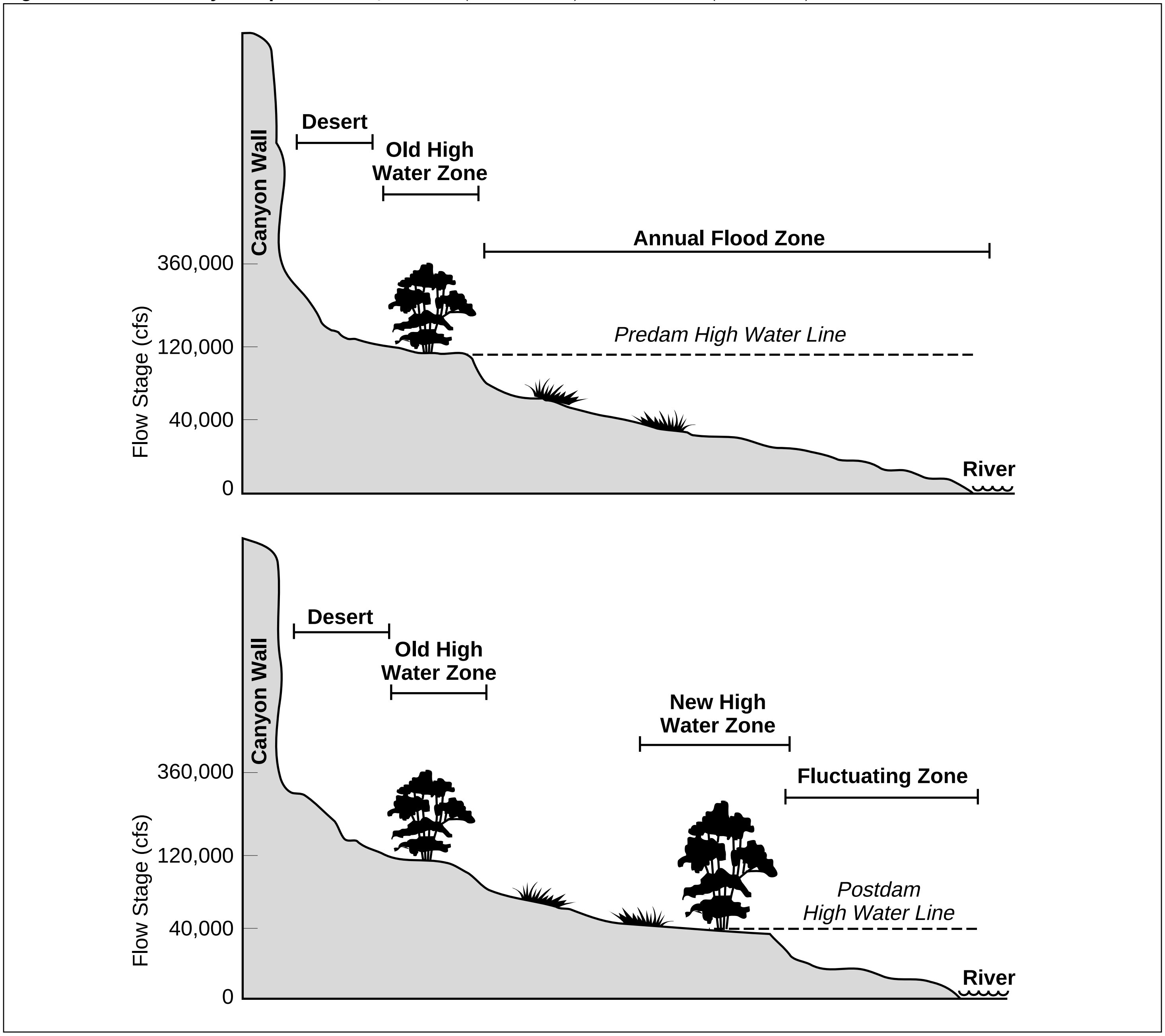
Also, during peak winter months, 19 species of wintering waterfowl have been found along the river corridor between Lees Ferry and Soap Creek. These waterfowl cannot be directly linked to riparian vegetation, but they are attracted to and use the clear, open, cold water of the Colorado River that resulted after the dam was constructed and that supports the abundant algae that are important to the aquatic food chain. Although survey data are not available, the EIS states that before the construction of the dam, the turbid river water was probably not very attractive to wintering waterfowl.

Effects of Pre- and Postdam Conditions on Vegetation and Wildlife/Habitat

Because of the dynamic interaction between riparian vegetation and water availability, the construction of the dam and any changes in its operations that change specific water release patterns would be expected to affect the abundance and distribution of plants. Before the Glen Canyon Dam was constructed, seasonally high riverflows carried large sediment deposits through the Glen and the Grand canyons and scoured away or buried most vegetation from the river corridor below the 100,000 to 125,000 cubic feet per second river stage elevation. Annual floodflows prevented the establishment of marsh plants (cattails and similar aquatic plants) along the river corridor. Before the dam, the only riparian vegetation present along the river was woody plants (trees and shrubs) that developed in what became known as the old high-water zone. Plants that can withstand the conditions created by periodic flooding characterize the old high-water zone—netleaf hackberry, honey mesquite, and catclaw acacia.

After the dam began operations and controlled annual spring flooding, additional vegetation began to develop near the river below the old high-water zone. This vegetation developed rapidly in what has become known as the new high-water zone. Within this new high-water zone are found both woody plants and emergent marsh plants (cattails and similar aquatic plants). Common woody plants found in the new high-water zone include both native and nonnative species such as the seep-willow, arrowweed, desert broom, coyote willow, and tamarisk. Tamarisk is a nonnative tree that has become the dominant woody plant in the new high-water zone. Besides cattails, emergent marsh plants found in the new high-water zone include bulrushes and giant reed. This new high-water zone provides over 1,000 acres of additional habitat for wildlife. Figure IX.1 illustrates the relative positions of the predam and postdam riparian zones in the Grand Canyon.

