Chapter Three

Affected Environment

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3.1 Introduction

Chapter 3 describes environmental resources (i.e., hydrologic, biologic, and socioeconomic) of the Colorado River Basin that could be affected by the proposed federal action described in Chapter 1and Chapter 2. The extent to which each specific resource may be impacted is discussed in Chapter 4.

Section 3.2 presents a general discussion of the geographic scope within which potential effects of the alternatives are analyzed and describes each of the Colorado River reaches and affected water service areas. Subsequent sections in this chapter describe specific resources that may be potentially affected, such as water deliveries, recreation and biologic resources. Each resource section contains a discussion of one or more specific issues identified for consideration through scoping, public review and comment, and internal review (Chapter 1, Table 1.5-1).

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3.2 Geographic Scope

The proposed federal action considers modified operations of Lake Powell and Lake Mead over a wide range of reservoir elevations as addressed by the four operational elements discussed in Section 1.2: shortage conditions; coordinated operation of Lake Powell and Lake Mead; storage and delivery of Colorado River system and non-system water; and the modified ISG. Such operational changes may affect reservoir storage levels of, and releases from, Lake Powell and Lake Mead, which in turn may subsequently affect river flows, available water supplies, and other resources.

This section describes the geographic scope of specific issues and potential effects associated with changes in the operations of Lake Powell and Lake Mead, as discussed and analyzed under the alternatives considered in this Draft EIS (Chapter 2). Reservoirs located upstream of Lake Powell and operated independently of Lake Powell would not be affected by changes in the operations of Lake Powell and Lake Mead, but the releases from reservoirs located downstream of Lake Mead could be affected by these changes. As such, the upstream limit of the potentially affected environment for the purposes of this Draft EIS is the full pool elevation of Lake Powell, and the downstream limit is the SIB (Figure 3.2-1).

In addition to the potential impacts that may occur within the river corridor, the alternatives may also affect the water supply that is available to specific Colorado River water users in the Lower Basin due to the shortage guidelines element. The following water agency service areas are included in the affected environment discussions:

- Arizona water users, particularly the lower priority water users located in the CAP service area;
- The SNWA service area; and
- The MWD service area.

3.2.1 Definition of Colorado River Reaches

The section of the Colorado River extending from Lake Powell to the SIB consists of river reaches, two large reservoirs (Lake Powell and Lake Mead) and two smaller reservoirs downstream of Lake Mead (Lake Mohave and Lake Havasu, Figure 3.2-2). The Colorado River and adjacent areas (e.g., backwaters and marshes) comprise heterogeneous geographic and hydrologic regimes, which differ in their resource composition and resource management administration.

Figure 3.2-1
Geographic Scope

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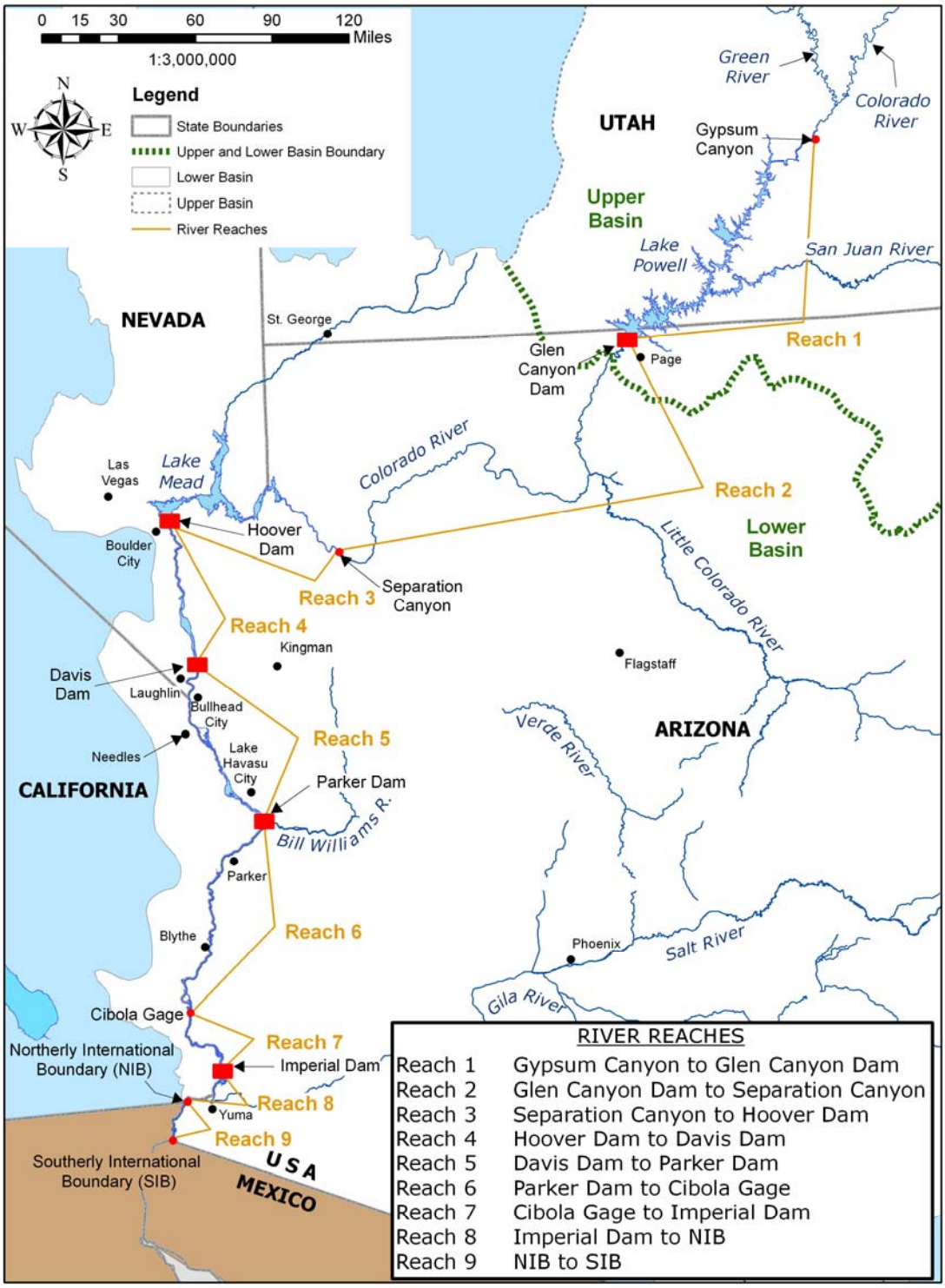
Figure 3.2-2
Colorado River Reaches



For the ease of discussion with respect to affected areas and potential effects, the Colorado River has been divided into the following reaches (Table 3.2-1).

Table 3.2-1
Colorado River Reaches and Reach Limits

Reach	Reach Limits
Lake Powell and Glen Canyon Dam	Gypsum Canyon to Glen Canyon Dam (RM 712.9)
Glen Canyon Dam to Lake Mead	Glen Canyon Dam to Separation Canyon (RM 450.6) [2], *including Grand Canyon National Park*
Lake Mead and Hoover Dam[1]	Separation Canyon (RM 450.6) to Hoover Dam (RM 342.2), *including Lake Mead*
Hoover Dam to Davis Dam[1]	Hoover Dam (RM 342.2) to Davis Dam (RM 276), *including Lake Mohave*
Davis Dam to Parker Dam[1]	Davis Dam (RM 276) to Parker Dam (RM 192.3), *including Lake Havasu*
Parker Dam to Cibola Gage (Adobe Ruin) [1]	Parker Dam (RM 192.3) to Adobe Ruin and Reclamation's Cibola Gage
Cibola Gage to Imperial Dam[1]	Reclamation's Cibola Gage (RM 87.3) to Imperial Dam (RM 49.2)
Imperial Dam to Northerly International Boundary (NIB) [1]	Imperial Dam (RM 49.2) to the NIB (RM 23.1)
NIB to SIB[1]	NIB (RM 23.1) to SIB (RM 0.0)

1 These reaches are identical to those described in the LCR MSCP.

2 For purposes of this Draft EIS, river miles are numbered along the length of the Colorado River channel south to north starting with RM 0.0 at the SIB with Mexico. Dam locations, other features and reach limits are identified and noted at their respective river miles.

These reaches and their associated issues are discussed briefly below and in more detail in Section 3.3, Hydrologic Resources. Each of the resource discussions is generally organized by river reaches and in some instances the river reaches are combined to better focus the discussion of issues.

3.2.1.1 Lake Powell and Glen Canyon Dam

Lake Powell is the second largest reservoir on the Colorado River and has a total storage capacity of 24.32 maf. It is formed by waters of the Colorado River impounded by Glen Canyon Dam. The reservoir is narrow, over 180 miles in length, and has a shoreline that is over 1,900 miles long. Lake Powell primarily provides water storage for use in meeting the delivery requirements to the Lower Basin consistent with the Law of the River. At the full pool elevation of Lake Powell, this reach includes approximately 25 miles of Cataract Canyon, 50 miles of the San Juan River and approximately 170 miles of Glen Canyon.

Lake Powell is located within the GCNRA which is administered by the NPS. Reclamation retains authority and discretion for the operation of Glen Canyon Dam and Lake Powell. The Navajo Indian Reservation also borders a segment of this river reach. The City of Page, Arizona is also located within this reach and diverts water from Lake Powell.

3.2.1.2 Glen Canyon Dam to Lake Mead

This reach of the Colorado River extends from Glen Canyon Dam to the upper limits of Lake Mead. It is comprised of a narrow river corridor through the last 15 miles of Glen Canyon, Marble Canyon, and the Grand Canyon. These canyons are in the GCNRA and Grand Canyon National Park which are administered by the NPS. The Navajo Indian Reservation and Hualapai Indian Reservation also border segments of this river reach.

3.2.1.3 Lake Mead and Hoover Dam

Lake Mead, formed by Hoover Dam, is the largest reservoir on the Colorado River and has a total storage capacity of 27.38 maf. The reservoir is approximately 115 miles in length and has a shoreline that is over 550 miles long. The reservoir provides water storage to regulate the water supply and meet the delivery requirements of the Lower Division states and Mexico. The reservoir is located within the LMNRA which is administered by the NPS. Reclamation retains authority and discretion for the operation of Hoover Dam and Lake Mead.

3.2.1.4 Hoover Dam to SIB

The Colorado River from Hoover Dam to the SIB is contained within the shallow Colorado River Valley in which Lake Mohave, Lake Havasu and other smaller diversion reservoirs are located. Under the BCPA and the Consolidated Decree (Chapter 1), releases from Hoover Dam are generally made to meet the downstream water delivery requirements for Arizona, California, Nevada and Mexico. The northern segment of this river reach, which includes Lake Mohave, lies within the LMNRA, which is administered by the NPS. The lower reach is bordered by a combination of federal, Tribal and private land. Lake Havasu State Park and Picacho State Recreation Area are administered by the state of Arizona. Refuges managed by the FWS include Havasu National Wildlife Refuge (NWR), Bill Williams River NWR, Cibola NWR, and Imperial NWR. Indian reservations which are located along this river reach include the Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma Indian, and Cocopah Indian reservations. The 23.7 mile long reach that extends between the NIB to the SIB also forms part of the international boundary with Mexico.

The individual reaches included between Hoover Dam and the SIB are:

- **Hoover Dam to Davis Dam.** This reach extends from Hoover Dam to Davis Dam and includes Lake Mohave up to its full-pool elevation. The approximately 67-mile length of this reach generally comprises Lake Mohave. The reach is bound for most of its length by the steep walls of Pyramid Canyon, El Dorado Canyon, and Black Canyon. Lake Mohave is relatively narrow, not more than four miles across at its widest point. A major feature located within this reach is the Willow Beach National Fish Hatchery which is located on the Colorado River approximately five miles downstream of Hoover Dam. The Willow Beach National Fish Hatchery is managed by the FWS and is used as a hatchery and for rearing razorback suckers and bonytail chub which are used for stocking nearby Lake Mohave and Lake Mead.

- **Davis Dam to Parker Dam.** This reach extends from Davis Dam to Parker Dam and includes Lake Havasu up to its full-pool elevation. Parker Dam is located approximately 155 miles downstream from Hoover Dam. The upper 39 miles of this reach comprises an open river reach. Lake Havasu, formed by Parker Dam, comprises the lower 45 miles of this reach and can store approximately 0.648 maf of water. At its maximum elevation of 450.5 feet msl, Lake Havasu has a surface area of approximately 20,390 acres.

  Several communities are located adjacent to this reach and include the cities of Laughlin, Needles, Bullhead City, and Lake Havasu City. The Fort Mojave and Chemehuevi Indian Reservations are also located within this reach. Other important features located within this reach include Topock Marsh and the Havasu NWR, both managed by the FWS. Topock Marsh is located on the Arizona side of the Colorado River midway between Davis Dam and Parker Dam and it is almost entirely within the Havasu NWR. Topock Marsh was created by backwaters resulting from the construction of Parker Dam. The Bill Williams River, a major tributary to the Colorado River, discharges to this reach at a point located just upstream of Parker Dam.

  Lake Havasu provides a forebay and desilting basin from which water is pumped into the Colorado River Aqueduct (California) and the CAP Aqueduct System (Arizona). The pumping plant that pumps water into the Colorado River Aqueduct is located on the west side of the river and operated by the MWD. The pumping plant that pumps water into the CAP Aqueduct is located on the east side of the river and is operated by the Central Arizona Water Conservation District (CAWCD).

- **Parker Dam to Cibola Gage.** This reach is approximately 105 miles long and extends from Parker Dam to Adobe Ruin and Reclamation's Cibola Gage located at RM 87.3. The reach is generally channelized with the greater portion bound by levees. Several features located downstream of Parker Dam are also used to manage the flows in the river and make deliveries to the Colorado River water users that divert water downstream of Parker Dam. This includes the Palo Verde Diversion Dam and Headgate Rock Dam. Lake Moovalya, the reservoir impounded by Headgate Rock Dam, is located between Parker Dam and Headgate Rock Dam. Several communities are located adjacent to this reach and include the cities of Parker, Arizona and Blythe, California. The Colorado River Indian Reservation is also located within this reach, as is the Cibola NWR.

- **Cibola Gage to Imperial Dam.** This reach is approximately 38 miles long and extends from the Cibola Gage to Imperial Dam. The major features located within this reach include Senator Wash Dam, Martinez Lake, Imperial NWR, and Imperial Dam. Senator Wash Dam and Regulating Reservoir are located approximately two miles upstream of Imperial Dam on the California side of the Colorado River. This is an off-stream water storage reservoir that is used by Reclamation to facilitate water scheduling and to help in balancing the river flows and supply with demands. The Imperial Dam and the impoundment that it forms upstream of the dam is to raise the water surface of the river flows by approximately 25 feet to provide controlled gravity flow of water into the AAC and the Gila Gravity Main Canal. The AAC system diverts water from the California side of Imperial Dam and serves Imperial Irrigation District (IID), Coachella Valley Water District (CVWD), the Yuma Project in Arizona and California, and the City of Yuma. The Gila Gravity Main Canal system diverts water from the Arizona side of Imperial Dam and serves the north and south Gila Valley, Yuma Mesa, and Wellton-Mohawk area. Imperial Dam is also used to regulate deliveries to Mexico. The AAC Desilting Works, which is located adjacent to the AAC diversion structure, is used to remove most of the sediment carried by the Colorado River prior to the water entering the AAC. The Imperial NWR is located mostly on the Arizona side of the Colorado River. Martinez Lake is a small water cove formed by the impoundment and backwater are located above Imperial Dam.

- **Imperial Dam to NIB.** This reach extends from Imperial Dam to the NIB between the United States and Mexico. The entire extent of the channel within this reach is bound by a system of levees. Several features located downstream of Imperial Dam are also used to manage river flows and make deliveries to the Colorado River water users that divert water downstream of Imperial Dam. These features include Laguna Dam, Laguna Desilting Basin, Morelos Diversion Dam, California Wasteway, and Pilot Knob Wasteway. Other features include water conveyance system components (levees, bypass channels, wasteways, etc.), access roads, farmlands, and vegetation. Mittry Lake is also located on the Arizona side of the Colorado River. The Gila River, a major tributary of the Colorado River, also discharges to the river at a point located approximately nine miles downstream from Laguna Dam.

