BALANCING CHANGING VALUES AND NEEDS

Bruce C. Moore[1]

ABSTRACT

The needs of the West have changed dramatically since the beginning of the century. Demands on Western water continue to grow rapidly, while changing societal values and greater environmental knowledge and awareness have demonstrated the need for Reclamation projects to be operated in a more environmentally beneficial manner. Today, residential, industrial, agricultural, recreational, hydropower, and environmental needs all compete for this finite resource. These changing needs have increased Reclamation's responsibilities and resulted in a fundamental shift and evolution in Reclamation's mission.

With concern growing over the negative impacts affecting the Glen and Grand Canyons, in 1982 the Secretary of the Interior (Secretary) initiated the two-phase, multi-agency Glen Canyon Environmental Studies (GCES) to better understand the environmental and recreational impacts associated with the operations of the dam. Findings from these studies led to a July 1989 decision by the Secretary for Reclamation to prepare an environmental impact statement (EIS) to reevaluate dam operations in order 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 the canyons.

One of the key elements outlined in the Glen Canyon Environmental Impact Statement (GCEIS) and mandated by the Record of Decision (ROD) is an "Adaptive Management Program" (AMP). The AMP is intended to provide the organization with a process to ensure that scientific information and recommendations from a diverse group of stakeholders are incorporated into the evaluation, management, and future decisions of Glen Canyon Dam operations.

The AMP calls for the continued interaction of managers and scientists to monitor the effects of current dam operations on the Colorado River ecosystem, and to conduct research on alternative dam operating criteria that may be necessary to ensure continued protection of resources and improve natural processes.

[1] Manager, Resources Management Division, U.S. Bureau of Reclamation, 125 S. State Street (UC-200), Salt Lake City, UT 84138-1102. (bmoore@uc.usbr.gov)

As the 21st century comes into focus, Reclamation is prepared to meet the continuing challenge of bringing together competing interests to find consensus-based solutions to contemporary Western water management challenges.

The paper will describe the sequence of events leading up to an EIS on Glen Canyon Dam operations, the implementation of the AMP, and a special event, the Beach Habitat Building Flow.

INTRODUCTION

The remarkable development that has taken place over the last 100 years in the Western United States is the direct result of the ability to carefully manage one vital and scarce resource: *water*. Most Western lands typically receive far less annual precipitation than that received by Eastern and Southern states. When settlers first began to inhabit the West, they discovered that survival in this area was extremely difficult because rainfall was neither plentiful nor reliable. The transformation of this dry, barren desert region into productive farmland and thriving towns and cities really began with the recognition that large-scale water projects were necessary to store and transport water.

President Theodore Roosevelt believed that water development was a national function and that Federal participation was necessary to construct large-scale projects because they would be beyond the means of states and local groups. He also believed a Federal presence was necessary to resolve the interstate conflicts that were sure to arise. Recognizing the many benefits that Western water development could bring, Roosevelt signed the Reclamation Act into law on June 17, 1902. This act formed the cornerstone for the founding of the Bureau of Reclamation, the agency charged with planning, designing, and constructing water projects throughout the West. By 1907, due to the immediate response for irrigation projects by Western farmers, businessmen, and politicians, work was already underway on 25 projects.

By 1928, Reclamation was the world's foremost builder of water storage, diversion, and distribution systems. Early projects such as Theodore Roosevelt Dam in Arizona and Elephant Butte Dam in New Mexico provided reliable irrigation water supplies for Western farmers as well as protection from damaging floods. As the West's desert lands were transformed into productive farmlands, a strong, stable economic base emerged and more people moved West, bringing with them new skills and trades. While this migration was beneficial in that it reduced the population pressures of the eastern United States, new demands were being placed on Reclamation projects to now supply water for growing cities and

industries and to generate hydroelectric energy to run factories and light homes. As the population continued to increase, it was necessary to build additional water projects.

Today, after constructing more than 600 dams and reservoirs, Reclamation's initial mission of reclaiming the arid lands of the West to allow for settlement and development has been accomplished. The Western United States is remarkably productive and prosperous with highly populated urban centers throughout this diverse region that ranges from high snowpacked mountains to the desert Southwest.