Figure IX.1: Grand Canyon Riparian Zone, Predam (Before 1963) **and Postdam** (After 1963)



Source: Bureau of Reclamation.

Issue

As developed in the final EIS, the issue of concern is how the dam's operations affect vegetation and wildlife and their habitat throughout the Glen and the Grand canyons.

Indicators

Two plant groups found in the Colorado River corridor—woody plants and emergent marsh plants—were selected by the EIS team for detailed evaluation and to serve as indicators of riparian vegetation. The impact determination for vegetation was generally limited to the Colorado River corridor that extends between the Glen Canyon Dam and Separation Canyon. Because of the variety of plants growing in the riparian zone and their differing water requirements, EIS team members concluded that a comprehensive evaluation of the effects of all of the dam's operating alternatives on all plants was beyond the scope of the EIS.

Although very little information on wildlife population exists for either the predam or postdam habitats found along the river corridor, it was assumed that almost all wildlife concerns could be addressed by considering the effects of the operating alternatives on riparian vegetation because it serves as habitat for many wildlife species that inhabit the river corridor. Thus, rather than make specific analyses of impacts on individual wildlife species, the EIS team assumed that almost all wildlife concerns could be addressed by considering the effects of each of the dam's alternative operating procedures on riparian vegetation. However, wintering waterfowl do not depend on riparian vegetation within the Colorado River corridor below the Glen Canyon Dam. Therefore, the EIS team used the abundance of the aquatic food base, mainly Cladophora, as an indicator for wintering waterfowl.

Methodology Used to Make Impact Determination

Reclamation designated a lead position for each resource and assigned that person the overall responsibility for developing the general impact determinations. For example, a riparian specialist was assigned for both the vegetation and wildlife/habitat resources. The riparian specialist developed his sections of the EIS through an iterative process of report drafting, formal and informal presentations to and review by the entire EIS team, and discussions with and input from key researchers and colleagues. In this process, it was important that the work of resource specialists responsible for other resource impact determinations be considered in the vegetation and wildlife/habitat analyses. For example, sediment is critical for supporting the riparian vegetation that provides wildlife habitat. Therefore, the impact determinations for the sediment resource are directly linked to the vegetation and wildlife and habitat resources and were used in the vegetation analyses. (See app. VIII for a discussion of the impact determinations for sediment.)

The riparian specialist prepared the vegetation and wildlife/habitat sections of the draft EIS and was responsible for any revisions to the EIS that were based on the 170 public comments received on these sections of the draft EIS (123 on vegetation and 47 on wildlife and habitat). In the preparation of material for the EIS impact determinations, he relied extensively on the research work of other scientists that was specific to the canyon's resources. For example, an ecologist, who is considered a leading authority on vegetation in the Grand Canyon region, was a major contributor of science-based information on the vegetation and wildlife and habitat resources of the canyon area. Key documented research considered by the riparian specialist in his analyses of impacts on vegetation and wildlife/habitat can be found in the scope and methodology section of this appendix.

The ecologist was also one of the peer reviewers of the impact determinations prepared by the riparian specialist. Others who reviewed the riparian specialist's work were a zoologist, who has done extensive fieldwork in the Glen Canyon, and a senior Glen Canyon Environmental Studies scientist affiliated with Arizona State University.

Effects of Flow Alternatives on the Resources

Summary of Impacts on Vegetation

According to the final EIS, in the short-term period of analysis, which was considered in the EIS to be between 5 and 20 years, the alternative operations of the Glen Canyon Dam would affect riparian vegetation within the river corridor in several different ways. While some plants do well in drier conditions, others require wetter conditions to survive. Some plants would likely decline as others adjusted to new water regimes. The reduced frequency of major, uncontrolled flood releases would result in an unknown, but assumed equal, decline in the area of coverage of riparian vegetation in the old high-water zone under all alternatives. Some plant species found in the old high-water zone would expand into the new high-water zone.

The Maximum Powerplant Capacity alternative would result in reduced areas of riparian vegetation in the new high-water zone because of the higher maximum flows permitted under this alternative. Under the No-Action alternative, woody plants within the new high-water zone would be maintained within stage boundaries equivalent to flows between about 22,000 cfs and 40,500 cfs. Periodic flooding that is similar to existing conditions would maintain emergent marsh vegetation at sites that are currently occupied at elevations between flows ranging from 10,000 cfs to 20,000 cfs.

Under alternatives with lower maximum flows—the restricted fluctuating and steady flow alternatives—new areas of sediment would be exposed, and these areas would be available for plant growth. These flow alternatives would all permit riparian vegetation to expand into sites created by the reduced maximum flows. Woody plants, such as coyote willow and arrowweed, found in the new high-water zone would continue to increase. Some new establishment of emergent marsh plants would occur at suitable sites; however, existing areas of emergent marsh plants that lose their water supply would become dominated by woody plants and eventually disappear.

The habitat maintenance flows included under the Moderate and Modified Low Fluctuating Flow alternatives and the Seasonally Adjusted Steady Flow alternative are assumed to affect the area available for vegetation, but the magnitude of the effect is unknown. Beach/habitat-building flows that restructure sediment deposits would disturb plants and interrupt succession in the riparian community. As a result of these flows, some woody vegetation would be buried and lost as sand is deposited on higher elevations, and patches of emergent marsh plants would be lost through scouring or burial. Both woody plants and emergent marsh vegetation would develop in the years following beach/habitat-building flows that would induce periodic changes in the combination of vegetation and open, bare areas.

In the long-term period of analyses (20 to 50 years), the differences among the alternatives would continue to develop. Because at least one major flood event is assumed to occur in the long term under the No-Action and Maximum Powerplant Capacity alternatives, riparian vegetation would decrease. However, woody and emergent marsh plants would recover after the flooding to a level comparable to baseline or no-action conditions. Also in the long term, riparian vegetation that is supported by

Lake Mead would increase by an unknown but assumed equal amount under all alternatives.