- Laguna Dam is located on the Colorado River some five miles downstream of Imperial Dam. The original purpose of this dam was to divert Colorado River water to the Yuma Project area. Laguna Dam now serves as a regulating structure for Colorado River water, for regulating sluicing flows from Imperial Dam, and for downstream toe protection for Imperial Dam. The reservoir created by Laguna Dam is commonly referred to as Laguna Reservoir.

Mittry Lake is located on the east side of the Colorado River between Laguna Dam and Imperial Dam. The Mittry Lake Wildlife Area generally surrounds and includes Mittry Lake and includes approximately 600 acres of water surface and 2,400 acres of marsh or upland. Numerous serpentine waterways connect to the main lake body. The Mittry Lake Wildlife Area is jointly managed by the BLM, Reclamation, and the Arizona Game and Fish Department.

The California Wasteway of the Yuma Main Canal is located approximately four miles downstream from the mouth of the Gila River. This wasteway returns to the river the water which is used to fulfill the 1944 Treaty obligation to Mexico. The Rockwood Heading, an old intake structure on the Alamo Canal, is located approximately two miles upstream from Morelos Diversion Dam. It is no longer used for an intake structure but it is used as a point of return for the Pilot Knob Powerplant and Wasteway from the AAC. Under normal operating procedures, a portion of the water scheduled to be delivered to Mexico is diverted at Imperial Dam, conveyed via the AAC, and then returned to the Colorado River through this wasteway.

- **NIB to SIB.** This reach extends from the NIB to the SIB and it is 23.7 miles long. This section of the Colorado River, referred to as the limitrophe section, serves as the international boundary between the United States and Mexico, and has levees on both sides.

  Located approximately 1.1 miles downstream of the NIB is Morelos Diversion Dam. This dam functions as a diversion control structure for the Alamo Canal, which conveys water to Mexico. The Morelos Diversion Dam and the limitrophe section the Colorado River channel, including the floodplain, are designed to convey a maximum flow of 140,000 cfs. Other major features located within this reach include water conveyance system components (levee, bypass channel, wasteways, etc.) and access roads.

3.2.2 Colorado River Water User Service Areas

In addition to the mainstream river reaches, certain service areas of Colorado River water users may be affected as a result of water management programs associated with the proposed federal action. These potential effects correspond to the following agency service areas.

3.2.2.1 Arizona Water Users, Central Arizona Project Service Area

The largest Arizona diversion of water is the CAP, which delivers water to contractors in the central part of the state. CAP's diversion is located at Lake Havasu. The CAWCD administers the CAP water diversions. The CAP has more than 80 customers that generally fall within three classifications of CAP users: municipal (e.g., cities such as Phoenix, Mesa, and Scottsdale), agricultural (irrigation districts such as the Maricopa-Stanfield Irrigation District), and Indian communities (12 tribes with Colorado River water allocations within Arizona). Table 3.2-2 provides a listing of the CAP users and Figure 3.2-3 presents the general service area of the CAP.

Figure 3.2-3
CAP Service Area

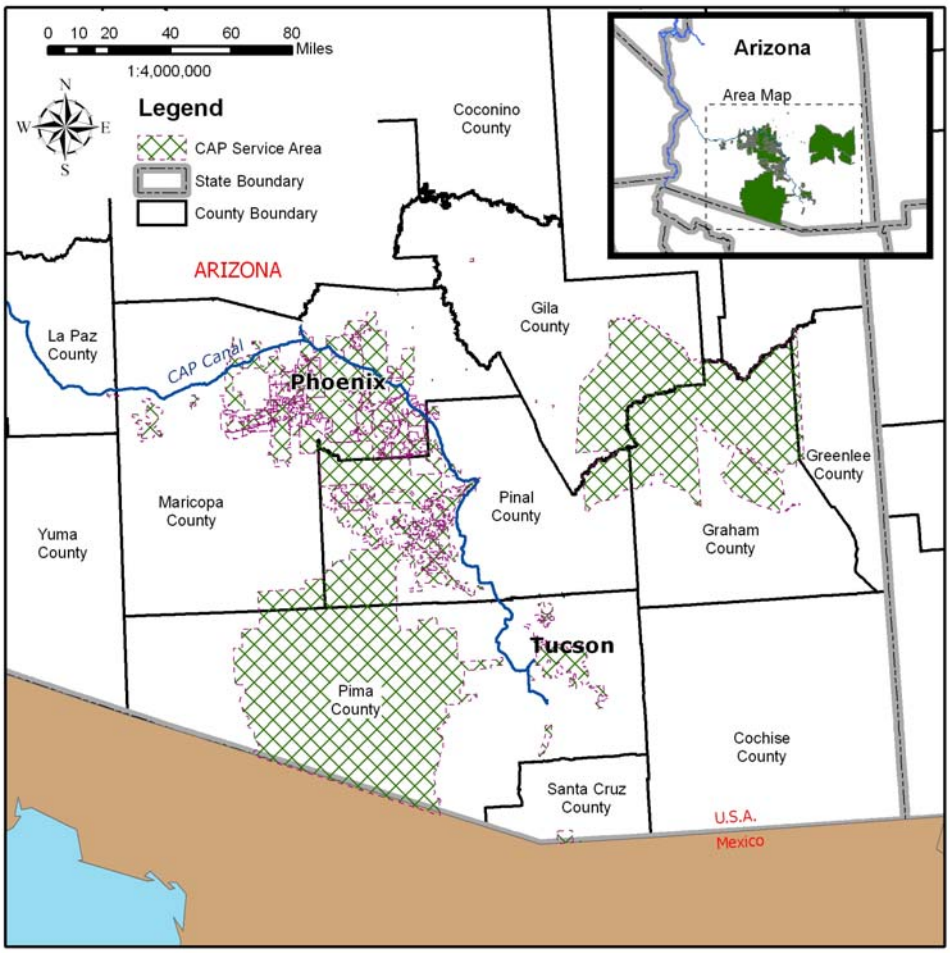


Table 3.2-2
CAP Water Users

Ak-Chin Indian Community	Eloy	Salt River
Apache Junction (AZ Water Co)	Florence	San Carlos (Phelps Dodge/Globe)
ASARCO (Ray Mine)	Flowing Wells ID	San Carlos Apache
Avondale	Fort McDowell	San Tan ID
Avra Coop	Gila River	Scottsdale
AZ State Land Dept.	Gilbert	Spanish Trail Water Co
AZ-American (Agua Fria)	Glendale	Superior
AZ-American (Paradise Valley)	Goodyear	Surprise
AZ-American (Sun City West)	Green Valley DWID	Tempe
AZ-American (Sun City)	H2O Water Co	Tohono O'odham Chui Chu District
Berneil Water Co (Cave Creek)	Marana	Tohono O'odham San Xavier District
Buckeye	Maricopa County Parks & Rec	Tohono O'odham Schuk Toak District
CAGRD	MDWID	Tonto Apache
Carefree Water Co	Mesa	Tonto Hills Utility Co
Casa Grande (AZ Water Co)	Oro Valley	Tucson
Cave Creek Water Co	Pasqua Yaqui	Unallocated HVID
Chandler Heights Citrus ID	Peoria	Vail Water Co
Chandler	Phelps Dodge Miami	Valley Utilities Water Co
Chaparral City Water Co	Phoenix Memorial Park	Water Util. Comm. Fac. Dist. (AJ)
Circle City Water Co	Phoenix	Water Util. Greater Buckeye
Comm. Water Co (Green Valley)	Pine Water Co	Water Util. Greater Tonopah
Coolidge (AZ Water Co)	Queen Creek Water Co	White Tank Sys. (AZ Water Co.)
El Mirage	Rio Verde Utilities	Yavapai Apache (Camp Verde)
		Yavapai Prescott

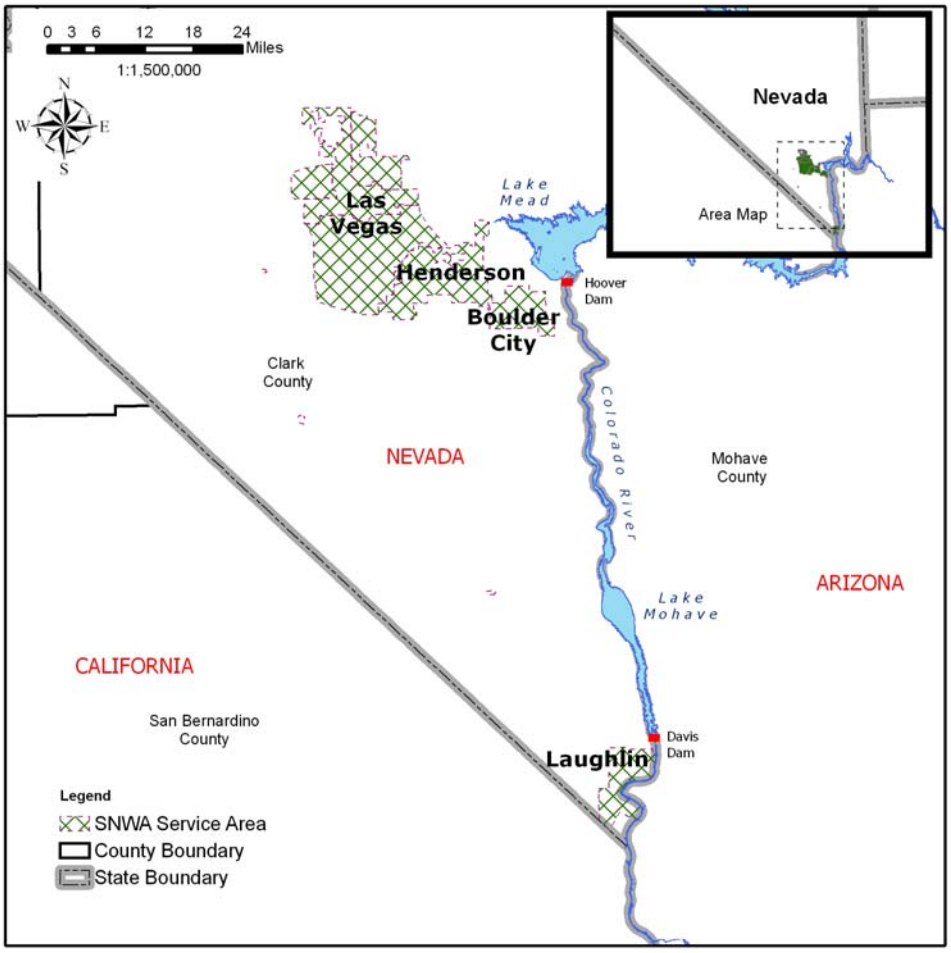
AZ Arizona

ID Irrigation District

3.2.2.2 Southern Nevada Water Authority Service Area

Most of the Colorado River water use in Nevada occurs in the southern portion of Nevada, primarily within the Las Vegas Valley and the Laughlin area approximately 60 miles south. The largest diversion is associated with the Las Vegas Valley water users who pump water from Lake Mead at Saddle Island (on the west shore of the lake's Boulder Basin) through facilities of SNWA. The SNWA member agencies include: Big Bend Water District, Boulder City, Clark County Water Reclamation District, Henderson, Las Vegas, Las Vegas Valley Water District, and North Las Vegas (Figure 3.2-4).

Figure 3.2-4
SNWA Service Area

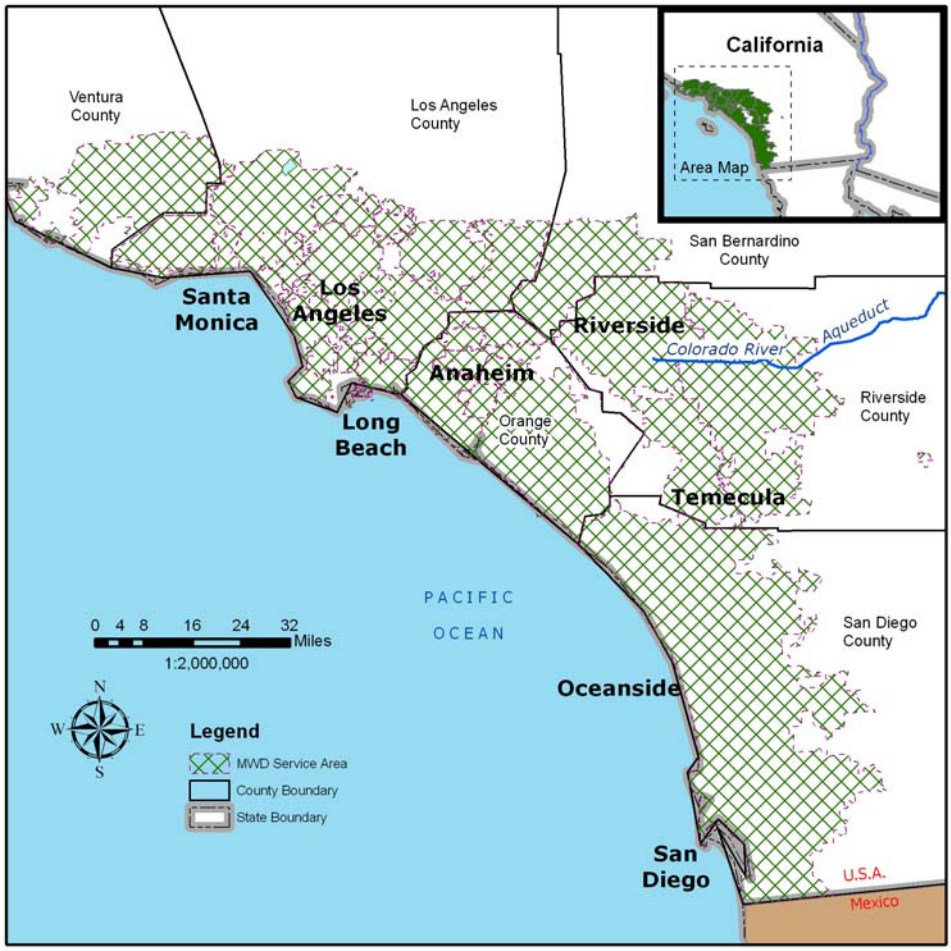


3.2.2.3 Metropolitan Water District of Southern California Service Area

MWD is a wholesale water agency that develops, stores, and distributes water to its member agencies. MWD owns and operates the Colorado River Aqueduct, which it uses to convey water from the Colorado River to its service area. MWD's Colorado River Aqueduct diversion is located at Lake Havasu.

MWD's service area covers the Southern California coastal plain. The total area served is nearly 5,200 square miles, and it includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. MWD is currently composed of 26 member agencies, including 14 cities, 11 municipal water districts, and one county water authority. Figure 3.2-5 shows the member agencies of MWD and the cities and communities served by those member agencies.

Figure 3.2-5
MWD Service Area



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3.3 Hydrologic Resources

Hydrologic resources within the study area that could potentially be affected by implementation of the proposed federal action include:

- reservoir storage, reservoir releases, and corresponding changes in Colorado River flows downstream of the reservoirs; and
- groundwater located within the Colorado River corridor and/or off-stream.

This section presents an overview of the hydrology of the Colorado River Basin, followed by descriptions of potentially affected hydrologic resources by river reach, from Lake Powell to the SIB.

A detailed description of the system facilities and current operations is provided in Appendix B. Water supply and water quality resources are discussed in Section 3.4 and Section 3.5, respectively.

3.3.1 Hydrologic Overview

Inflows into Lake Powell originate from the mainstream of the Colorado River, the Green River, and the San Juan River. Although most of the Colorado River Basin is comprised of desert or semi-arid rangelands, which generally receive less than 10 inches of precipitation per year, many of the mountainous areas that rim the Upper Basin receive, on average, over 40 inches of precipitation per year. Most of the total annual flow in the Colorado River Basin is the result of runoff from mountain snowmelt. As such, river flows are typically very high in the late spring and early summer and diminish rapidly by mid-summer. While flows in late summer through autumn sometimes increase following rain events, flow in the late summer through winter is generally low.