Reclamation is the largest water wholesaler in the United States, bringing this precious resource to 31 million people and irrigating 10 million acres of land. Reclamation is also the Nation's second largest producer of hydroelectric power and the ninth largest electric utility. Reclamation's 56 powerplants annually provide more than 40 billion kilowatt-hours, generate nearly a billion dollars in power revenues, and serve 6 million homes.

But the needs of the West have changed dramatically since the beginning of the century. Demands on Western water continue to grow rapidly while changing societal values and greater environmental knowledge and awareness have demonstrated the need for Reclamation projects to be operated in a more environmentally-beneficial manner. Today, residential, industrial, agricultural, recreational, hydropower, and environmental needs all compete for this finite resource. These changing needs have increased Reclamation's responsibilities and resulted in a fundamental shift and evolution in Reclamation's mission.

Many of the challenges of managing these changing values and competing demands can be characterized by focusing on the history of the Colorado River, and more specifically, on the management of the river within Reclamation's Upper Colorado Region (UC). The UC Region encompasses almost all of Utah and New Mexico, the western portion of Colorado, northeastern Arizona, southwestern Wyoming, the far west corner of Texas, and small portions of Nevada and Idaho. The UC Region designed, constructed, and now operates the Colorado River Storage Project (CRSP), one of the most complex and extensive river resource developments in the world, of which Glen Canyon Dam is the key unit.

The Colorado River

The Colorado River has always been an important factor in the equation of Western water. Figure 1 shows the seven states that comprise the upper and lower Colorado River Basin which depend heavily on the water coursing through this

river. As a result, the Colorado River is today, one of the most regulated rivers in the world. Structurally, this river is regulated with more than 20 major dams in the system. Legally, this river is regulated by numerous statutes, compacts, decrees, and a treaty, generally referred to collectively as the "Law of the River."

In the early 1900s, the Colorado River flowed freely, with very few diversions made for irrigation. In its natural state, the Colorado River was a seasonally variable river which fluctuated greatly depending on precipitation and inflows from side canyons. Flows in the Colorado would run from little more than a trickle during hot, dry summer months to raging floods in the spring. Because the threat of flooding left farmers vulnerable, demand began to grow for some type of permanent flood control to be developed. An early Reclamation engineering board report recommended construction of a dam and storage reservoir to help alleviate this problem.

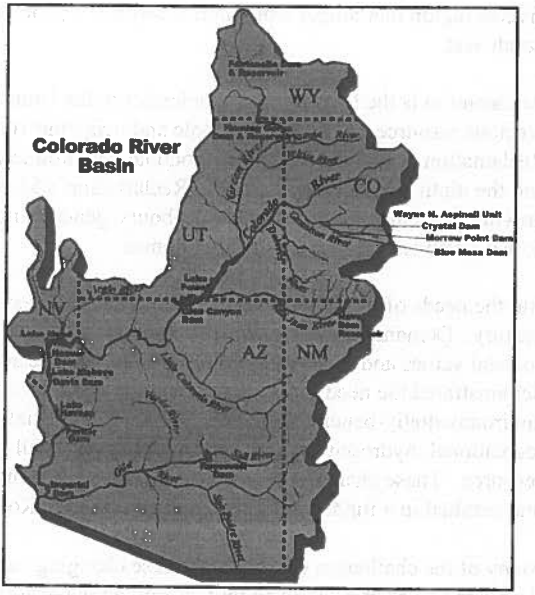

Fig. 1. Seven Basin States.

Water law in most Western states was based on the "doctrine of prior appropriation." Utah, Colorado, New Mexico, and Wyoming were concerned that a storage reservoir would mean the faster-growing states of California, Arizona, and Nevada would establish prior rights to large amounts of the river's water before they could make use of flows passing through their streams. The proposed Boulder Dam (today, known as Hoover Dam) as part of the Boulder Canyon Project Act, caused bitter conflict between the "upriver" and "downriver" states over the establishment of each states' portion of Colorado River water. In order to resolve this conflict, the Colorado River Commission was formed in 1921, with representatives from each of the seven basin states. After a year of work, the

historic document known as the Colorado River Compact (Compact) was created, dividing the river into the upper and lower basins at Lee Ferry, Arizona, near the Arizona/Utah border. Each basin was allocated use of 7.5 million acre-feet (maf) of water annually, to be divided up among each basin's states.