The restricted fluctuating and steady flow alternatives include measures to reduce the frequency of floods that would support increases in the coverage of woody plants at the end of the long-term period of analysis. Over the long term, habitat maintenance and beach/habitat-building flows would maintain woody and emergent marsh plants that developed during the short term. The dryer conditions created in the upper elevations of the new high-water zone would shift species composition from tamarisk and willow to mesquite and other plants. Tamarisk, willow, and other plants would favor the wetter sites at lower elevations.

Summary of Impacts on Wildlife/Habitat

According to the final EIS, wildlife and habitat would be affected in ways similar to riparian vegetation under the operating alternatives, i.e., those dam-operating alternatives that tend to increase riparian vegetation would result in increased wildlife habitat. In the short term, woody plant coverage, and therefore riparian habitat, would increase under most alternatives. Emergent marsh plants would either remain similar in coverage to the no-action condition or decrease.

The No-Action alternative would maintain the existing riparian vegetation area, while the Maximum Powerplant Capacity alternative would create conditions leading to a decline in habitat area. The remaining alternatives would permit woody riparian vegetation to expand. It is assumed that as the area of woody riparian vegetation increases, so too will the size of the area of wildlife habitat that would provide valuable food resources and shelter. Habitat maintenance and beach/habitat-building flows would move and deposit sediment that would bury some vegetation, thus temporarily reducing its value as habitat. Vegetation that is not buried or that grows up through new sediment deposits would be unusable to area wildlife during the period of inundation.

Generally, individual animals would not be directly affected by the daily operations of the Glen Canyon Dam because animals are mobile and would move as required by the daily fluctuations in water releases. Birds using the riparian zone as a travel lane through the Grand Canyon would not be directly affected by any of the alternatives. However, species that nest in riparian vegetation would be indirectly affected by changes in area coverage of plants.

Wintering waterfowl would be affected by changes in minimum discharge. The No-Action and Maximum Powerplant Capacity alternatives have a minimum discharge of 1,000 cfs. The remaining alternatives increase minimums from 3,000 cfs to 11,400 cfs. Increased minimum discharges, as well as brief high release periods during habitat maintenance and beach/habitat-building flows, are assumed to benefit the aquatic food base and ultimately wintering waterfowl.

Assessment of Impact Determinations

EIS team members and researchers we contacted were generally complimentary of the process used in making the impact determinations of the dam's various operating procedures on the vegetation and the wildlife/habitat resources. Also, scientists we interviewed believed that the data used in the analyses were the best and most current available at the time and that the research used in the analyses was properly interpreted. While some scientists believe that some data may have been incomplete at the time the EIS segments were prepared, subsequent research only served to confirm and refine the analyses presented in the final EIS. Therefore, according to one official, there was little controversy associated with these resources and the presentation of impact determinations in the EIS. This opinion seems to be supported by the relatively low number of comments received on the draft EIS in connection with these resources.

Also, many people we talked to were supportive of the preferred alternative selected by Reclamation. There were, however, some concerns expressed. For example, one researcher believed that to further improve the aquatic food base, the Seasonally Adjusted Steady Flow may be a more advantageous operating regime. However, the riparian specialist disagreed with the researchers who favored the Seasonally Adjusted Steady Flow because he believes that the preferred alternative provides for higher water levels during the summer months, which would be more beneficial to plants that are important as an aquatic food base. Overall, he believes that the preferred alternative was the proper choice and that it would create conditions that permit the recovery of downstream resources to acceptable management levels while maintaining some hydropower capability. Overall, the riparian specialist believed that the results of the impact determinations for the vegetation and wildlife/habitat resources were reasonable. The riparian specialist thought that the methodology used in making the impact determinations was appropriate and properly implemented and the data used were the best available.

Scope and Methodology

Our analyses of the impact determinations on the vegetation and wildlife/habitat resources were based on an evaluation of scientific studies used by the riparian specialist in his assessments, the study review process used, the impact determinations themselves, and extensive interviews with officials involved in the process. In addition, we provided the riparian specialist with our description of the processes followed in making the impact determinations for his review and comment. He agreed that our description accurately presented the facts.

Key Studies Identified

We reviewed the following studies and research materials that Reclamation officials said were instrumental in making EIS decisions:

- Anderson, L.S., and G.A. Ruffner. "Effects of Post-Glen Canyon Flow Regime on the Old High Water Line Plant Community Along the Colorado River in Grand Canyon," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.
- Carothers, S.W., and B.T. Brown. "The Colorado River Through Grand Canyon: Natural History and Human Change." Tucson, Arizona: University of Arizona Press, 1991.
- Pucherelli, M.J. "Evaluation of Riparian Vegetation Trends in the Grand Canyon Using Multitemporal Remote Sensing Techniques," pp. 172-181. Anchorage, Alaska: American Society of Photogrammetry and Remote Sensing Technical Papers, 1986.
- Stevens, L.E., and T. J. Ayers. "The Impacts of Glen Canyon Dam on Riparian Vegetation and Soil Stability in the Colorado River Corridor, Grand Canyon, Arizona," Draft Annual Report. National Park Service Cooperative Studies Unit. Northern Arizona University, Flagstaff, Arizona. 1991.
- Stevens, L.E., J.C. Schmidt, and B.T. Brown. "Geomorphic Control of Vegetation Establishment and Marsh Development Along the Colorado River in Grand Canyon, Arizona," in AGU 1991 Fall Meeting Program and Abstracts. American Geophysical Union EOS Transactions, supp. to vol. 72, No. 44, p. 223, 1991.
- Stevens, L.E., and G.L. Waring. "Effects of Post-Dam Flooding on Riparian Substrates, Vegetation, and Invertebrate Populations in the Colorado River Corridor in Grand Canyon, Arizona," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1986.