Due to variability in climatic conditions, natural flow in the system is highly variable from year to year. Natural flow is an estimate of the flow that would exist at a specific point in a natural setting, without upstream storage, alteration or depletion by humans. About 92 percent of the total natural flow in the lower Colorado River originates in only 15 percent of the watershed — in the mountains of Colorado, Utah, Wyoming and New Mexico. While the average annual natural flow from 1906 through 2004 at Lees Ferry Gaging Station in Arizona is calculated as approximately 15.024 maf, annual flows have ranged between 5.399 maf and 25.432 maf.

The natural flow calculated at Lees Ferry Gaging Station from 1906 through 2004 is shown in Figure 3.3-1. By comparison, the observed flows recorded at Lees Ferry Gaging Station for the period 1922 through 2005 are shown in Figure 3.3-2. The natural flow has been calculated from the observed flow by correcting for upstream reservoir changes in storage and release, losses including evaporation, as well as depletions due to agriculture and

domestic uses (Reclamation 2005). The natural flow record at the Lees Ferry Gaging Station has also been extended from 1922 back to 1906 by using other observed records (Lee / Salas 2006).

Figure 3.3-1
Natural Flow of the Colorado River at Lees Ferry Gaging Station, Arizona
1906 through 2004

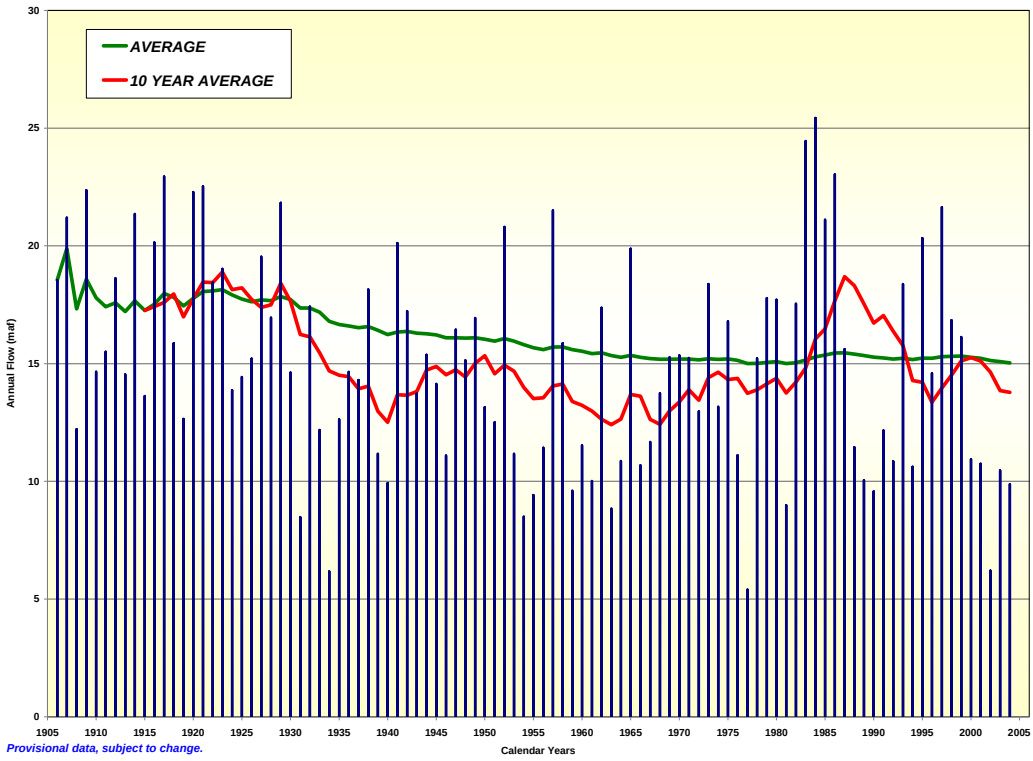

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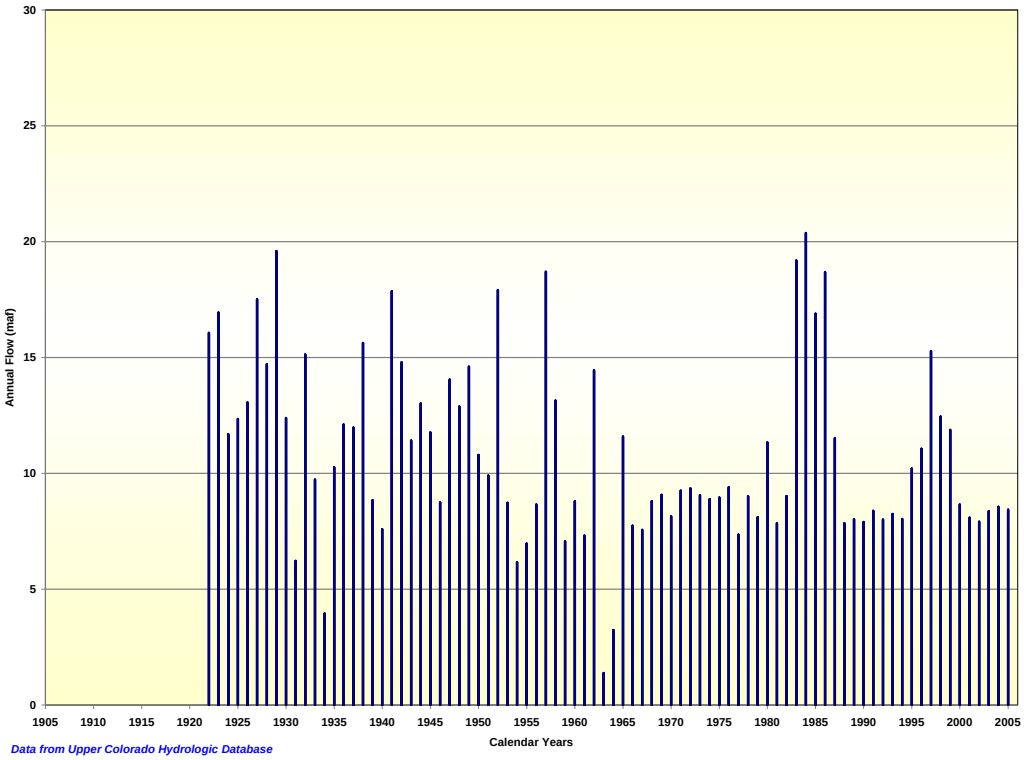
Figure 3.3-2
Historic Annual Flow of the Colorado River at Lees Ferry Gaging Station, Arizona
1922 through 2005



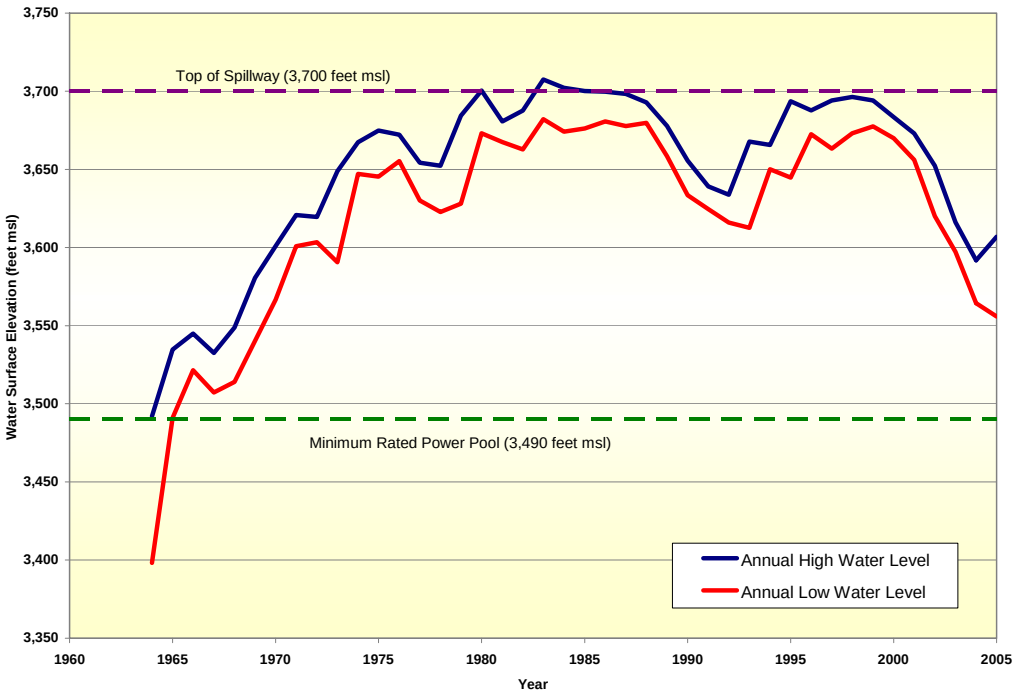
3.3.2 Lake Powell and Glen Canyon Dam

Lake Powell is the reservoir impounded by Glen Canyon Dam. Glen Canyon Dam and Lake Powell are operated consistent with the Colorado River Project Storage Act, the authoring legislation, which states that the purpose of the project is "to initiate the comprehensive development of the water resources of the Upper Colorado River Basin, for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes, to construct, operate, and maintain… "Additionally, some water deliveries are made directly from Lake Powell (e.g., for the city of Page, Arizona and for the Navajo Generating Station's cooling water).

The operating range of Lake Powell is between elevations 3,490 and 3,700 feet msl. Elevation 3,490 feet msl corresponds to minimum power pool. Releases from Glen Canyon Dam can be made below elevation 3,490 feet msl down to elevation 3,370 feet msl through the river bypass tubes. Elevation 3,700 feet msl corresponds to the top of the spillway radial gates, with the crest of each spillway at elevation 3,648 feet msl. The crest of Glen Canyon Dam itself is at elevation 3,715 feet msl.

Lake Powell began filling in 1962 and reached a high elevation of 3,708.34 feet msl in 1983. The elevation of the reservoir has ranged from an elevation of approximately 3,400 feet msl in 1964 to the 1983 maximum high elevation of 3,708.34 feet msl, as shown in Figure 3.3-3. The fluctuations in Lake Powell elevations are primarily the result of the highly variable hydrologic inflows into the Upper Basin as discussed in Section 1.7.

Figure 3.3-3
Historic Annual Lake Powell Water Levels
(Annual Highs and Lows)



Under the proposed federal action, future elevations of Lake Powell are expected to be within the range of historic water levels. However, the amount of time that the reservoir may be at any given elevation in the future may be affected by the proposed federal action. These potential effects are analyzed and discussed in Section 4.3.

Releases from Glen Canyon Dam are scheduled on an annual, monthly and hourly basis. The annual volume of water released from Glen Canyon Dam is made according to the provisions of the LROC that includes a minimum objective release of 8.23 maf, storage equalization between Lake Powell and Lake Mead under prescribed conditions, and the avoidance of spills. Annual releases from Lake Powell greater than the minimum objective release occur if Upper Basin storage is greater than the storage required by Section 602(a) of the CRBPA, if storage in Lake Powell is greater than the storage in Lake Mead, and to avoid anticipated spills (Appendix A).

Monthly release decisions are generally made to meet intermediate targets needed to systematically achieve the annual operating requirements, comply with the coordinated operation requirements of the CRBPA, and provide other authorized project benefits. The actual volume of water released from Lake Powell each month depends on the forecast inflow, storage targets, and annual release requirements described above. Demand for energy is also considered and accommodated within the constraints described above.

Glen Canyon Dam is operated consistent with the 1996 Glen Canyon Dam ROD (62 C.F.R. pt. 9447) developed as directed under the Grand Canyon Protection Act of 1992. The 1996 Glen Canyon Dam ROD describes criteria to ensure Glen Canyon Dam is operated in a manner consistent with the Grand Canyon Protection Act of 1992. The daily and hourly release constraints of Glen Canyon Dam are as shown in Table 3.3-1.

Table 3.3-1
Glen Canyon Dam Release Constraints

Parameter	Release Volume (cfs)	Conditions
Maximum Flow[1]	25,000	
Minimum Flow	5,000	Nighttime
	8,000	7:00 a.m. to 7:00 p.m.
Ramp Rates		
Ascending	4,000	Per hour
Descending	1,500	Per hour
Daily Fluctuations[2]	5,000 to 8,000	

1 May be exceeded for emergency and during extreme hydrological conditions.

2 Daily fluctuation limit is 5,000 cubic feet per second (cfs) for months with release volumes less than 0.6 maf; 6,000 cfs for monthly release volumes of 0.6 maf to 0.8 maf; and 8,000 cfs for monthly volumes over 0.8 maf.

Future daily and hourly releases are expected to continue to be made according to the parameters of the 1996 Glen Canyon Dam ROD and will not be affected by the proposed federal action. However, the annual minimum release as well as the monthly distribution of releases may be affected; these potential effects are analyzed and discussed in Section 4.3.

In addition to the daily and hourly release constraints discussed previously, the 1996 Glen Canyon Dam ROD implemented an Adaptive Management Program that provides a process for assessing the effects of Glen Canyon Dam operations on downstream resources, and by using the results to develop recommendations to the Secretary with regard to Glen Canyon Dam operations and other resource management actions. These recommendations have included releases for sediment conservation (i.e., BHBF), modification of powerplant fluctuations, non-native fish removal, and native fish translocation. Recommendations are developed by the AMWG, a federal advisory committee. Long-term monitoring and research activities provide a continuous record of resource conditions for use in evaluating the effectiveness of any subsequent actions.

3.3.3 Glen Canyon Dam to Lake Mead

The segment of the Colorado River between Glen Canyon Dam and Lake Mead is a narrow river corridor through Marble Canyon, Glen Canyon, and Grand Canyon. The flows in this river reach are primarily from the controlled releases from Glen Canyon Dam (Lake Powell) with contributions from the tributaries between Glen Canyon Dam and Lake Mead. Releases from Glen Canyon Dam are managed as discussed in the previous section.

The Paria River and the Little Colorado River are the major tributaries that discharge to the Colorado River within this reach. The Paria River is a perennial stream and provides the principal drainage for the Painted Desert. The Little Colorado River is also a perennial stream and it drains the rugged and arid region southeast of the Colorado River.

Inflows from these two tributaries are variable and on average provide less than three percent of the total flow in this reach. For the 99-year period from 1906 through 2004, the annual inflow from the Little Colorado River ranged from 17 kaf to 643 kaf and averaged 179 kafy. During this same period, the annual inflow from the Paria River ranged from 9 kaf to 48 kaf and averaged 20 kafy. By contrast, the annual release from Glen Canyon Dam from 1996 to 2005 ranged from 7,795 kaf to 15,289 kaf and averaged 9,975 kafy.

The daily and hourly releases from Glen Canyon Dam and therefore the daily and hourly flows in this reach will not be affected by the proposed federal action. However, the monthly and annual flows in this reach may be affected; these potential effects are analyzed and discussed in Section 4.3.

Groundwater in hydraulic connection with the Colorado River in the Grand Canyon is limited to sandbars. Due to the incised nature of this river corridor, there are no anticipated groundwater related issues that need to be considered.