Although the Colorado River Compact was signed on November 24, 1922, differences of opinion among the basin states continued. Because Mexico also had a growing reliance on Colorado River water, treaty negotiations with Mexico were undertaken. It wasn't until 1941, when Mexico's annual usage of Colorado River water reached approximately 1.5 maf, that negotiations between Mexico and the United States were successful. A treaty was drafted by the International Boundary and Water Commission in 1944 that ensured Mexico a 1.5 maf annual apportionment of the Colorado River, as well as apportioning the flows of the Rio Grande.

Once the Colorado River Compact was established, the upper and lower basin states had the responsibility for dividing the use of their 7.5 million-acre feet apportionment. This proved to be a more difficult task for the lower basin states (California, Arizona, Nevada) than the upper basin states (Colorado, New Mexico, Utah, Wyoming). The upper basin states' agreement to divide water among themselves on a percentage basis was agreed to in the Upper Colorado River Basin Compact of 1948.

It wasn't until a 1964 United States Supreme Court Decree that the lower basin states reached an agreement on their water division issues. The heart of the lower basin's difficulty was the dispute between California and Arizona over differing interpretations of parts of the 1922 Compact, and the Boulder Canyon Project Act with respect to surplus water, and Gila River (a Colorado River tributary) flows. The 1964 Supreme Court Decree and subsequent negotiations between Arizona and California finally resulted in a lower basin water allocation agreement.

The Lower Basin and the Boulder Canyon Project Act

The Boulder Canyon Project Act was passed in 1928 to authorized facilities necessary to meet critical needs of the lower basin including flood control, flow regulation, water storage and delivery, and hydropower generation. The Boulder Canyon Project Act authorized the construction of Hoover Dam and the All-American Canal. These first two major structures controlled the erratic flows of the Colorado River and delivered water to California. Smaller downstream projects such as Parker Dam, Davis Dam, Imperial Dam, and the Colorado Aqueduct were built later.

The Upper Basin and The Colorado River Storage Project

The guiding force behind the development and management of water in the upper basin was the Colorado River Storage Project Act (CRSP) of 1956. This act provided for the comprehensive development of the water resources of the upper basin states while ensuring long-term regulatory storage of water to meet lower basin delivery requirements under the Compact.

As a basin-wide water resource development plan, the CRSP called for facilities to be built on the tributaries of the Colorado, as well as a major one on the main stem of the river. Four primary storage facilities were built, including the Wayne N. Aspinall Unit on the Gunnison River in Colorado (includes Blue Mesa, Crystal, and Morrow Point Dams), Flaming Gorge Dam on the Green River in Utah, Navajo Dam on the San Juan River in New Mexico, and Glen Canyon Dam on the Colorado River in Arizona. These facilities were constructed to regulate the flow of the Colorado River to provide storage of water for beneficial consumptive use, including irrigation, municipal and industrial use, flood control, and power generation, and to meet downstream obligations under the Compact. With the construction of these facilities, a combined total storage capacity of nearly 34 maf of water became available. The CRSP also authorized participating projects to develop water in the upper Colorado River system for irrigation and related uses.

Glen Canyon Dam

Several dams and canals were already in place in the lower basin by the 1950s, but only limited development had taken place in the upper basin. The upper basin states were anxious to begin putting their water to beneficial use before any potential claims by the lower basin were made on this water, even temporarily. The needs for water development in the upper basin, coupled with the undependable flows of the Colorado River, led to the Colorado River Storage Project Act and the construction of Glen Canyon Dam.