In addition to the above studies, which directly addressed vegetation resources, we examined the following other relevant documents in the wildlife and habitat resource area:

- Threatened Native Wildlife in Arizona. Phoenix, Arizona: Arizona Game and Fish Department, 1988.
- Brown, B.T. "Monitoring Bird Population Densities Along the Colorado River in Grand Canyon," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1987.
- _____. Abundance, Distribution, and Ecology of Nesting Peregrine Falcons in Grand Canyon National Park, Arizona. Final report submitted to Grand Canyon National Park, Grand Canyon, Arizona, 1991b.
- _____. Nesting Chronology, Density, and Habitat Use of Black-Chinned Hummingbirds Along the Colorado River, Arizona, 1991c.
- Brown, B.T., R. Mesta, L.E. Stevens, and J. Weisheit. "Changes in Winter Distribution of Bald Eagles Along the Colorado River in Grand Canyon, Arizona," Journal of Raptor Research, vol. 23, No. 3, pp. 110-113, 1989.
- Brown, B.T., G.S. Mills, R.L. Glinski, and S.W. Hoffman. "Density of Nesting Peregrine Falcons in Grand Canyon National Park, Arizona," Southwestern Naturalist, Vol. 37, No. 2, pp. 188-193, 1992.
- Jakle, M.D., and T.A. Gatz. "Herpetofaunal Use of Four Habitats of the Middle Gila River Drainage, Arizona," Riparian Ecosystems and Their Management: Reconciling Conflicting Uses, R.R. Johnson et al. (technical coordinators). Forest Service General Technical Report RM-120, pp. 355-358, 1985.
- Jones, K.B., and P.C. Glinski. "Microhabits of Lizards in a Southwestern Riparian Community," Riparian Ecosystems and Their Management: Reconciling Conflicting Uses, R.R. Johnson et al. (technical coordinators). Forest Service General Technical Report RM-120, pp. 342-346, 1985.
- Warren, P.L., and C.R. Schwalbe. "Lizards Along the Colorado River in Grand Canyon National Park: Possible Effects of Fluctuating River Flows," Glen Canyon Environmental Studies Technical Report. Salt Lake City, Utah: Bureau of Reclamation, 1988.
- Wilson, M.F., and S.W. Carothers. "Avifauna of Habitat Islands in the Grand Canyon," Southwestern Naturalist, Vol. 24, No. 4, pp. 563-576, 1979.

Officials Interviewed

In addition to the riparian specialist, we interviewed 11 other EIS team members and researchers from the government, private, and academic sectors. A listing of the officials we contacted and the organizations they represent follows.

Michael Armbruster, Bureau of Reclamation, Denver, Colorado
Steven W. Carothers, SWCA Inc., Flagstaff, Arizona
Byran Brown, SWCA Inc., Salt Lake City, Utah
Duncan Patten, Arizona State University (Retired), Tempe, Arizona

Larry Stevens, Glen Canyon Environmental Studies, Flagstaff, Arizona
Dean W. Blinn, Northern Arizona University, Flagstaff, Arizona
Tina Ayers, Northern Arizona University, Flagstaff, Arizona
Michael Pucherelli, Bureau of Reclamation, Denver, Colorado
Susan Anderson, The Nature Conservancy, Tucson, Arizona
William Leibfried, SWCA Inc., Flagstaff, Arizona
David Wegner, Glen Canyon Environmental Studies, Flagstaff, Arizona
Mark Sogge, National Biological Service, Flagstaff, Arizona

Water

The construction of the Glen Canyon Dam altered the historical flow pattern of the Colorado River and the characteristics of the water being discharged downstream. While different water flow alternatives would alter the pattern of water that is released from the dam, existing statutes, compacts, a treaty, and operating criteria guide the allocation of water to the seven basin states.[1] Currently, these laws, known collectively as the "Law of the River," establish minimum annual releases of water from the Glen Canyon Dam.

The area of potential impact for the resource water includes the Colorado River downstream from the Glen Canyon Dam, Lakes Powell and Mead, and the upper and lower basin states. These impacts include annual streamflows, reservoir storage, water allocation deliveries, upper basin state yield determinations, and water quality. The EIS team used computer modeling studies to project the dam's operations for 50 years to estimate the long-term impacts and for 20 years to estimate the short-term impacts.

The EIS team found that the impacts on water issues of the dam's various flow alternatives are essentially the same as under the No-Action alternative, except for the volume of monthly water releases and floodflow frequency. The annual streamflows, reservoir storage, water allocation deliveries, upper basin yield determinations, and water quality are only slightly affected by the alternatives.

The EIS team members and researchers we spoke with were confident that the computer modeling tools and the data used in the analyses were the best available at the time. Also, while some researchers believed that the maximum flow parameters under the preferred alternative should be increased, there was general acceptance of the selection of the Modified Low Fluctuating Flow as the preferred alternative.

Description of the Resource

Most of the Colorado River water flowing into Lake Powell and ultimately released into the Glen and the Grand canyons originates in the Rocky Mountains. Runoff from spring snowmelt in the Rockies is high during April through July, when the flow in the Colorado River above Lake Powell reaches its annual maximum, then recedes for the remainder of the year. During the summer and fall, thunderstorms cause flooding in the tributaries originating on the Colorado Plateau, producing additional peaks in the river, but they are usually smaller than the snowmelt peaks

[1]The basin states consist of the upper basin—which covers parts of Arizona, Colorado, New Mexico, Utah, and Wyoming; and the lower basin—which covers parts of Arizona, California, Nevada, New Mexico, and Utah.

and of much shorter duration. Since the Glen Canyon Dam was completed in 1963, flows immediately below the dam have consisted almost entirely of water released from Lake Powell.