3.3.4 Lake Mead and Hoover Dam

Lake Mead is the reservoir impounded by Hoover Dam and in accordance with the BCPA, is operated to meet the following priorities:

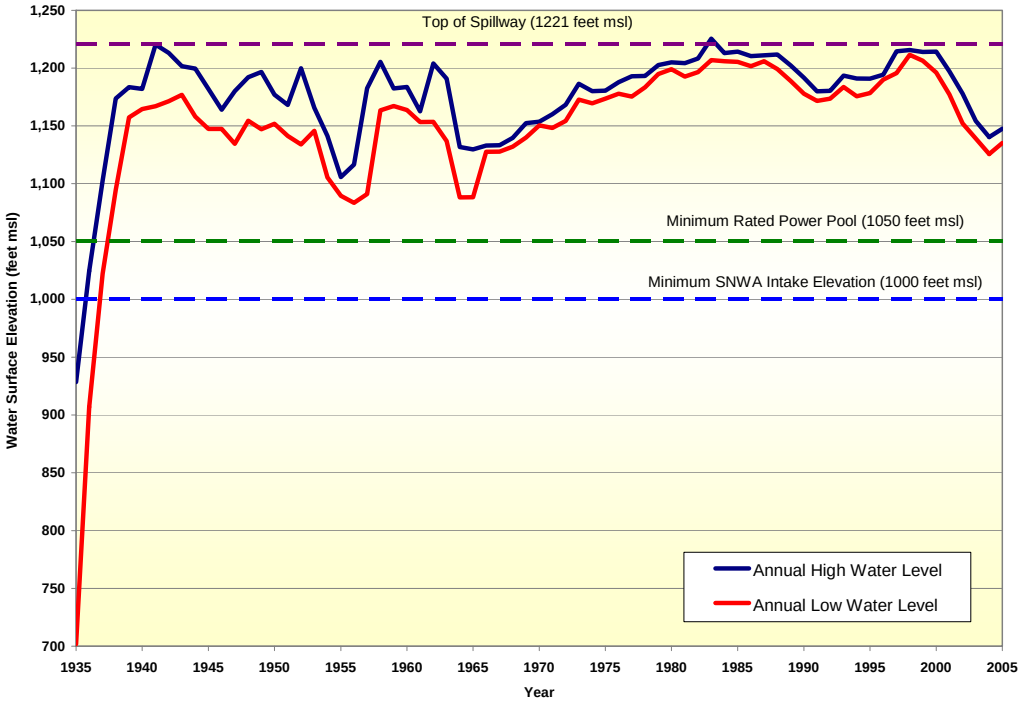
1) to provide river regulation, improvement of navigation, and flood control;

2) to provide water to meet irrigation and domestic uses, including the satisfaction of present perfected water rights; and

3) to generate hydropower.

The typical operating range of Lake Mead is between elevations 1,219.6 and 1,050 feet msl. Elevation 1,050 feet msl corresponds to the minimum power pool. Releases through the turbines can be made from Hoover Dam below elevation 1,050 feet msl down to 895 feet msl through the intake towers, although the turbines currently in place would require modification or replacement to consistently generate hydropower below elevation 1,050 feet msl. The crest of the spillways is at elevation 1,205.4 feet msl and the top of the raised spillway gates is at elevation 1,221.0 feet msl. The storage space above elevation 1,219.6 feet msl is reserved exclusively for flood control purposes. Since its initial filling in the late 1930s, the Lake Mead elevations have fluctuated from a high of 1,225.8 feet msl in July 1983 to a low of 1,083.2 feet msl in April 1956, as illustrated in Figure 3.3-4.

Figure 3.3-4
Historic Annual Lake Mead Elevations
(Annual Highs and Lows)



Future Lake Mead elevations may be affected by the proposed federal action. These potential effects are analyzed and discussed in Section 4.3.

Lake Mead's annual release is determined either by strict flood control regulations or to meet the water use apportionments to the Lower Division states and allotment to Mexico.

The USACE is responsible for developing the flood control operation plan for Hoover Dam and Lake Mead (33 C.F.R. pt. 208.11) and the Secretary is responsible for operating Hoover Dam in accordance with these regulations. The current regulations were implemented under the Field Working Agreement[1] which set forth criteria to meet system space requirements in the fall (August through December) and to determine reservoir releases during the spring runoff season (January through July). During all months of the year, the top 1.5 maf of space (the space above elevation 1,219.6 feet msl) is reserved exclusively for flood control purposes. Lake Mead is considered to be under flood control operations when the regulations determine that releases need to be made in excess of those necessary to meet water use demands in order to make available this flood control space.

Water use demands are determined by the apportionments to each Lower Division state and Mexico. For the Lower Division states, the Secretary determines the water supply condition for each year (Surplus, Normal, or Shortage), as specified by the Consolidated Decree and the LROC. Under Normal conditions, water is delivered to meet a total of 7.5 maf of use by the Lower Division states. Under Surplus conditions, additional water can be made available for consumptive use in the Lower Division states. Adopted in 2001 and extending through 2016, the ISG provide additional guidance on the amount and use of surplus water depending upon Lake Mead's elevation and other factors. Under Shortage conditions, an amount of water less than 7.5 maf would be made available for use by the Lower Division states. However, as noted in Section 1.3 there are currently no guidelines with regard to when and by how much water supplies would be reduced.

In addition to the releases to meet the Lower Division states' consumptive use, releases are made from Hoover Dam to meet Mexico's water schedule. In accordance with the 1944 Treaty, Mexico can schedule a total delivery of 1.5 maf each year and under current practice, up to an additional 200 kaf during flood control years when and the water supply exceeds the needs of Colorado River water users in the United States.

During non-flood control operations, the end-of-month Lake Mead elevations are driven by water needs pumped from and delivered below Hoover Dam and releases from Glen Canyon Dam, and tributary inflows. Lake Mead end-of-month target elevations are not fixed as are the end-of-month target elevations for Lake Mohave and Lake Havasu. Normally, Lake Mead elevations decline with increasing irrigation deliveries through June and July and then rise slightly by November and December.

[1] Field Working Agreement between the Department of the Interior, Bureau of Reclamation and USACE for Flood Control Operation of Hoover Dam and Lake Mead, Colorado River, Nevada-Arizona, February 8, 1984.

Hoover Dam releases are managed on an hourly basis to maximize the value of generated power by providing peaking during high-demand periods. The monthly release is determined based on water demands and is converted to a monthly energy target. The Hoover Dam powerplant is run on a real-time basis to meet fluctuating energy and capacity demands while meeting the end-of-month energy target. This results in fluctuating hourly flows below Hoover Dam that can typically vary from 1,000 cfs to 49,000 cfs. However, these flows are regulated by Lake Mohave immediately downstream. For the 10-year period from 1996 to 2005, annual releases from Hoover Dam have ranged from 8.275 maf to 12.776 maf and averaged 10.380 mafy.

Hourly and daily releases from Hoover Dam will not be affected by this proposed federal action. However, the proposed federal action may alter the annual release as well as the monthly distribution of those releases. These potential effects are analyzed and discussed in Section 4.3.

3.3.5 Hoover Dam to Davis Dam

The 67-mile reach from Hoover Dam to Davis Dam is dominated by Lake Mohave, the reservoir formed by Davis Dam. The upper part of this reach is bounded by the steep walls of Pyramid Canyon, El Dorado Canyon, and Black Canyon. Lake Mohave is relatively narrow, not more than four miles across at its widest point. At the high reservoir elevations (635 feet msl), the backwater from Lake Mohave affects the river stage (known as the tailbay) just downstream of Hoover Dam. Although there are some minor side washes in this river reach, the flows in this reach are comprised almost entirely of releases from Hoover Dam.

The hourly and daily operation of Hoover Dam will not be affected by the proposed federal action. As such, the hourly and daily flows through this river reach will also not be affected.

Although the annual and monthly releases from Hoover Dam may be affected by the proposed federal action, Lake Mohave will continue to be operated to meet monthly target elevations as explained in Appendix B. Lake Mohave generally reaches its maximum elevation in the spring and its minimum elevation in the fall. Reclamation generally lowers the lake level in the fall to provide flood control storage space for runoff that results from large hurricane-type storms coming up-river from Baja California, Mexico. The minimum elevation of Lake Mohave under future conditions will continue to be about 630 feet msl. The maximum target elevation will continue to be 646.5 feet msl. Therefore, the proposed federal action will not change the range of elevations that have been historically observed in Lake Mohave. Combined with the extent of this reach occupied by Lake Mohave, these potential changes in Hoover Dam monthly and annual releases will have no effect on this reach.

The upper section of this reach is the narrow Black Canyon immediately below Hoover Dam. Groundwater connected to the river in this bedrock canyon is limited to a few small sandbars. The rest of this reach is dominated by Lake Mohave. As noted above, the proposed federal action will have no effect on the operation of Lake Mohave or the elevations in this reservoir. Therefore, there are no anticipated effects of the proposed federal action to these groundwater basins.

3.3.6 Davis Dam to Parker Dam

This reach is approximately 84 miles long and it is bounded downstream by Parker Dam which forms Lake Havasu. Lake Havasu provides a forebay and desilting basin from which water is pumped into aqueducts for delivery to the MWD and CAP service areas. Above Lake Havasu, there are some minor tributaries. However, the flows in the reach are comprised almost entirely of releases from Davis Dam.

The largest tributary in this reach is the Bill Williams River, which flows directly into Lake Havasu. Inflows from the Bill Williams River are regulated by USACE operations of Alamo Dam upstream and are typically small (on the order of 50 cfs). Larger flows from the Bill Williams River are concentrated over short periods of time and are due to flood control operations at Alamo Dam. For the 99-year period from 1906 to 2004, the annual inflow to the Colorado River mainstream from the Bill Williams River ranged from 1.3 kaf to 702 kaf and averaged 98 kafy. By contrast, during the 10-year period from 1996 to 2005, the annual releases from Davis Dam ranged from 8.000 kaf to 12.587 kaf, and averaged approximately 10.092 kafy.

Releases from Davis Dam are scheduled on a daily and hourly basis, primarily to meet downstream water needs, although the hourly release pattern is typically shaped to meet demand for power. Releases can range from a maximum of 28,000 cfs to a minimum of about 1,000 cfs, the minimum flow needed to run one turbine at about one-half capacity. Such low flows are usually associated with downstream flooding, construction, search and rescue, or other emergency conditions.

The ranges of hourly releases from Davis Dam and the corresponding ranges of flows in this river reach will not be affected by this proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

Although releases from Davis Dam may be affected by the proposed federal action, Lake Havasu will continue to be operated to meet monthly target elevations as explained in Appendix B.

Lake Havasu generally reaches its maximum elevation in the spring and its minimum elevation in the winter. Similar to Lake Mohave, Reclamation generally lowers the lake level during the winter months to provide flood control storage space for runoff that results from large storms coming up-river from Baja California, Mexico. The minimum elevation of Lake Havasu under future conditions will continue to be about 445.8 feet msl. Reclamation attempts to accommodate this minimum target elevation when other higher priority uses are not compromised. The maximum target elevation will continue to be 450.5 feet msl. Therefore, the proposed federal action will not affect the range of historically observed Lake Havasu elevations.

The Davis Dam to Parker Dam reach of the Colorado River flows through two separate groundwater basins. The bedrock Topock Narrows separates the Mohave Valley to the north of the narrows from the Chemehuevi Valley to the south. On the Arizona side, the valley south of Topock Narrows is called the Lake Havasu basin.

The aquifer in Mohave Valley is mostly alluvial fill deposited by both the river and the washes draining to the river from the mountains bounding the valley, and may be affected by the proposed federal action. The potential effects due to the potential change in river flows are in this segment of this river reach are analyzed and discussed in Section 4.3.

The portion of the river reach that is located within the Chemehuevi Valley and the Lake Havasu basin is dominated by Lake Havasu. As noted above, the proposed federal action will have no effect on the operation of Lake Havasu or the elevations in this reservoir. Therefore, there are no anticipated effects of the proposed federal action to the groundwater basins underlying the Chemehuevi Valley and the Lake Havasu basin.

3.3.7 Parker Dam to Cibola Gage

This reach is approximately 105 miles long and it is bounded by Reclamation's Cibola Gage at RM 87.3 downstream. Although there are some minor drainages, flows in this reach are almost entirely comprised of releases from Parker Dam to meet water delivery requirements in the United States and Mexico.

Similar to Davis Dam, releases from Parker Dam are scheduled on daily and hourly basis, primarily to meet downstream water needs, although the hourly release pattern is typically shaped to meet demand for power. Releases can range from a maximum of 16,800 cfs to a minimum of about 1,000 cfs, the minimum flow needed to run one turbine at about one-half capacity. Such low flows are usually associated with downstream flooding, construction, search and rescue, or other emergency conditions. For the 10-year period from 1996 to 2005, annual releases from Parker Dam have ranged from 6.185 maf to 10.344 maf and averaged 7.578 mafy.

The ranges of hourly releases from Parker Dam and the corresponding ranges of flows in this river reach will not be affected by this proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

Impoundments associated with the two major diversion dams located in this reach (Headgate Rock Dam, diverting water for use by the Colorado River Indian tribes, and Palo Verde Diversion Dam, diverting water for use by the Palo Verde Irrigation District) are operated at nearly constant levels in order to facilitate the diversion of water. These facilities will continue to be operated in this same manner and therefore, the elevations of these impoundments will not be affected by the proposed federal action. However, releases from the diversion dams may be affected; these potential effects are analyzed discussed and analyzed in Section 4.3.

The Colorado River from Parker Dam to Cibola Gage flows through one very large groundwater basin but it is typically referred to by separate valley names (Parker Valley, Cibola Valley, and Palo Verde Valley). The aquifer underlying these valleys is mostly alluvial fill deposited by the river and secondarily by the washes draining to the river from the mountains bounding the valleys. The potential effects due to the potential change in river flows are analyzed and discussed in Section 4.3.

3.3.8 Cibola Gage to Imperial Dam

This reach is approximately 38 miles long and it is bounded by Imperial Dam downstream. Although there are some minor drainages, flows in this reach are almost entirely comprised of the water released from Parker Dam reduced by upstream depletions, including diversions of water for the Colorado River Indian tribes and the Palo Verde Irrigation District.

The ranges of hourly releases from Parker Dam and the corresponding ranges of flows in this river reach will not be affected by this proposed federal action. However, the shape and duration of hourly flows and the corresponding daily, monthly, and annual flows may be affected; these potential effects are analyzed and discussed in Section 4.3.

The impoundment associated with Imperial Dam is operated at a nearly constant level in order to facilitate the diversion of water. The AAC diverts water from the California side of Imperial Dam and serves IID, CVWD, the Yuma Project in Arizona and California, the City of Yuma, and Mexico. The Gila Gravity Main Canal system diverts water from the Arizona side of Imperial Dam and serves the north and south Gila Valley, Yuma Mesa, and Wellton-Mohawk area. This facility will continue to be operated in this same manner and therefore, the elevations of this impoundment will not be affected by the proposed federal action.

Senator Wash, an off-stream reservoir just upstream of Imperial Dam is used to store and release mainstream water to meet demands at Imperial Dam. It will continue to be operated in the same manner to manage water deliveries and will not be affected by the proposed federal action.

The Colorado River from the Cibola Gage to Imperial Dam flows through a relatively narrow alluvial fill valley. There is no irrigated agriculture along this reach and there are many backwaters, especially in the southern half of the reach. The potential effects due to the potential change in river flows are analyzed and discussed in Section 4.3.

3.3.9 Imperial Dam to NIB

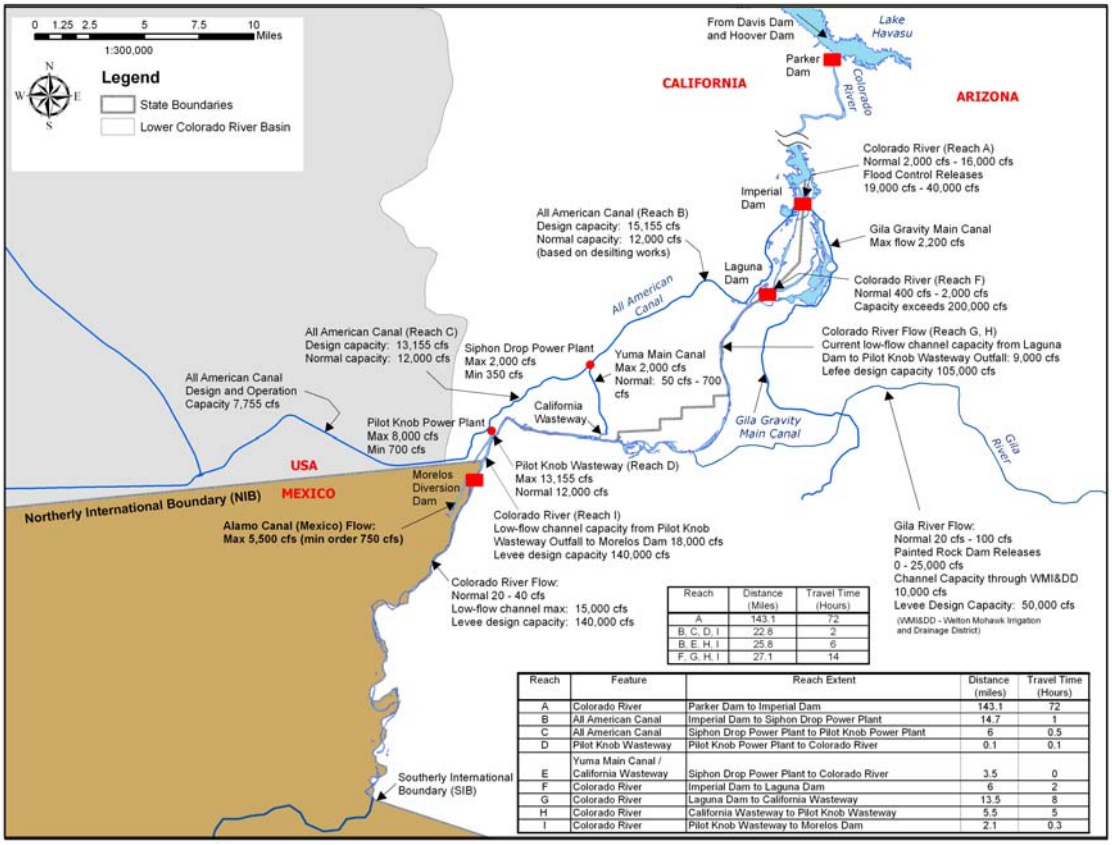
This reach is approximately 26 miles long and is bounded by the NIB downstream. Excluding inflows from the confluence of the Gila River, flows in this reach are comprised primarily of water that has leaked or been released from Imperial Dam and return flows from water diverted at Imperial Dam.