Glen Canyon Dam was constructed on the main stem of the Colorado River near the Utah/Arizona border. Completed in 1963, Glen Canyon Dam is the key unit of the CRSP, providing significant water storage, flood control, and hydropower generation. Additionally, Glen Canyon Dam controls water releases to the lower basin in accordance with the 1922 Colorado River Compact and 1944 Mexican Water Treaty.

The reservoir impounded by the 710-foot dam, is the second largest reservoir in North America. Lake Powell has a total storage capacity of over 26 maf, over 1,900 miles of shoreline, and is one of the most scenic lakes in the world. As with

numerous other Reclamation reservoirs, it didn't take long for the wonderful recreational value of the lake to be recognized and utilized by people all over the country.

The powerplant at Glen Canyon Dam was completed and brought on-line in 1964. It provides about 80 percent of the power generated by CRSP facilities. When Glen Canyon Dam was first built, and for many years, the powerplant was operated to provide power during high demand periods (peaking power). As a result, the volume of the releases made from the dam fluctuated daily and hourly to respond to power demands.

By the late 1960s, however, evidence of the Nation's changing values and greater environmental awareness became apparent when Congress enacted the 1968 Colorado River Basin Project Act which provided for further comprehensive development of Colorado River Basin water resources. Additional benefits, including recreation, water quality, and fish and wildlife were now considered important purposes of water development in the Colorado River Basin.

The Act also mandated that the *Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs* (including Glen Canyon Dam) be developed. The Criteria, completed by a Federal/state group in 1970, requires that the Annual Operating Plan for Colorado River reservoirs:

> . . . shall reflect appropriate consideration of the uses of the reservoirs for all purposes, including flood control, river regulation, beneficial consumptive uses, power production, water quality control, recreation, enhancement of fish and wildlife, and other environmental factors.

With this evolution of the Nation's values, managing the operations of the dam was becoming more challenging. The demand for water and power continued to increase throughout the West, but this demand now had to be balanced with more diverse and potentially competing needs.

After Glen Canyon Dam had been in operation for a period of years, Federal, state, and tribal resource management agencies, fishing and rafting interests, and environmental groups became concerned over the detrimental effects the daily fluctuating releases were having on the downstream cultural, fish, wildlife, and other river resources. Because the dam was constructed prior to the enactment of the National Environmental Policy Act of 1969 (NEPA), no environmental impact studies were conducted or a final statement completed on the construction or operation of the dam.

Fundamental changes had occurred in the natural dynamics of the river after the dam was constructed. The Colorado River had once been a sediment-laden river with highly variable flow rates depending on the season. With the dam in place, the Colorado's natural flow pattern was forever altered. No longer did the tremendous raging floods wash through Glen and Grand Canyons in the spring carrying the sediment it once did. Behind the dam, the river flowed into a lake. Below the dam, the river became cold and clear. Downstream from the dam, a new ecosystem emerged as different wildlife species and vegetation appeared in the Grand Canyon. The enhanced riparian habitat resulted in a significant increase in the peregrine falcon population. In addition, a blue-ribbon trout fishery developed which increased the food base for bald eagles, allowing that population to flourish while attracting anglers and establishing fishing as a viable, highly valued recreation resource. However, there were also negative environmental impacts occurring downstream as a result of fluctuating releases.

With concern growing over the negative impacts affecting the Glen and Grand Canyons, in 1982 the Secretary initiated the two-phase, multi-agency GCES to better understand the environmental and recreational impacts associated with the operations of the dam. Findings from these studies led to a July 1989 decision by the Secretary for Reclamation to prepare an EIS to reevaluate dam operations in order 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 the canyons.

Until the EIS was completed, Reclamation implemented interim flow operations and began a monitoring program in 1991 to protect downstream resources. The criteria of the interim operations were essentially the same as those specified in *Low Fluctuating Flow Alternative* under consideration in the EIS. This included restricted peak releases of fluctuating flows to 20,000 cfs; limited minimum releases to 5,000 cfs at night, and 8,000 cfs during the day; limited daily fluctuations between 5,000 and 8,000 cfs, depending on the monthly release volume; and limited rate of change to 2,500 cfs per hour (cfs/hr) during periods of increasing releases and 1,500 cfs/hr during periods of decreasing releases.