For purposes of the resources addressed in the EIS, water was described in terms of streamflows, floodflows, reservoir storage, annual water allocation deliveries, upper basin state yield determinations, and water quality:

- The annual streamflows are determined by the Law of the River, which currently requires a minimum annual release of 8.23 million acre-feet of water from the Glen Canyon Dam.
- Floodflows are defined as releases in excess of the powerplant capacity of 33,200 cubic feet per second (cfs).
- The reservoir storage in Lakes Powell and Mead depends on annual and monthly reservoir inflow and release volumes. Storage levels affect shore line resources and recreation on the lake. Furthermore, the upper basin states use storage in Lake Powell to meet their water delivery requirements to the lower basin states.
- The water allocation deliveries are the deliveries of Colorado River water to entities in the seven basin states and Mexico in accordance with the Law of the River. In recent years, the demand for water by the lower basin states has approached their entitlement of 7.5 million acre-feet.
- The upper basin state yield determination is the legal maximum volume of water available for annual use by the upper basin states.
- The Glen Canyon Dam altered downstream water quality by changing the water's temperature and clarity.

Effects of Pre- and Postdam Conditions on Water

Before construction of the Glen Canyon Dam, the Colorado River was sediment-laden, and its flows fluctuated dramatically during different seasons of the year. Flows of greater than 80,000 cfs were common during the spring. In contrast, flows of less than 3,000 cfs were typical throughout the late summer, fall, and winter. The water temperatures ranged from near freezing in the winter to more than 80 degrees Fahrenheit in the summer.

The construction of the Glen Canyon Dam altered the natural dynamics of the Colorado River. The dam replaced seasonal flow variations with daily fluctuations and greatly reduced the amount of sediment in the river. Lake Powell now accumulates the sediment that would have traveled the Colorado River before the dam's construction. In addition, the water released from the dam to produce hydropower is withdrawn from the cold depths of Lake Powell, 230 feet below the surface when the reservoir is full. As a result of this water withdrawal process, the water temperature downstream of the dam is nearly a constant, year-round 46 degrees Fahrenheit.

The quality of the water has also been affected. Most of the nutrients carried by the river are associated with or attached to sediments, and sediments are now trapped by the dam. Variations in the levels of salinity in the water have also been reduced.

Issue

As defined in the final EIS, the issue of concern for water resources is how the dam's operations affect the amount and quality of water available from Lake Powell at specific times.

Indicators

The indicators for water resources listed in the final EIS are the

- acre-feet of streamflows,
- frequency and volume of floodflows,
- reservoir storage in Lakes Powell and Mead,
- acre-feet of annual water allocation deliveries (deliveries of Colorado River water to entities in the seven basin states and Mexico),
- acre-feet of upper basin state yield determination (hydrologic assessment of the total water depletion that can ultimately be allowed in the upper basin), and
- chemical, physical, and biological characteristics of water quality.

Methodology Used to Make Impact Determinations

Reclamation established a water resource team to make the impact determinations for the EIS. The team consisted of two hydraulic engineers from Reclamation; one was a water resource and an environmental specialist, and the other was a water quality specialist.

The water resource specialist was assigned the responsibility for the hydrology impact assessment and provided information on the Colorado River's operations. He wrote the background sections for the water resource area and helped write the technical descriptions of the various alternatives presented in the EIS. The water quality specialist was responsible for water quality issues in the EIS.

The team used the Colorado River Simulation System (CRSS) to analyze the impacts of the nine flow alternatives on the annual and monthly streamflows, floodflows and other spills, water storage, water allocation deliveries, and upper basin yield determinations for the EIS. CRSS, a package of computer programs and databases, is widely regarded as the most comprehensive and detailed simulation system of the Colorado River. CRSS is designed to assist water resource managers in performing long-range planning and operation studies.

The CRSS database contains reconstructed natural flow data from the U.S. Geological Survey for the Colorado River during 1906 through 1990. The CRSS model can simulate the operations of the Colorado River, including the effects of changes to the operation of the Glen Canyon Dam. The modeling process begins with the assumption that the previous natural flows in the river are indicative of future activity. Thus, the model uses historical data to project water availability in the future. The CRSS can address many of the “what if” questions stemming from proposed changes in the Colorado River’s operations, from proposed development in the Colorado River Basin, or from changes to present water use throughout the basin. The model’s estimates are widely accepted by water resource managers.

CRSS produces data on a monthly basis; therefore, a peak-shaving model was used to predict hourly distribution from the CRSS-projected monthly release volumes. (Peak shaving is the concept whereby hydroelectric powerplants are used to serve (shave) the highest electric load (peak) during a 24-hour period.) These hourly distributions were produced for the No-Action and the Maximum Powerplant Capacity Flow alternatives and for each of the restricted fluctuating flow alternatives. The hourly projections were needed to develop and analyze the effects of fluctuating flows on sediment and other resources. The steady flow alternatives did not require this analysis because flows from hour to hour would be essentially steady.

The water resource specialist developed the technical analyses of the alternatives using the CRSS model. The technical development of the alternatives was an iterative process, whereby the team presented the results of the modeling program at the EIS team meetings; the EIS team would then analyze and discuss the information to determine what additional adjustments to the alternatives were needed. Using the CRSS program, the water resource specialist calculated various parameters for each alternative, including annual releases, monthly releases, reservoir storage, water allocation yield, and floodflows. The EIS team members then prepared impact analyses of each alternative for the various resource areas. Their analyses were based on the CRSS results, preliminary data from various research projects, and their professional judgment. The results of the impact analyses were presented and discussed at the EIS team meetings.

Effects of the Flow Alternatives on Water

According to the final EIS, the annual streamflows would differ only slightly from the No-Action alternative under all alternatives and are therefore not expected to affect the distribution of water among the basin states. Under the restricted fluctuating and steady flow alternatives, the measures included for reducing the frequency of floods would reduce the frequency of unscheduled floodflows that are greater than 45,000 cfs from an average of once in 40 years to once in 100 years. Other spills would differ only slightly from the No-Action alternative under all other alternatives.