The flows in the upper portion of this reach (just below Imperial Dam) typically range from about 250 cfs to 350 cfs and are comprised principally of return flows from the AAC desilting basins, gate leakage from the California sluiceway gates at Imperial Dam, and occasional small releases to meet Mexico's scheduled water deliveries at the NIB. In addition, water may be released to remove sediment accumulated from the desilting basins in the sluiceway channel (known as "sluicing flows"). These flows occur two to three times per month, may range from 8,000 cfs to 12,000 cfs, and the duration may be up to 20 minutes. Laguna Dam, just downstream of Imperial Dam, is used to capture these sluicing flows for subsequent delivery downstream. These operations and the flows in the upper portion of the reach will not be affected by the proposed federal action.

The drainage return flows originate from the irrigated lands located in the Yuma area and are nearly constant throughout the year and from year to year. These drainage return flows comprise both gravity and pumped drainage flows and are not expected to be affected by the proposed federal action.

Most of Mexico's scheduled delivery at the NIB is diverted at Imperial Dam into the AAC and returned to the river through the Pilot Knob and Siphon Drop Powerplants and their respective wasteway channels, 2.1 miles and 7.6 miles upstream of the NIB, respectively. Mexico diverts that water at Morelos Diversion Dam which it owns, operates, and maintains. Figure 3.3-5 show how water deliveries to Mexico pursuant to the 1944 Treaty are routed from Imperial Dam to the NIB, as well as the source and routing of other flows that occur between Imperial Dam and the NIB. The proposed federal action will not alter the operation of these diversions and wasteways.

Figure 3.3-5
Water Routing from Imperial Dam to NIB
Deliveries to Mexico Pursuant to the 1944 Treaty



Reach	Distance (Miles)	Travel Time (Hours)
A	143.1	72
B, C, D, I	22.8	2
B, E, H, I	25.8	6
F, G, H, I	27.1	14

Reach	Feature	Reach Extent	Distance (miles)	Travel Time (Hours)
A	Colorado River	Parker Dam to Imperial Dam	143.1	72
B	All American Canal	Imperial Dam to Siphon Drop Power Plant	14.7	1
C	All American Canal	Siphon Drop Power Plant to Pilot Knob Power Plant	6	0.5
D	Pilot Knob Wasteway	Pilot Knob Power Plant to Colorado River	0.1	0.1
E	Yuma Main Canal / California Wasteway	Siphon Drop Power Plant to Colorado River	3.5	0
F	Colorado River	Imperial Dam to Laguna Dam	6	2
G	Colorado River	Laguna Dam to California Wasteway	13.5	8
H	Colorado River	California Wasteway to Pilot Knob Wasteway	5.5	5
I	Colorado River	Pilot Knob Wasteway to Morelos Dam	2.1	0.3

The Gila River is highly regulated and although inflows from the Gila River to the mainstream of the Colorado River have averaged approximately 250 kafy over the past 75 years, these inflows occur very sporadically and they are of very high magnitudes. These inflows are not expected to be affected by the proposed federal action.

Groundwater basins proximal to the Colorado River within this reach include portions of the Yuma Valley and the South Gila Valley. With the exception of the Yuma Valley, these basins are generally small in size and are bounded by zones of non-water-bearing rock. As noted above, the method used to route water from Imperial Dam to the NIB bypasses most of the river channel and the proposed federal action will not affect these operations. Therefore, the portions of the groundwater basins adjacent to this reach are not anticipated to be affected by the proposed federal action.

3.3.10 NIB to SIB

Mexico diverts the majority of its Colorado River water supply at Morelos Diversion Dam, and only limited flows occur in the river reach that extends between Morelos Diversion Dam and SIB. These flows may occur as a result of:

1) seepage from Morelos Diversion Dam;

2) water in excess of Mexico's scheduled delivery (e.g. flood flows, cancelled orders in the United States) not diverted by Mexico and released from Morelos Diversion Dam;

3) irrigation return flows from Mexico and the United States; and

4) groundwater accumulation from both the United States and Mexico.

Water released from Parker Dam, under orders from irrigation districts in Imperial Valley, Coachella Valley, and the lower Colorado River Valley, normally takes up to three days to reach its point of diversion. Occasionally, unforeseen events such as localized precipitation force the irrigation districts to cancel these water delivery orders after the water has been released at Parker Dam. Usually, the water is diverted at Morelos Diversion Dam for use in Mexico. However, some of this water may flow past Morelos Diversion Dam. The proposed federal action will not affect water that flows past the NIB as a result of canceled water orders.

Morelos Diversion Dam forms an impoundment that facilitates Mexico's diversion of water from the Colorado River. The elevation of this impoundment is maintained at a nearly constant level in order to facilitate the diversion of water by Mexico. It is anticipated that Mexico will continue to operate Morelos Diversion Dam and this impoundment in this same manner, and therefore, elevations of this impoundment will not be affected by the proposed federal action. Accordingly, the rate of seepage that occurs at Morelos Diversion Dam will not be affected by the proposed federal action.

Gila River flood events reaching the mainstream of the Colorado River are rare. Only once has flow been recorded over 4,000 cfs at the Dome Gaging Station, Arizona, since 1941. In 1993, up to 27,500 cfs flowed past the Dome Gaging Station as a result of the 1993 Gila River flood (USGS 1999). The 1993 flood created much of the habitat presently found along the Colorado River below its confluence with the Gila River (Glenn 2000). The proposed federal action will not affect water that flows past the NIB as a result of Gila River flood events.

Excess flows to Mexico are almost entirely due to flood control releases originating at Hoover Dam. These flood control releases are dictated by the flood control criteria established for Lake Mead and Hoover Dam and are largely dependent upon hydrologic conditions. The proposed federal action may affect the frequency and magnitude of flood control operations that originate at Hoover Dam due to potential changes in reservoir storage that occurs under the different action alternatives. These potential effects are analyzed and discussed in Section 4.3.

The Colorado River from the NIB to the SIB flows through the large and deep Colorado River delta groundwater basin. The upper portion of this reach is a gaining reach, which means that groundwater enters the channel and provides a portion of the river flow. This occurs because the high groundwater level in the adjacent lands has a sloping gradient that intercepts the channel. The proposed federal action is not expected to affect this gaining reach because the high groundwater levels occur due to application of water on the adjacent irrigated lands, a condition that will remain unchanged.

The lower part of this reach is a losing reach which means that a portion of the flows from the river channel provides recharge to the groundwater basin. However, the proposed federal action will not affect the flows that normally occur in this lower part of this river reach and that contribute to groundwater recharge. Therefore, the portions of the groundwater basins adjacent to this reach are not anticipated to be affected by the proposed federal action.

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3.4 Water Deliveries

Colorado River water is delivered to entities in the seven Basin States and Mexico, consistent with a body of documents often referred to as the Law of the River, as discussed in Section 1.7. Water is diverted from the river at various points and used for irrigation and domestic purposes. A portion of the diverted water may be returned to the river for subsequent use downstream and is referred to as return flow. The net amount of water used (termed consumptive use or depletion) is equal to the diversion less the return flow.

This section describes the water deliveries within the study area that could potentially be affected by implementation of the proposed federal action, including shortage determinations, the storage and delivery of conserved water in Lake Mead, and modification and/or extension of the ISG.

3.4.1 Apportionments to the Upper Division States

As described in Section 1.7, the Compact apportioned 7.5 maf of water per year for consumptive use in the Upper Basin and stipulated that the flow in the river at the Lee Ferry Compact Point not be depleted below 75 maf for any consecutive 10-year period. The Upper Colorado River Basin Compact of 1948 allocated the Upper Basin apportionment among the four Upper Division states. The apportionments are based on percentages of the total quantity of consumptive use available each year within the Upper Basin remaining after deduction of the use, not to exceed 50,000 afy made in the State of Arizona. These apportionment percentages are provided in Table 3.4-1.

Table 3.4-1
Upper Division States Apportionment

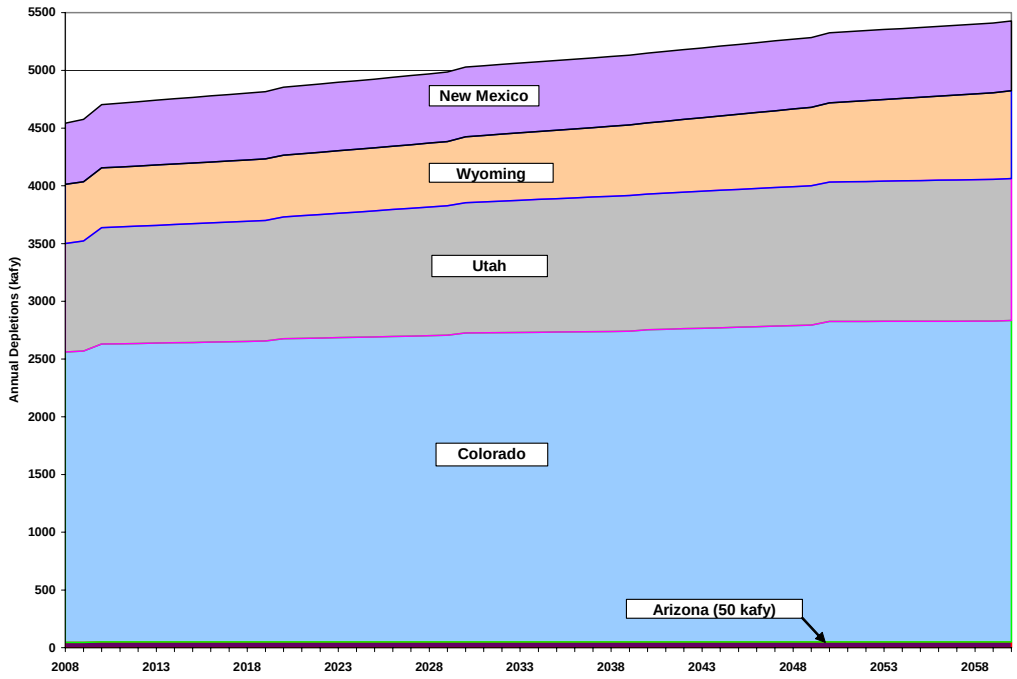
State	Annual Apportionment (%)
Colorado	51.75
New Mexico	11.25
Utah	23.00
Wyoming	14.00

The Upper Colorado River Basin Compact of 1948 also established the Upper Colorado River Commission (Commission). The Commission is an interstate administrative agency, that among other duties, makes findings with regard to the annual quantities of Colorado River water that are available for use and are used by each Upper Basin state, and the annual quantity of water delivered at Lee Ferry. Reclamation operates the mainstream reservoirs to meet the project purposes including the delivery of water downstream. Each Upper Division state regulates and controls the use of Colorado River water within its boundaries.

The depletion schedules for the Upper Basin states were developed by the Commission and submitted to Reclamation in December 1999. These depletions were subsequently updated by Reclamation in coordination with the Commission to include updated Indian tribe depletions (Appendix C).

Figure 3.4-1 shows that the total scheduled depletion of the Upper Division states increases from approximately 4.5 maf in 2008 to approximately 5.4 maf by 2060. These schedules do not include the evaporation losses that occur within the Upper Basin, estimated to average approximately 574,000 afy.

Figure 3.4-1
Upper Basin Scheduled Depletions
Years 2008 to 2060



The proposed federal action would not affect the apportionments to the Upper Division states nor their ability to use those apportionments.

3.4.2 Apportionments to the Lower Division States and Water Entitlements within Each State

The apportionments to the Lower Division states which were established by the BCPA and confirmed by the Consolidated Decree are provided in Table 3.4-2.

Table 3.4-2
Lower Division States Apportionment

State	Annual Apportionment (maf)
Arizona	2.8
California	4.4
Nevada	0.3
Total	7.5

The apportionments to the Lower Division states would not be affected by the proposed federal action.

3.4.2.1 Water Delivery Entitlements to Entities in the Lower Division States

With the exception of approximately 10,000 af in the state of Arizona, all of the water apportioned to each Lower Division state by the BCPA is allocated to specific entities within each state. These allocations, known as entitlements, are established in accordance with the BCPA and the Consolidated Decree.

Section 5 of the BCPA authorizes the Secretary to operate as the contracting authority for the delivery of water from the lower Colorado River and requires any user of Colorado River water in the Lower Basin to have a water delivery contract with Reclamation. This requirement, which was confirmed by the Consolidated Decree, applies to all diversions made from the river except for federal establishments and PPRs.

For Colorado River water users in the Lower Division states, an entitlement to use Colorado River water can exist in one of three forms: (i) a Consolidated Court decreed right, (ii) a Section 5 water delivery contract with the Secretary of the Interior, or (iii) a Secretarial Reservation.

A "decreed right" is a right to use water defined by the Consolidated Decree. The right, which must have existed prior to June 15, 1929 (the effective date of the BCPA), is also referred to as a PPR. The Consolidated Decree lists and quantifies these PPRs. A summary of the total volumes of water apportioned to the PPRs in each of the Lower Division states is provided in Table 3.4-3. These entitlements are summarized based on the diversion and consumptive-use entitlements. The return flow credits used to compute consumptive use have been estimated from historical data.

Table 3.4-3
Volumes of Water Apportioned to PPRs in the Lower Division States

State	Estimated Diversion Entitlement (afy)	Estimated Consumptive-use Entitlement (afy)
Arizona	1,078,398	618,172
California	3,019,573	2,723,325
Nevada	13,034	8,898
Total Lower Division States	4,111,005	3,350,395

A Section 5 water delivery contract is a written agreement between the United States, through the Secretary or his/her duly authorized representative, and another person or entity. All Colorado River water delivery contracts in the Lower Basin are for permanent service, as provided in the BCPA. The form and content of these contracts have evolved since 1929 to reflect advancements in flow measurement, water scheduling, and water accounting technology. Water delivery contracts describe the entitlement in terms of an annual diversion right, an annual consumptive use right, or in some cases both.

A "Secretarial Reservation" is an entitlement established by the Secretary. Secretarial Reservations have been used to reserve Colorado River water for use at federal facilities or lands. Secretarial Reservations have been exercised for Colorado River water use at the Cibola NWR, for use on BLM lands, and for uses at Hoover Dam and Davis Dam.

The proposed federal action will not affect the entitlements to Colorado River water for water users in the Lower Division states. However, water deliveries to each state and to users within each state may potentially be affected and are analyzed and discussed in Section 4.4.

3.4.3 Lower Division States Water Supply Determination

In accordance with the Consolidated Decree and Article III of the LROC, the Secretary determines yearly the water supply condition for the Lower Division states. The conditions are as follows:

- Normal condition: when sufficient mainstream water is available to satisfy 7.5 maf of consumptive use in the Lower Division states;
- Surplus condition: when sufficient mainstream water is available to satisfy in excess of 7.5 maf of consumptive use in the Lower Division states; and
- Shortage condition: when insufficient mainstream water is available to satisfy 7.5 maf of consumptive use in the Lower Division states.