A total of eight action alternatives, representing a reasonable range of operational options, and one no action alternative were evaluated during the EIS process. This document would provide the necessary information and analysis for the Secretarial decision on how to best balance competing interests, meet statutory responsibilities for protection of downstream resources, produce hydropower, and to protect Native American interests.

In addition to the Secretary's decision for the re-evaluation of Glen Canyon Dam operations, Congress subsequently enacted the Grand Canyon Protection Act

(GCPA) of 1992. Section 1802 (a) of the GCPA 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."

The GCPA directs the Secretary to implement section 1802 in a manner fully consistent with all existing laws that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

The Final Glen Canyon Dam EIS was completed and filed with the Environmental Protection Agency on March, 21, 1995. This document was prepared with an unprecedented amount of scientific research, public involvement, and stakeholder cooperation. Over 33,000 comments were received on the Draft EIS, reflecting the national attention and intense interest in the EIS. The Secretary signed the ROD on the EIS, on October 9, 1996, documenting the decision to implement the Modified Low Fluctuating Flow Alternative (preferred alternative) which included the use of beach/habitat-building and maintenance flows as an environmental restoration tool.

A New Era of Water Resource Management: The Beach/Habitat-Building Flows

The years spent conducting research and collecting and analyzing data on the dam's affect on the canyons, the preparation of the EIS, and the signing of the ROD are indicative of the changing environmental attitude in the United States in the latter part of the century, and a new era of water resource management for Reclamation.

The detrimental environmental impacts occurring in the Glen and Grand Canyons were primarily due to the greatly fluctuating releases from the dam and from the lack of flooding that historically occurred along the river each spring. These natural floods would regularly strip all but the highest vegetation from the channel banks, deposit sandbars along the river, and remove boulders from constricted rapids. With the dam in place, virtually all sediment coming from upstream is trapped above the dam. As the releases fluctuated with no new sediment being deposited downstream, the sandbars in the Grand Canyon were slowly eroding and steadily disappearing, reducing the backwater habitats available for endangered species.

The preferred alternative of the EIS included beach/habitat-building and maintenance flows as an integral element. The flows also fit within the intent of the GCPA which provides for the operation of Glen Canyon Dam for environmental purposes in addition to traditional water and power benefits. The

objective of these scheduled short-duration high releases is to rebuild high elevation sandbars, deposit nutrients, restore backwater channels for endangered species, and provide some of the dynamics of a natural system. Reclamation tested this method for rebuilding sandbars and restoring habitat when it conducted the first such beach/habitat-building flow, or "spike" flow at Glen Canyon Dam in March 1996. Following 4 days of steady flows at 8,000 cfs, flows were increased to 45,000 cfs on March 26, through April 2, 1996. This volume of releases was accomplished by running the powerplant at full capacity and releasing water through the four jet valve bypass tubes.

Scientists conducting the flood experiment expected the high flows to redeposit sediment from the bottom of the river onto the banks above the fluctuating flow level of 20,000 cfs (since August 1991 when Interim Flows were implemented), thus rebuilding the sandbars. The sandbars are vital to the establishment of native vegetation, which increases insect populations, which in turn provides a strong food base for native fish and bird species. Greater recreational value and protection of cultural resources are also a benefit of newly created or improved sandbars.

At the conclusion of this flood experiment, scientists continued gathering and analyzing data for several months. Overall, the test was successful in increasing the number and volume of sandbars along the river, creating some new backwater habitats, and widening several constricted rapids. No negative impacts were observed on fish species, endangered bird species, or the endangered Kanab ambersnail, and no Native American cultural artifacts and sites in the canyons were harmed. Since this flood event, however, 50 percent of the aggradation has been lost to natural erosion which continues to take place, making it probable that future controlled flood events may be initiated periodically to restore what is lost to erosion.