Reservoir storage under all fluctuating flow alternatives would be essentially the same as under the No-Action alternative. Water allocation deliveries would be affected slightly under all alternatives. However, if reserving more space in the reservoir is used to reduce flood frequency, the amount of water available for use by the upper basin states would be reduced. None of the alternatives affect water quality under normal reservoir levels, which occur 95 percent of the time.

Assessment of Impact Determinations

The CRSS model is widely accepted as the best method available for analyzing the effects of changes to the operations of the Glen Canyon Dam. The officials and researchers we interviewed generally stated that the CRSS model was the best method available at the time for analyzing and describing the various alternatives. Some alternative modeling programs did exist; however, EIS team members told us they would not have produced significantly different results.

The EIS team members and researchers we spoke with generally support the preferred alternative. Two reasons cited were that the alternative (1) strikes a balance for the resources at Glen Canyon Dam and (2) represents a reasonable compromise among the various interest groups. However, two researchers believe that the preferred alternative's operating parameters are still too conservative, even after they were increased following public comment on the draft EIS. They told us that higher maximum releases and higher fluctuating flows are needed and that adaptive management will show that the higher flows are acceptable. They stated that compromises made for the benefit of environmental issues may have gone too far because one-third of the hydropower capacity of the dam was lost.

In addition, none of the EIS team members or researchers we interviewed provided any data or research that would change the conclusions reached by the EIS team.

The team's water resource specialist provided us with his responses to the issues and comments noted above. He agreed with the comments, especially noting that the preferred alternative was a reasonable compromise and that adaptive management may lead to less restrictive flows. He stated that

- the process used in making the impact determinations for the water resource was reasonable,
- the methodologies employed in this process were appropriate, and
- the data used were the best available.

Scope and Methodology

To determine the process used to develop the flow alternatives, we identified and reviewed the following documents.

Key Studies Identified

Key documents we reviewed were the draft EIS and final EIS and associated appendixes, the public comments on the draft EIS and final EIS, and Reclamation's responses to the comments on the draft EIS. We also obtained and reviewed copies of the minutes of the EIS team meetings and summaries of the cooperating agencies' meetings. We studied the Colorado River Simulation System Overview prepared by Reclamation and the Glen Canyon Environmental Studies chapter prepared by the Power Resources Committee. We also reviewed the Final Analysis Report on Scoping Comments, the Glen Canyon Dam EIS Preliminary Alternatives Report, and the newsletters issued by the Colorado River Studies Office from June 1990 to February 1995. We also obtained and studied the Glen Canyon Dam: Beach/Habitat-Building Test Flow, Final Environmental Assessment and Finding of No Significant Impact, issued in February 1996.

We also reviewed three papers presented at a 1990 symposium on the Grand Canyon (published in Colorado River Ecology and Dam

Management by the National Academy of Sciences in 1991). These papers were "Sediment Transport in the Colorado River Basin" by Edmund D. Andrews, "Hydrology of Glen Canyon and the Grand Canyon" by David R. Dawdy, and "Reservoir Operations" by Trevor C. Hughes.

Furthermore, we reviewed "Assessment of Changes to the Glen Canyon Dam Environmental Impact Statement Preferred Alternative from Draft to Final EIS," issued by Reclamation in October 1995. This paper explained the background and scientific basis for the changes to the preferred alternative between the draft and final EIS.

EIS team members stated that the documents generated using the CRSS model were key to the development of the water resource area. Appendix VIII of this report contains a list of those documents. Another document that was identified as important to the process was Hydrologic Determination 1988: Water Availability From Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico. Salt Lake City, Utah: Bureau of Reclamation, 1989.

Officials Interviewed

To assess the procedures followed and obtain views on the quality of the data used in developing the flow alternatives, we interviewed the water resource team and the internal and external reviewers of the work. Finally, we asked the EIS team's water resource specialist to review our description of the impact determination process for factual accuracy. He agreed that our description was generally accurate but made some suggestions for changes. We have incorporated these changes into our process description. A list of the officials we interviewed follows.

Trevor Hughes, Utah State University/National Research Council
William Lewis Jr., University of Colorado-Boulder/National Research Council
Margaret Matter, Western Area Power Administration, Denver, Colorado
Randy Peterson, Bureau of Reclamation, Salt Lake City, Utah
Craig Phillips, Bureau of Reclamation, Denver, Colorado
Tim Randle, Bureau of Reclamation, Denver, Colorado
Spreck Rosekrans, Environmental Defense Fund
Thomas Slater, Bureau of Land Management, Salt Lake City, Utah
Leslie Stillwater, Bureau of Reclamation, Denver, Colorado

Summary Comparison of the Alternatives and Impacts as Presented in the Glen Canyon Dam's Final Environmental Impact Statement

	No Action	Maximum Powerplant Capacity	High Fluctuating Flow	Moderate Fluctuating Flow
WATER				
Streamflows (1,000 acre-feet)				
Annual streamflows				
Median annual release	8,573	8,573	8,559	8,559
Monthly streamflows (median)				
Fall (October)	568	568	568	568
Winter (January)	899	899	899	899
Spring (May)	587	587	592	592
Summer (July)	1,045	1,045	1,045	1,045
SEDIMENT				
Riverbed sand (percent probability of net gain)				
After 20 years	50	49	53	61
After 50 years	41	36	45	70
Sandbars (feet)				
Active width	44 to 74	47 to 77	33 to 53	28 to 47
With habitat maintenance flows				41 to 66
Potential height	10 to 15	10 to 16	7 to 11	6 to 10
With habitat maintenance flows				9 to 14
FISH				
Aquatic food base	Limited by reliable wetted perimeter	Same as no action	Minor increase	Moderate increase
Native fish	Stable to declining	Same as no action	Same as no action	Same as no action
Non-native warmwater and coolwater fish	Stable to declining	Same as no action	Same as no action	Same as no action
Interactions between native and non-native fish	Some predation and competition by non-natives	Same as no action	Same as no action	Same as no action
Trout	Stocking-dependent	Same as no action	Same as no action	Increased growth potential, stocking-dependent