Under a Surplus condition, the Consolidated Decree apportioned 46 percent of the surplus in excess of 7.5 maf for use in Arizona, 50 percent for use in California, and 4 percent for use in Nevada. The ISG established further guidelines for the Secretary's decision with regard to when a surplus would be declared and the volumes and type of use (e.g., agriculture and domestic use) of that surplus water, including the recognition of any agreements between the states that might modify how the surplus waters would be divided amongst the states (known as "forbearance" agreements).

Under a Shortage condition, the Consolidated Decree directs the Secretary to first satisfy all PPR's in order of their priority dates without regard to state lines, and then to apportion any remaining shortage amount consistent with the BCPA and other applicable federal statutes. The CRBPA states that satisfaction of all PPRs and California's 4.4 maf apportionment would have priority over CAP and other post-1968 water delivery contracts. It also states that Nevada shall not be required to bear shortages in any proportion greater than would have been imposed in the absence of the CRBPA. The proposed federal action will provide guidance to the Secretary's annual determination of the water supply condition for the Lower Division states, and are analyzed and discussed in Section 4.4.

3.4.4 Depletion Schedules for Lower Division States (Normal and Surplus)

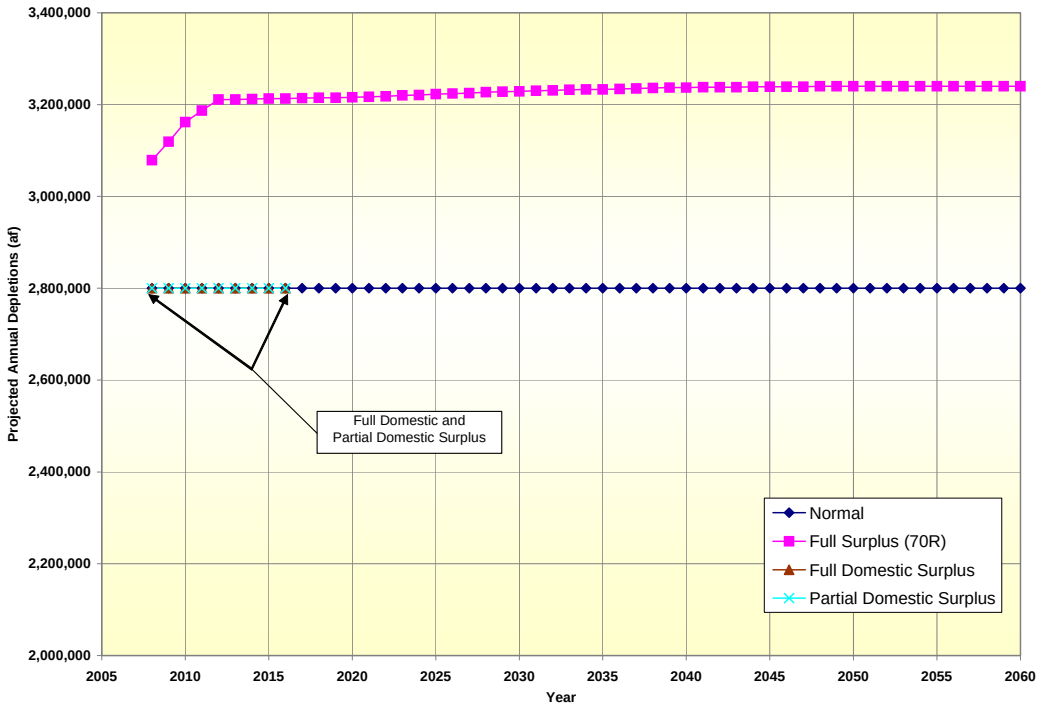
The following sections describe the projected depletions of the three Lower Division states, Arizona, California, and Nevada, for Normal and Surplus conditions, under the No Action Alternative. Surplus schedules for each action alternative are presented in Appendix D.

3.4.4.1 State of Arizona

Arizona's normal year depletion schedule is shown on Figure 3.4-2. The normal year depletions are projected to be 2.8 maf throughout the period of analysis (i.e., 2008 to 2060). The CAP is the largest single Arizona diverter and its (consumptive use) are projected to be approximately 1.382 maf in 2008 and gradually decrease to 1.271 maf by 2060. Concurrently, the demands of Arizona's non-CAP users increase towards their full apportionment, making up the balance of Arizona's normal 2.8 maf apportionment.

The state's projected Full Surplus depletions increase from 3.08 maf in 2008 to approximately 3.24 maf in 2060. The projected CAP Surplus condition demand rises steadily from 1.715 maf to approximately 1.835 maf in 2012. Thereafter, the CAP Surplus condition depletion schedule remains at approximately 1.835 maf.

Figure 3.4-2
Arizona's Projected Colorado River Water Depletion Schedules Under No Action Alternative

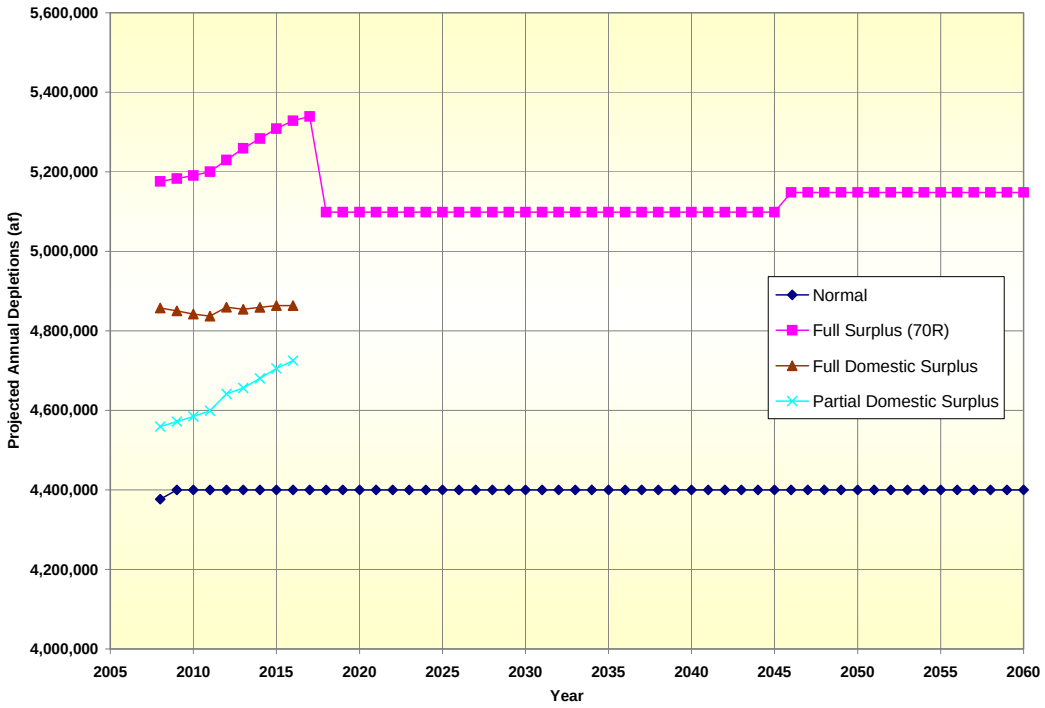


3.4.4.2 State of California

California's normal year depletion schedule is shown on Figure 3.4-3. The normal year depletions are projected to be 4.4 mafy throughout the period of analysis (i.e., 2008 to 2060). The exception to this is the first year (2008) wherein the depletion schedule reflects a delivery reduction of 23,315 af which coincides with scheduled repayment of inadvertent overruns by IID (14,763 af) and CVWD (8,552 af). As such, California's scheduled depletion for 2008 is 4.377 maf.

The surplus schedules for California consider its continued need for surplus water, when available, in order to implement the conjunctive use programs (e.g., groundwater banking) that will assist California in reducing its projected Colorado River depletion to its normal apportionment of 4.4 mafy. California's surplus schedule considers the potential availability of more surplus water during the effective period of the ISG, which are scheduled to expire in 2016. Figure 3.4-3 shows the surplus depletion schedules under the Full Surplus, Full Domestic Surplus, and Partial Domestic Surplus conditions during the ISG period and the surplus depletion schedule for the post-2016 period.

Figure 3.4-3
California's Projected Colorado River Water Depletion Schedules Under No Action Alternative

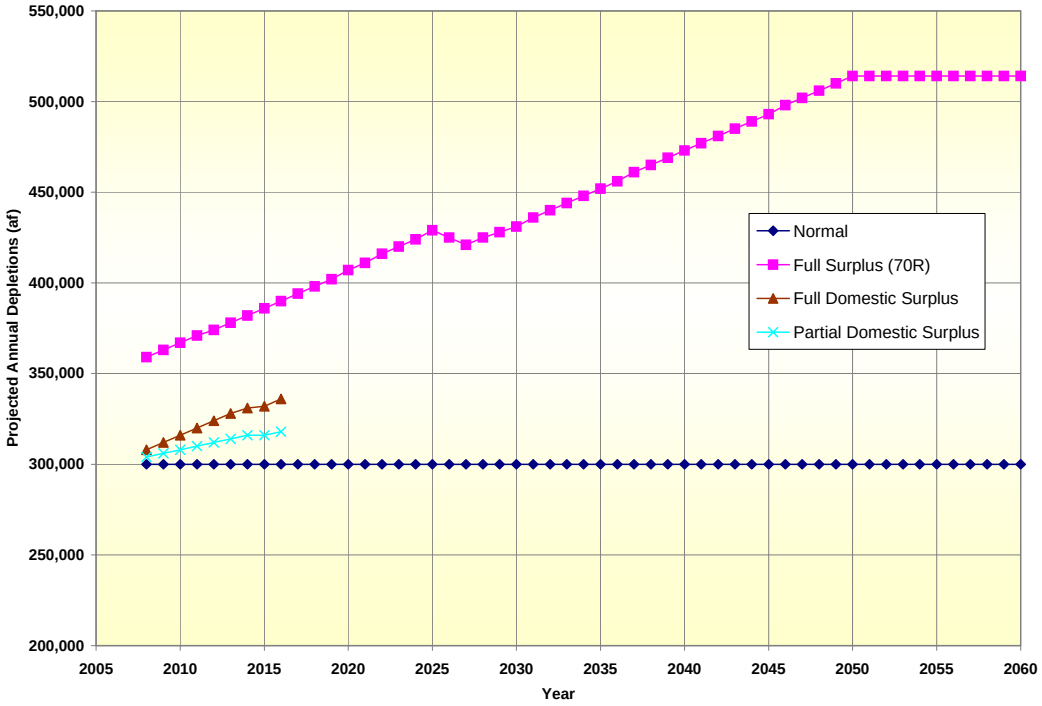


3.4.4.3 State of Nevada

Nevada's normal year depletion schedule is shown on Figure 3.4-4. The normal year depletions are projected to be 300 kaf throughout the period of analysis (i.e., 2008 to 2060). The SNWA is the largest single Nevada diverter and its normal year depletions are projected to be approximately 271 kaf for the period 2008 through 2025, increases to 279 kaf in 2026, increases to 287 kaf in 2027 and remains at that level through 2060.

Figure 3.4-4 also shows Nevada's surplus depletion schedule under the Full Surplus, Full Domestic Surplus, and Partial Domestic Surplus conditions during the ISG period and the surplus depletion schedule for the post-2016 period. Nevada's Full Surplus condition depletion schedule projects that Full Surplus depletion in 2008 is approximately 330 kaf in year 2008 and increases to approximately 501 kaf in 2060.

Figure 3.4-4
Nevada's Projected Colorado River Water Depletion Schedules Under No Action Alternative



3.4.5 Mexico's Allotment

As discussed earlier in Section 1.7, Mexico has an allotment to Colorado River water under the 1944 Treaty that states the following:

> "Of the waters of the Colorado River, from any and all sources, there are allotted to Mexico:
>
> (a) A guaranteed annual quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty.

> (b) Any other quantities arriving at the Mexican points of diversion, with the understanding that in any year in which, as determined by the United States Section, there exists a surplus of waters of the Colorado River in excess of the amount necessary to supply uses in the United States and the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually to Mexico, the United States undertakes to deliver to Mexico, in the manner set out in Article 15 of this Treaty, additional waters of the Colorado River system to provide a total quantity not to exceed 1,700,000 acre-feet (2,096,931,000 cubic meters) a year. Mexico shall acquire no right beyond that provided by this subparagraph by the use of the waters of the Colorado River system, for any purpose whatsoever, in excess of 1,500,000 acre-feet (1,850,234,000 cubic meters) annually.
>
> In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) a year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced."

Additionally, Minute 242 provides, in part, that the United States will deliver to Mexico approximately 1,360,000 af annually upstream of Morelos Diversion Dam and approximately 140,000 af annually on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Diversion Dam. It should be noted that while a portion of Mexico's 1.5 maf annual allotment is actually delivered below Morelos Diversion Dam, the entire delivery to Mexico was modeled at Morelos Diversion Dam. This basic assumption, while different than actual practice, served to simplify and facilitate the analysis of water deliveries to Mexico under the No Action Alternative and the action alternatives.

Allocation of Colorado River water to Mexico is governed by the 1944 Treaty. The proposed federal action will improve the Department's annual management and operation of key Colorado River reservoirs. However, in order to assess the potential effects of the proposed federal action in this Draft EIS, certain modeling assumptions (discussed in Chapter 2) are used that display projected water deliveries to Mexico. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Treaty or to represent current or future United States policy regarding reductions in deliveries to Mexico. The United States will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Treaty with Mexico through the IBWC in consultation with the Department of State.

3.4.6 Distribution of Shortages To and Within the Lower Division States

The assumptions with respect to the distribution of shortages between the three Lower Division states are discussed in Section 4.2. The following sections describe how the shortages would be distributed within Arizona, California, and Nevada.

3.4.6.1 Distribution of Shortages Within Arizona

Of Arizona's 2.8 maf apportionment, the largest use is the CAP which has historically diverted up to 1.7 mafy from Lake Havasu for delivery to water users in the central part of the state. Other noteworthy diversions are those of the Colorado River Indian Reservation at Headgate Rock Dam and the Gila and Yuma Projects at Imperial Dam. Other diversions serve irrigated areas and communities along the Colorado River corridor, including lands of the Fort Mojave Reservation, water used by federal agencies in Arizona, the cities of Bullhead, Lake Havasu and Parker, the Mohave Valley Irrigation and Drainage District, and the Cibola Valley Irrigation and Drainage District. A portion of the water from the river corridor is also diverted by wells located along the river.

Arizona established the Arizona Water Banking Authority (AWBA) in 1996 to store unused apportionment from Arizona and other states in groundwater basins in Arizona for future use. These banked water supplies help ensure an adequate water supply to CAP M&I water users in times of shortages or disruptions of the CAP system, in meeting water management plan objectives of the Arizona state groundwater code, and in Indian water rights claims settlements.

Within Arizona, a priority system for the delivery of Colorado River water to water users within the state has been included in the water delivery contracts executed after 1992. Prior to 1992, the contracts defined priorities as existing in three time bands: entitlements existing before June 25, 1929, entitlements existing between June 26, 1929 and September 30,1968, and entitlements existing after September 30, 1968. For water delivery contracts in Arizona executed after 1992, Reclamation assigned a numerical rating to these priorities (priorities 1 through 4) and also defined priorities for unused apportionment (priority 5) and surplus water (priority 6) (Table 3.4-4).

Table 3.4-4
Arizona Priority System for Mainstream Colorado River

Priority	Rights to be Satisfied
First	Present Perfected Rights (PPRs) established prior to June 25, 1929
Second	Federal reservations and perfected rights established or effective prior to September 30, 1968
Third	Entitlements pursuant to contracts executed on or before September 30, 1968
Fourth	(1) Entitlements pursuant to contracts, Secretarial reservations, and other arrangements between the United States and water users established subsequent to September 30, 1968 (2) Contract for CAP
Fifth	Any unused Arizona entitlement
Sixth	Entitlements to surplus water

All Arizona water users in each priority are listed in Appendix E.