A smaller-scale high flow event from Glen Canyon Dam took place from November 3-5, 1997, in an attempt to redistribute sediment deposited in the Marble Canyon reach of the Grand Canyon by the Paria River (a Colorado River tributary, just below Lees Ferry). During this smaller, high release event, releases from the dam were made at full powerplant capacity of 31,000 cfs. No water bypassed the powerplant as it did in the 1996 controlled flood. The objective of this high flow event was similar to the first flood event in that it was intended to stir up the sediment and redeposit it onto sandbars that had eroded from normal dam operations.

The use of this operational technique to maintain the ecological health of the Grand Canyon represents a new management approach within Reclamation in response to national concerns over environmental impacts associated with dam

operations. This kind of science-based decision-making process is vital to protecting the environment and balancing competing needs.

The Adaptive Management Process

Throughout the environmental studies and EIS process, a vast amount of research was conducted, work completed, knowledge gained, and progress made toward understanding the environmental impacts of the dam's operations in the Glen and Grand Canyons. This process culminated in the completion of a Final EIS and ROD which implemented operational changes that would reduce the detrimental environmental impacts and balance the needs of the many stakeholders with an interest in the river and the canyons.

An important aspect of this new environmentally responsible management approach is continued long-term monitoring and research. Section 1805 of the GCPA requires the Secretary to ". . . establish and implement a long-term monitoring and research programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of section 1802."

The Act also states that:

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

One of the key elements outlined in the GCEIS and mandated by the ROD is an AMP intended to provide the organization and process to ensure scientific information and recommendations from a diverse group of stakeholders are incorporated in the evaluation, management, and future decisions on Glen Canyon Dam operations.

The AMP calls for the continued interaction of managers and scientists to monitor the effects of current dam operations on the Colorado River ecosystem, and to conduct research on alternative dam operating criteria that may be necessary to ensure continued protection of resources and improve natural processes.

This long-term process of adaptive management is being implemented through the formation of a Federal advisory committee called the Adaptive Management Work Group (AMWG). The AMWG was chartered by the Secretary on January 15, 1997, and consists of Federal and state resource managers, Native American tribes, power marketers, environmental groups, recreationists, and other interested stakeholders. The AMWG was established to develop, evaluate, and

recommend monitoring and research programs, modifications, and alternative operation strategies for Glen Canyon Dam, and make recommendations to the Secretary to meet the requirements of the GCPA. The AMWG does not displace the legal authority and responsibility of Federal agencies to manage resources in the best interests of both the environment and society.

In addition to the creation of the AMWG, the Technical Work Group (TWG) and the Grand Canyon Monitoring and Research Center (GCMRC) were created to play vital roles as part of the adaptive management process. The TWG is composed of technical representatives from various stakeholder groups, appointed by the AMWG. The TWG provides the AMWG detailed guidance on issues and objectives; develops criteria and standards for monitoring and research programs; designs research and monitoring programs; develops resource management questions for monitoring and research by, or under, the direction of the GCMRC; provides information for annual resource reports; and translates the AMWG's management objectives into research needs for the GCMRC.

The GCMRC was established on November 11, 1995, by the Assistant Secretary for Water and Science, during the transition from the GCES program to the AMP. The GCMRC was established to conduct the research and monitoring programs necessary to evaluate dam operations, as directed by the GCPA and GCEIS to ensure that Glen Canyon Dam is operated in a manner consistent with Section 1802 of the GCPA. In addition, an independent review panel will be created to provide outside review of, and credibility for, the monitoring and research programs and recommendations made to the Secretary.

A Continuing Challenge

For nearly 100 years, the Bureau of Reclamation has played an important role and provided a vital service to the Western United States. The return on the national investment made in the planning and construction of water projects to store and deliver water to the parched desert lands of the West is immeasurable. But there have been many challenges along the way. As the history of managing the Colorado River and Glen Canyon Dam operations demonstrate, Reclamation's role in managing water in the West has evolved to meet new and often conflicting demands with an increased sensitivity toward the environment, public opinion, and our customers' changing needs.

As the 21st century comes into focus, Reclamation is prepared to meet the continuing challenge of bringing together competing interests to find consensus-based solutions to contemporary Western water management challenges.