Modified Low Fluctuating Flow	Interim Low Fluctuating Flow	Existing Monthly Volume Steady Flow	Seasonally Adjusted Steady Flow	Year-Round Steady Flow
8,559	8,559	8,559	8,554	8,578
568 899 592 1,045	568 899 592 1,045	568 899 592 1,045	492 688 1,106 768	699 703 699 699
64 73	69 76	71 82	71 82	74 100
24 to 41 41 to 66 6 to 9 9 to 14	24 to 41 6 to 9	10 to 19 3 to 5	16 to 29 37 to 60 4 to 7 8 to 13	0 0 to 1
Potential major increase	Potential major increase	Major increase	Major increase	Major increase
Potential minor increase	Potential minor increase	Uncertain potential minor increase	Uncertain potential major increase	Uncertain potential minor increase
Potential minor increase	Potential minor increase	Potential minor increase	Potential minor increase	Potential minor increase
Potential minor increase in warm, stable microhabitats	Potential minor increase in warm, stable microhabitats	Potential minor increase in warm, stable microhabitats	Potential minor increase in warm, stable microhabitats	Potential minor increase in warm, stable microhabitats
Increased growth potential, stocking-dependent	Increased growth potential, stocking-dependent	Increased growth potential, possibly self-sustaining	Increased growth potential, possibly self-sustaining	Increased growth potential, possibly self-sustaining

	No Action	Maximum Powerplant Capacity	High Fluctuating Flow	Moderate Fluctuating Flow
VEGETATION				
Woody plants (area)				
New high water zone	No net change	0 to 9% reduction	15 to 35% increase	23 to 40% increase
With habitat maintenance flows				0 to 12% increase
Species composition	Tamarisk and others dominate	Tamarisk and others dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate
Emergent marsh plants				
New high water zone				
Aggregate area of wet marsh plants	No net change	Same as no action	Same as or less than no action	Same as or less than no action
WILDLIFE AND HABITAT				
Riparian habitat	*See vegetation.*			
Wintering waterfowl (aquatic food base)	Stable	Same as no action	Same as no action	Potential increase
ENDANGERED AND OTHER SPECIAL STATUS SPECIES				
Humpback chub	Stable to declining	Same as no action	Same as no action	Same as no action
Razorback sucker	Stable to declining	Same as no action	Same as no action	Same as no action
Flannelmouth sucker	Stable to declining	Same as no action	Same as no action	Same as no action
Bald eagle	Stable	Same as no action	Same as no action	Potential increase
Peregrine falcon	No effect	No effect	No effect	No effect
Kanab ambersnail	No effect	Some incidental take	Some incidental take	Some incidental take
Southwestern willow flycatcher	Undetermined increase	Same as no action	Same as no action	Same as no action

Modified Low Fluctuating Flow	Interim Low Fluctuating Flow	Existing Monthly Volume Steady Flow	Seasonally Adjusted Steady Flow	Year-Round Steady Flow
30 to 47% increase	30 to 47% increase	45 to 65% increase	38 to 58% increase	63 to 94% increase
0 to 12% increase			0 to 12% increase	
Tamarisk, coyote willow, arrowweed, and camelthorn dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate	Tamarisk, coyote willow, arrowweed, and camelthorn dominate
Same as or less than no action	Same as or less than no action	Less than no action	Less than no action	Less than no action
Potential increase	Potential increase	Potential increase	Potential increase	Potential increase
Potential minor increase	Potential minor increase	Uncertain potential minor increase	Uncertain potential major increase	Uncertain potential minor increase
Potential minor increase	Potential minor increase	Uncertain potential minor increase	Uncertain potential minor increase	Uncertain potential minor increase
Potential minor increase	Potential minor increase	Uncertain potential minor increase	Uncertain potential major increase	Uncertain potential minor increase
Potential increase	Potential increase	Potential increase	Potential increase	Potential increase
No effect	No effect	No effect	No effect	No effect
Some incidental take	Some incidental take	Some incidental take	Some incidental take	Some incidental take
Same as no action	Same as no action	Same as no action	Same as no action	Same as no action

	No Action	Maximum Powerplant Capacity	High Fluctuating Flow	Moderate Fluctuating Flow
CULTURAL RESOURCES				
Archeological sites (number affected)	Major (336)	Major (336)	Potential to become major (263)	Moderate (Less than 157)
Traditional cultural properties	Major	Same as no action	Potential to become major	Moderate
Traditional cultural resources	Major	Same as no action	Same as no action	Increased protection
AIR QUALITY				
Regional air quality				
Total emissions (thousand tons)				
Sulfur dioxide	1,960	Same as no action	Slight reduction	Slight reduction
Nitrogen oxides	1,954			
RECREATION				
Fishing				
Angler safety	Potential danger	Same as no action	Same as no action	Moderate improvement
Day rafting				
Navigation past 3-Mile Bar	Difficult at low flows	Same as no action	Negligible improvement	Major improvement
White-water boating				
Safety	High risk at very high and very low flows	Same as no action	Negligible improvement	Minor improvement
Camping beaches (average area at normal peak stage)	Less than 7,720 square feet	Same as no action	Same as no action	Minor increase
Wilderness values	Influenced by range of daily fluctuations	Same as no action	Minor increase	Moderate increase
Economic benefits				
Change in equivalent annual net benefits (1991 nominal $ million)	0	0	0	+0.4
Present value (1991 $ million)	0	0	0	+4.6

Source: Bureau of Reclamation.