Under a Shortage condition, any use of water occurring under contracts for unused entitlement would be the first eliminated. In the absence of shortage-sharing agreements, any remaining reduction in Arizona would most likely be shared proportionately among the CAP and the non-CAP holders with fourth priority entitlements. More severe

shortages would result in holders of higher priority entitlements having to incur reductions in their water use.

Arizona's framework for responding to shortages is presented in the Arizona Drought Preparedness Plan and the Operational Drought Plan that was released in October 2004. Elements of this framework are discussed in Section 4.14.

3.4.6.2 Distribution of Shortages Within California

Of California's 4.4 maf apportionment, the largest use is the IID which diverts approximately 3.0 mafy from Imperial Dam for delivery and use primarily for irrigated agriculture in the Imperial Valley. Other major water users include the Palo Verde Irrigation District (PVID), the CVWD, the Chemehuevi Reservation, the Fort Yuma Indian Reservation, the Colorado River Indian Reservation, the Fort Mojave Reservation, and the MWD. Other diversions serve irrigated areas and communities along the river corridor. A portion of the water from the river corridor is also diverted by wells located along the river.

Within California, a priority system for the delivery of mainstream Colorado River water to users within the state was established by Secretarial regulations that incorporated provisions of the California Seven-Party Agreement of 1931, and is shown in Table 3.4-5.

Table 3.4-5
California's Seven-Party Agreement for Mainstream Colorado River

Priority	Rights to be Satisfied
First	PVID for beneficial use upon 104,500 acres
Second	Reclamation's Yuma Project for beneficial use upon 25,000 acres
Third[1]	(a) Imperial Irrigation District and Coachella Valley Water District (b) Palo Verde Irrigation District for use on 16,000 acres on the Lower Palo Verde Mesa
Fourth[2]	MWD and/or City of Los Angeles and/or others on the coastal plain of Southern California for 550,000 afy
Fifth	(a) MWD and/or City of Los Angeles and/or others on the coastal plain of Southern California for 550,000 afy (b) City and/or County of San Diego for 112,000 afy
Sixth[3]	(a) IID and CVWD (b) PVID for use on Lower Palo Verde Mesa
Seventh	All remaining water available within California for agricultural use

1 The total beneficial use of Priorities 1, 2, and 3 shall not exceed 3.85 mafy

2 The sum of priorities 1 through 4 totals 4.4 mafy.

3 The sum of priority six is 300 kafy

The Consolidated Decree, however, also identified a number of PPRs in California as listed in Appendix E. Although some of the California PPRs were included in the Seven-Party Agreement, the recently implemented "California 4.4 Plan" addressed how the rights of other PPRs would be met relative to the priority scheme set forth in the Seven-

Party Agreement during the applicable term of the agreements embodied in the "California 4.4 Plan."

Due to the provision in the CRBPA that CAP and other fourth priority rights in Arizona are junior to 4.4 maf of water use in California, reductions to California water users would occur only during severe shortages. If that were to occur, MWD would most likely incur the shortage owing to its lower priority within the 4.4 maf apportionment.

MWD's short-term and long-term strategies for managing and building its portfolio of water supplies are presented in its 2006 Integrated Water Resources Plan. Elements of this plan are discussed in Section 4.14.

3.4.6.3 Distribution of Shortages within Nevada

Of Nevada's 0.3 maf apportionment, SNWA is the single largest diverter, with consumptive use of approximately 280 kafy. Established in 1991, SNWA delivers M&I water from Lake Mead to the service areas of Las Vegas, North Las Vegas, Henderson, Boulder City and Nellis Air Force Base. Water is pumped from two intakes at elevations 1,050 feet msl and 1,000 feet msl.

Existing water delivery contracts that authorize the use of Colorado River water by entities within Nevada are listed below in Table 3.4-6. This priority scheme was developed and implemented in 1992 when Reclamation contracted with the SNWA for the balance of Nevada's apportionment.

Table 3.4-6
Nevada's Priority System for Mainstream Colorado River

Priority	Rights to be Satisfied
First	Fort Mojave Indian Reservation (12,534 afy) Lake Mead National Recreation Area (Diversion = 500 afy or CU= 300 afy)
Second	Lake Mead National Recreation Area (1,500 afy, estimated)
Third	Boulder City (5,876 afy)
Fourth	City of Henderson (15,878 afy) Basic Management, Inc. (8,608 afy)
Fifth	Lakeview Co. (0 afy) Pacific Coast Building Products (PABCO) (928 afy)
Sixth	Las Vegas Valley Water District (15,407 afy)
Seventh	U.S. Air Force (Delivery from SNWA) (4,000 afy) Boy Scouts (Annexed by SNWA) (10 afy) Reclamation (300 afy) NV Dept of Fish and Game (25 afy) and NV Dept of Wildlife (25afy)
Eighth	Robert B. Griffith Water Project (304,000 afy) Big Bend (10,000 afy) SNWA (balance of state apportionment, unused and surplus)

Under a Shortage condition, Nevada would likely share in shortages due to the recent dates of the majority of its water delivery contracts. Within Nevada, reductions would most likely be borne by the lower priority use of SNWA. More severe shortages would result in holders of higher priority entitlements having to incur reductions in their water use. As noted previously, in accordance with the Consolidated Decree, the PPRs would not be affected.

SNWA and the State of Nevada's Colorado River Commission have developed a water resources management plan for Southern Nevada to manage and develop water supplies to meet the current and future water demands of the region. This plan is summarized in SNWA's 2006 Water Resource Plan. Elements of this plan are discussed in Section 4.4.

3.5 Water Quality

This section describes the existing water quality constituents that could potentially be affected by the alternatives. These water quality constituents of concern include:

- salinity;
- temperature;
- sediment;
- nutrients and algae;
- dissolved oxygen;
- metals; and
- perchlorate.

While other water quality-related issues and parameters were also considered, they were determined unlikely to be affected by the alternatives and are therefore not discussed here.

3.5.1 Salinity

Increased salinity levels are a primary water quality concern in the Colorado River because of its effects on agricultural, municipal and industrial users. With increased salinity levels, agricultural water users may suffer economic damage due to reduced crop yields, added labor costs for irrigation management, and added drainage requirements. Urban or municipal users must replace plumbing and appliances more often, or spend increased money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of infrastructure (Colorado River Basin Salinity Control Forum 2002). Water treatment plants face increased costs when salinity is elevated, and results in disinfection byproducts that exceed drinking water standards.

Salinity occurs naturally in the Colorado River Basin due to the erosion of saline sediments and rocks; however, human activities such as agriculture, irrigation, and energy production may increase the rate of natural salt movement to the system (Colorado River Basin Salinity Control Forum 2002; USEPA 1971). Consumptive use of system water also reduces the dilution capacity of the watershed, increasing the salinity concentrations.

In 1972, the United States Environmental Protection Agency (USEPA) suggested the development of water quality criteria for salinity in the Colorado River following passage of the Clean Water Act (CWA). In 1973, the seven Basin States formed the Colorado River Basin Salinity Control Forum (Forum) to develop salinity criteria and an implementation plan to provide compliance while allowing the Basin States to continue to develop their Compact-allocated water. The Forum specifies flow-weighted average annual salinity criteria

for three locations on the lower Colorado River (Table 3.5-1). The criteria, first established in 1975, are reviewed every three years; the latest review was completed in 2005.

Table 3.5-1
Numeric Salinity Standards for the Colorado River

Station	Flow-weighted average annual salinity (mg/L)[1]
Below Hoover Dam (to Parker Dam)	723
Below Parker Dam (to Imperial Dam)	747
At Imperial Dam	879

(Colorado River Basin Salinity Control Forum, 2005)

1 mg/L – milligram per liter

Salinity below Glen Canyon Dam has varied between 390 to 660 mg/L. Historic salinity concentrations and flows, and the criteria specified by the Forum by location for the lower reaches of the Colorado River below Hoover Dam are illustrated in Figures 3.5-1 through 3.5-3. As shown, increases in salinity typically correspond to decreases in flow. Diluting effects of record high flows during the 1980s resulted in lower salinity levels. Conversely, low flows from 1988 to 1992 and 2000 to 2004 caused relatively higher salinity levels. While the salinity concentrations vary from year to year, concentrations have not exceeded the criteria, even during the recent drought. Although salinity at Hoover Dam has approached the criteria of 723 mg/L on several days during the current drought, the salinity criteria would not be violated unless the annual average salinity exceeds the salinity criteria.

Figure 3.5-1
Historic Salinity Concentrations and Flows below Hoover Dam from 1941 to 2005

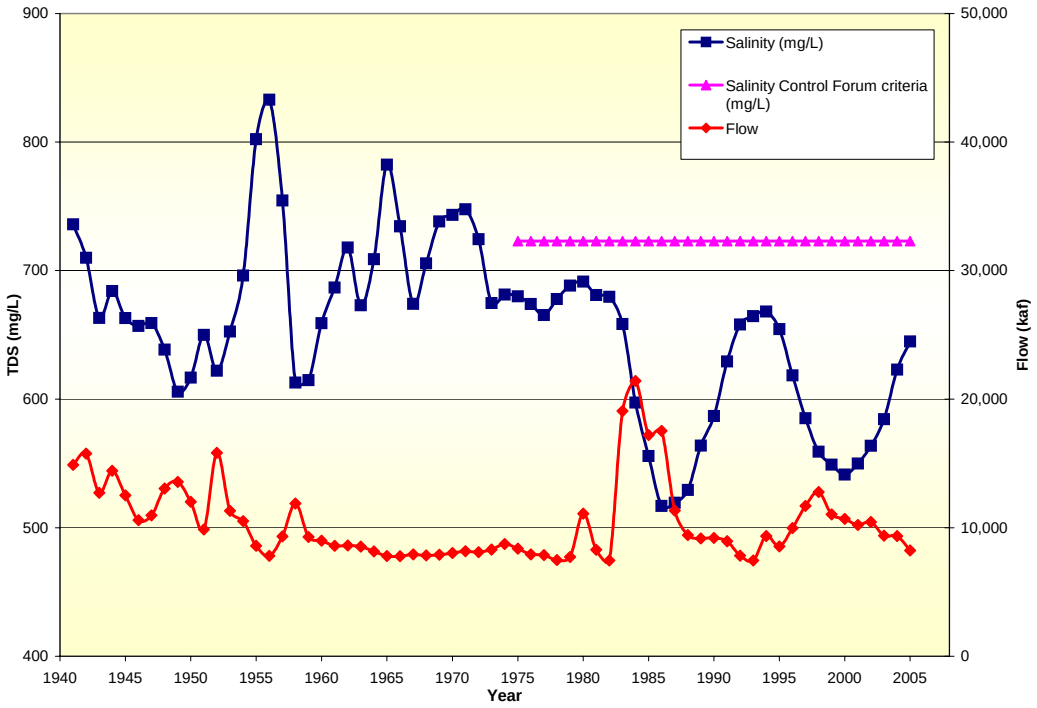


Figure 3.5-2
Historic Salinity Concentrations and Flows below Parker Dam from 1941 to 2005

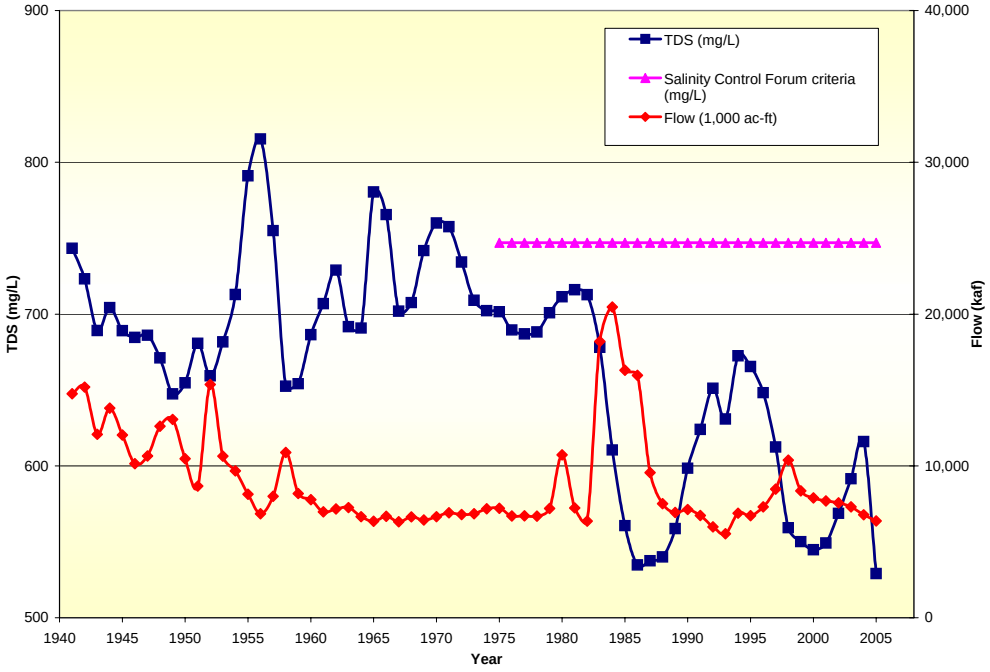
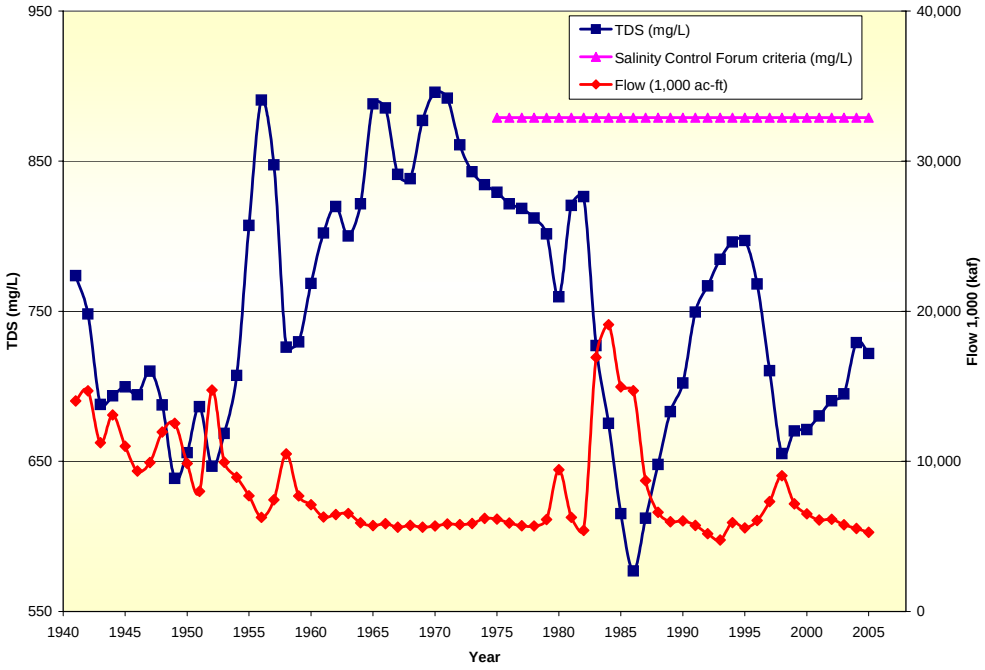


Figure 3.5-3
Historic Salinity Concentrations and Flows at Imperial Dam from 1941 to 2005



1

To address Mexico's concerns with regard to salinity, Minute 242 (Section 3.4) was developed in 1973 pursuant to the 1944 Treaty. Minute 242 limits the differential in annual salinity between Imperial Dam and the NIB to 115 parts per millimeter (ppm) ± 30 ppm. In addition, the Colorado River Basin Salinity Control Act of 1974 was authorized to implement desalting and salinity control projects to improve river water quality. Salinity control projects that have been implemented include projects to control irrigation seepage and reduce transport of groundwater salt loads to the Colorado River.

3.5.2 Temperature

Impounding water in reservoirs affects the water temperatures of dam releases due to stratification. The surface layer (epilimnion) of Lake Powell and Lake Mead warms as a result of inflows, ambient air temperature, and solar radiation. For example, during the summer, both Lake Powell and Lake Mead epilimnions reach temperatures as high as 30° degrees Celsius(C) or 86° degrees Fahrenheit (F) (LaBounty and Horn 1997). Lake Mead's deeper layer (hypolimnion) remains around 12° C (54° F) year-round and Lake Powell's ranges from 6 to 9° C (43-48° F) (LaBounty and Horn 1997), resulting in cold dam release temperatures.