Modified Low Fluctuating Flow	Interim Low Fluctuating Flow	Existing Monthly Volume Steady Flow	Seasonally Adjusted Steady Flow	Year-Round Steady Flow
Moderate (Less than 157)	Moderate (Less than 157)	Moderate (Less than 157)	Moderate (Less than 157)	Moderate (Less than 157)
Moderate	Moderate	Moderate	Moderate	Moderate
Increased protection	Increased protection	Increased protection	Increased protection	Increased protection
Slight reduction	Slight reduction	Slight reduction	Slight reduction	Slight reduction
Moderate improvement	Moderate improvement	Major improvement	Major improvement	Major improvement
Major improvement	Major improvement	Major improvement	Major improvement	Major improvement
Minor improvement	Minor improvement	Moderate improvement	Potential to become major improvement	Major improvement
Minor increase	Minor increase	Major increase	Potential to become major increase	Major increase
Moderate to potential to become major increase	Moderate to potential to become major increase	Major increase	Major increase	Major increase
+3.7	+3.9	+3.9	+4.8	+2.9
+43.3	+45.6	+45.6	+55.0	+23.5

	No Action	Maximum Powerplant Capacity	High Fluctuating Flow	Moderate Fluctuating Flow
POWER				
Annual economic cost				
1991 nominal $ million				
Hydrology	0	-1.5	2.1	54.0
Contract rate of delivery	0	0	2.5	36.7
Present value (1991 $ million)				
Hydrology	0	-17.3	24.3	624.5
Contract rate of delivery	0	0	28.9	424.5
Wholesale rate (1991 mills/kWh)	18.78	18.78	19.38 (+3.2%)	22.82 (+21.5%)
Retail rate (1991 mills/kWh)				
70% of end users	No change	No change	No change to slight decrease	No change to slight decrease
23% of end users	No change	No change	Slight decrease to moderate increase	Slight decrease to moderate increase
7% of end users (weighted mean)	64.1	64.1	64.6 (+0.8%)	69.7 (+8.8%)
NON-USE VALUE	*No data.*			

Note: Reclamation's estimates for the non-use values are presented in table VI .4 in appendix VI.

Source: Bureau of Reclamation.

Source: Bureau of Reclamation.

Modified Low Fluctuating Flow	Interim Low Fluctuating Flow	Existing Monthly Volume Steady Flow	Seasonally Adjusted Steady Flow	Year-Round Steady Flow
15.1 44.2	36.3 35.6	65.9 68.7	88.3 123.5	69.7 85.7
174.6 511.2	418.7 411.7	761.4 794.6	1,021.2 1,428.4	805.0 991.2
23.16 (+23.3%)	23.18 (+23.4%)	25.22 (+34.3%)	28.20 (+50.2%)	26.78 (+42.6%)
No change to slight decrease	No change to slight decrease	No change to slight decrease	No change to slight decrease	No change to slight decrease
Slight decrease to moderage increase	Slight decrease to moderage increase	Slight decrease to moderate increase	Slight decrease to moderate increase	Slight decrease to moderate increase
70.5 (+10.0%)	70.2 (+9.6%)	72.9 (+13.8%)	75.8 (+18.4%)	74.5 (+16.3%)

Comments From the Department of the Interior

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

SEP 1 3 1996

Mr. Victor S. Rezendes
Director, Energy, Resources,
and Science Issues
General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Rezendes:

Enclosed are comments on the draft General Accounting Office report entitled "An Assessment of the Glen Canyon Dam's Environmental Impact Statement" (GAO/RCED-96-221). We appreciate the opportunity to review this draft report and comment on the subject matter. We are impressed with the quality of the product developed by the audit team. In a relatively short time, they have grasped a multitude of technical issues and have produced credible review documents. The comments are intended to clarify and improve the factual basis of the descriptions in the report.

Now GAO/RCED-97-12.

Sincerely,

Patricia J. Beneke
Assistant Secretary
for Water and Science

Enclosure

Bureau of Reclamation Comments

"An Assessment of the
Glen Canyon Dam's
Environmental Impact Statement"
GAO/RCED 96-221

Now GAO/RCED-97-12.

See comment 1.

Suggest the title of the report be changed to "An Assessment of the Environmental Impact Statement on the Operation of Glen Canyon Dam". The focus of the EIS was the operation of the dam, not the dam itself.

See comment 2.
Now on p. 4.

Page 5, 3rd paragraph. Consider describing the high steady releases "periodic" .

Now on p. 6.
See comment 3.

Page 7, 2nd paragraph. The two computational errors referred to here were made only in the Phase III analysis. One might accidentally infer from the sentence here that this occurred in the Phase II analysis. This is correctly described in the power economics appendix.

Now on p. 16, paragraph 1.
See comment 4.

Page 17, 2nd paragraph. Change "1966" to "1968". Releases from the dam were less than 8.23 maf prior to 1968.

See comment 5.

Page 51, 1st paragraph. One problem with paraphrasing is that sometimes the meaning of the original statement is obscured. The NOAA blue ribbon report actually states that, "The Panel concludes that CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values" (page 4610, col 3, par 3).

Now on p. 108.
See comment 6.

Page 143, 2nd paragraph. The computational errors referred to here were made only in the Phase III analysis. Although more specifics are provided later, one might accidentally infer from the sentence here that this occurred in the Phase II analysis.

Now on p. 114.
See comment 7.

Page 152, footnote. Both the words "load" and "demand" appear adjacent to each other in the footnote. As these words are often used synonymously, we suggest deleting one or the other.

Now on p. 123.
See comment 8.

Page 163, table. The heading over the left most column heading indicates that these values are for Glen Canyon. The note correctly indicates that these values are for the SLCA/IP system in total.

GAO's Comments

The following are GAO's comments on the Department of the Interior's comments enclosed in a letter dated September 13, 1996.

1. We have revised the title of the report as suggested.

2. We have added the term "periodic" to our description of the Modified Low Fluctuating Flow alternative.

3. We revised the text to clarify that the computational errors were made during the third phase of the power analysis.

4. The year was changed to 1968.

5. We have deleted the sentence from the report.

6. See comment 3 above.

7. We deleted the word "load" from the report.

8. We revised the footnote to clarify that the energy and capacity values referred to in the table are attributable to the Salt Lake City Area/Integrated Projects in total, but the change in annual economic costs are attributable solely to the Glen Canyon Dam's operations.

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