Water temperatures downstream of Lake Powell are influenced by Lake Powell elevations and release volumes. Figure 3.5-4 illustrates that Lake Powell release temperatures have varied from 7 to 11° C (46 to 52° F) until 2002. Between 1999 and 2005, Lake Powell elevations have dropped more than 140 feet as a result of a basin-wide drought. While winter release temperatures remained cold, Lake Powell release temperatures increased to 16° C (61° F) in the summer of 2005. The drop in Lake Powell elevation has resulted in the warmer epilimnion being closer to the penstock withdrawal zone and the warmer water being released downstream. Release temperatures from Glen Canyon Dam during 2004 and 2005 were the highest since August 1971 when the reservoir was filling.

As water travels between Glen Canyon Dam and Lake Mead, water temperatures in the Colorado River can increase by 7° C (14.4° F). The amount of warming is affected by season and release volume, with highest warming rates occurring in mid-summer and at low release volumes (Vernieu et. al. 2005). Generally, during late fall and winter, as air temperatures decrease, water released from Glen Canyon Dam cools as it moves downstream towards Lake Mead. Figure 3.5-5 illustrates that historic water release temperatures at Lake Mead have typically been approximately 13°C (58°F).

3.5.3 Sediment

After Glen Canyon Dam and Hoover Dam were constructed, the reservoirs retained the vast majority of the inflowing sediment. Following dam closure, large sediment deltas formed near the inflow areas. When the reservoirs are drawn down during droughts, the Colorado River must cut a new channel through these sediments into the reservoirs. Generally the greater the reservoir drawdown, the greater the sediment delta headcut and the finer the sediment exposed. The resuspended sediments have a significant oxygen demand and also temporarily release nutrients which can result in greater algal growth.

1

Figure 3.5-4
2 Historic Elevation and Dam Release Temperatures at Lake Powell

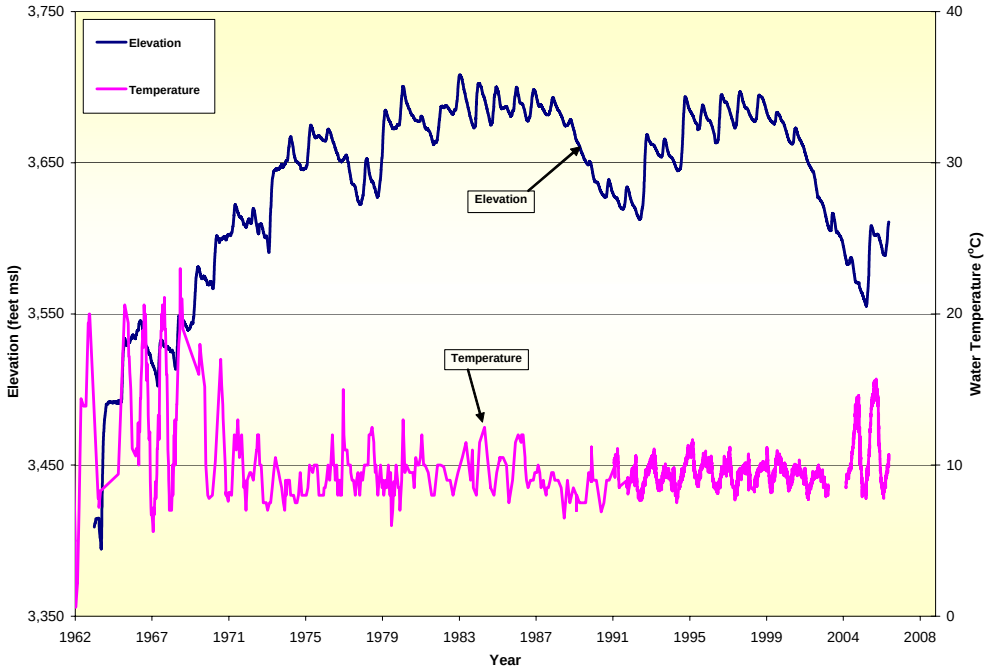
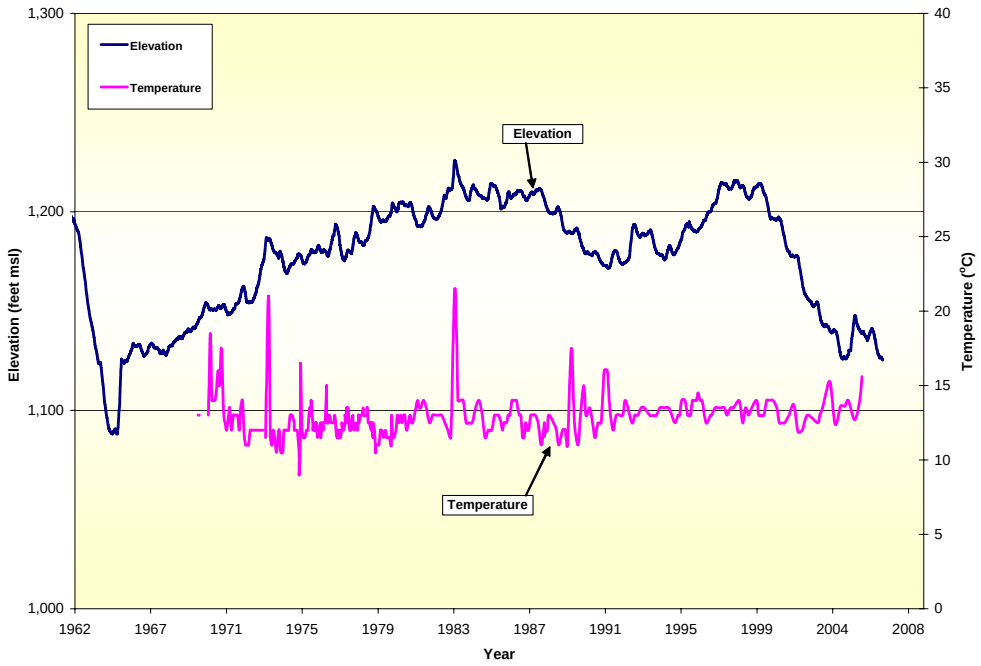


Figure 3.5-5
Historic Elevation and Dam Release Temperatures at Lake Mead



Riverine sediment transport is an important concern in the Glen Canyon Dam to Lake Mead reach due to recreation and biological resource impacts, and is addressed in the AMP. Beach sediment volumes have declined since closure of Glen Canyon Dam eliminated annual replenishment by sediment-laden spring runoff. Recent efforts by the AMP have focused on making BHBF releases from Glen Canyon Dam timed with downstream tributary inputs from the Paria and Little Colorado rivers.

Downstream of Hoover Dam the only significant sediment inputs are produced by large, infrequent events on the Bill Williams River and the Gila River, affecting the reaches from Parker to Imperial Dam and from Imperial Dam to the NIB. On-going Reclamation dredging operations remove this sediment at and upstream of Imperial Dam as well as upstream of Morelos Diversion Dam to improve diversion capability and to efficiently convey water to downstream users (Figure 3.3-5). These operations will continue and therefore the action alternatives would have no significant impact.

3.5.4 Nutrients and Algae

Nutrients are a group of chemical elements and compounds such as carbon, nitrogen, and phosphorus. When nutrient concentrations rise above certain thresholds or levels (usually measured in mg/L) they impair water quality. Nitrogen and phosphorous are nutrients of concern because they foster algal growth. Excess algal growth can affect drinking water treatment operations and can contribute to taste and odor problems and potentially toxic disinfection by-product (DBP) formation. Noxious and toxic blue-green algae blooms may also be a concern.

Large, long reservoirs like Lake Powell are very efficient at retaining nutrients (nitrogen and phosphorus) through biological processes and settling. Paulson and Baker (1983) found phosphorus to be the limiting nutrient for primary biological activity in both reservoirs. More than 95 percent of the phosphorous reaching Lake Powell is in particulate form or associated with suspended sediment particles, and a large percentage of the particulate phosphorous load settles out of the water column in the upstream portion of the reservoir. Therefore, primary biological activity is phosphorous-limited by the time the water reaches Glen Canyon Dam. A similar storage effect is repeated in Lake Mead. This settling process can be reversed when the reservoirs are drawn down and deltaic sediments are re-suspended by the inflows. Nutrient concentrations remain elevated in the hypolimnion where the lack of light limits primary biological activity. Consequently, hypolimnetic releases from Glen Canyon Dam are relatively nutrient rich whereas periods of epilimnetic releases may cause a reduction in the amount of nutrients available to the downstream ecosystem.

Tributary inflows (Paria River and Little Colorado River) are important sources of phosphorus in the Colorado River between Glen Canyon Dam and Lake Mead (Maddux et. al. 1987). However, most phosphorus arrives in particulate form adsorbed to fine sediment. This fine sediment causes high turbidity and restricts primary biological activity due to limited light penetration.

Lake Mead receives nutrient loads primarily from Las Vegas Wash and the Colorado River. A Total Maxium Daily Load (TMDL) has been developed by the Nevada Division of Environmental Protection (NDEP) and USEPA to reduce ammonia and phosphorous concentrations in Las Vegas Wash. Boulder Basin, the receiving body of Las Vegas Wash, has the highest nutrient concentrations in the Lake Mead system (Paulson and Baker 1981; Prentki and Paulson 1983). Except for the algae growth in Boulder Basin of Lake Mead, substantial algae growth along the rest of the system is not common.

3.5.5 Dissolved Oxygen

Dissolved oxygen concentrations in the reservoirs are affected by variations in inflow volume and temperature, seasonal reservoir circulation, and biological production and decomposition. In years of high inflows when the reservoir elevations are low, tributary inputs cut through deltaic sediments, resuspending organic matter and nutrients that contribute to both chemical and biological oxygen demand as the inflow water passes down the reservoir water column. The resulting plumes of low oxygen water cause the release of oxygen-poor water. When deltaic sediments and organic matter are not resuspended, oxygen demand is lower and dissolved oxygen concentrations remain higher. Downstream of dams, turbulence, exposure to the atmosphere, and primary productivity reaerate the water.

To date, low dissolved oxygen has only been an issue in Lake Powell and at Glen Canyon Dam. The dissolved oxygen concentration reaches saturation downstream of Glen Canyon Dam before the confluence with the Little Colorado River (Gloss et. al. 2005)) after passing through several major rapids.

In Lake Mead, dissolved oxygen concentrations decrease in Boulder Basin as a result of nutrient contributions from Las Vegas Wash and algae growth. However, dissolved oxygen has not been documented to have dropped below acceptable minimum levels. Further, dissolved oxygen has not been documented as an issue in downstream reaches.

3.5.6 Metals

Metals of concern in the study area are selenium, chromium, and mercury. Selenium is an essential trace element, but can be bioconcentrated in a complex aquatic food chain to potentially hazardous levels to wildlife. A chronic standard to protect wildlife has been adopted by the Lower Basin states of 2 micrograms per liter (µg/L). This is a higher standard than the USEPA criteria for selenium. The drinking water standard for selenium is 50 µg/L, therefore selenium is not a human health concern from drinking water.

Selenium present in marine sedimentary rocks dissolves in runoff and groundwater flows to the Colorado River and its tributaries. Concentrations along the Colorado River in the Lower Basin indicate that the selenium loads to the Colorado River are from the Upper Basin and Lower Basin tributaries only (U.S. Department of the Interior and The Metropolitan Water District of Southern California 2004). The Colorado River from Hoover Dam to Lake Mohave inlet and from Parashant Canyon to Diamond Creek, and reaches of the Gila River, Las Vegas Wash, and the Virgin River have all been designated as impaired waterbodies due to selenium. To date, TMDLs have not been drafted or approved for selenium in these waterbodies.

The Forum established a selenium sub-committee in 2004 (U.S. Department of the Interior 2005). The long term average selenium concentration is 2.4 µg/L below Glen Canyon Dam, greater than the Lower Basin states selenium standard of 2 µg/L (Department of the Interior 2005).

The USEPA's drinking water standard for the soluble hexavalent form of chromium, (Cr(VI)) is 100 parts per billion (ppb); at this concentration, it is considered dangerous to human and environmental health. The Cr(VI) is impacting groundwater in two known locations in the lower Colorado River Basin, at the Pacific Gas & Electric (PG&E) Compressor Station near Needles, California, and at the former McCulloch manufacturing plant in Lake Havasu City, Arizona. The plume of contaminated groundwater from the PG&E facility has concentrations of Cr(VI) as high as 700 ppb and has traveled several hundred feet from its source to within 60 feet of the Colorado River. Investigation and mitigation efforts are ongoing and under direction of the California Environmental Protection Agency Department of Toxic Substances Control (DTSC).

The Cr(VI) plume in Lake Havasu City has been delineated and it is being monitored by the current land owner. Concentrations have been detected as high as 240,000 ppb Cr(VI) and the plume is approximately 3,800 feet from the Colorado River.

Mercury is naturally occurring in the Colorado River Basin and has been mobilized as a result of historic mining activities. Mercury can be toxic to both humans and wildlife and has been shown to bioaccumulate and biomagnify up the food chain. High levels of methylmercury have been detected in fish tissue at Alamo Lake in the Bill Williams Watershed, a tributary to Lake Havasu. Mercury is present in the discharge from Alamo Lake and may also be entering the Colorado River from the Little Colorado River and between Lake Mead and Lake Havasu. Mercury is highly regulated with the Safe Drinking Water Act maximum contaminant level of 2.0 ppb.

3.5.7 Perchlorate

Perchlorate in the form of ammonium perchlorate is a concern when found in drinking water because of its potential adverse effect on human thyroid function. No final USEPA standards for perchlorate have been developed. Perchlorate contamination in water supplies in the lower Colorado River was traced to Lake Mead and Las Vegas Wash from a groundwater plume from the Kerr McGee Chemical Company in Henderson, Nevada. Containment, control and mitigation activities are ongoing to reduce perchlorate concentrations in Lake Mead and downstream.

3.6 Air Quality

The only air quality issue related to the proposed federal action would be fugitive emissions (dust) generated from shorelines exposed by changes in the Lake Powell and Lake Mead elevations.

3.6.1 Federal Air Quality Requirements

The Clean Air Act as amended (42 USC 7401 *et seq*.) established Prevention of Significant Deterioration (PSD) provisions for use in protecting the nation's air quality and visibility. The PSD provisions apply to new or modified major stationary sources and are designed to keep an attainment area in continued compliance with the National Ambient Air Quality Standards (NAAQS). Major stationary sources are industrial-type facilities and include power plants and manufacturing facilities that emit over 100 tons per year of a regulated pollutant. The USEPA promulgated NAAQS for six criteria pollutants to protect public health and welfare. One of the national air quality standards addresses particulate matter (PM), or dust.

No major stationary sources are being proposed for construction or modification by the proposed federal action; therefore the statutory provisions are not applicable. However, the standards do provide thresholds from which to evaluate potential effects to ambient air quality.

The PSD standards are most stringent in Class I Areas and are progressively less stringent in the Class II and Class III Areas (Table 3.6-1). Lake Powell and Lake Mead are designated as Class II Areas while the Grand Canyon National Park is a Class I Area. .

Table 3.6-1
Clean Air Act Prevention of Significant Deterioration Designations

Designation	Definition
Class I Area	Visibility is protected more stringently than under the national ambient air quality standards; includes national parks, wilderness areas, monuments, and other areas of special national and cultural significance.
Class II Area	Moderate change is allowed but stringent air quality constraints are nevertheless desired.
Class III Area	Substantial industrial or other growth is allowed and increases in concentrations up to the national standards would be considered insignificant.

The allowable PM concentrations increase over the baseline concentrations for the Class I, II and III Area designations are provided in Table 3.6-2.

Table 3.6-2
Clean Air Act Allowable Particulate Matter Concentration Increases over the Baseline Concentrations

Pollutant	Averaging Times	Class I Area [1,2]	Class II Area [1,2]	Class III Area [1,2]
Particulate Matter	Annual Geometric Mean	5	19	37
	24-Hour Maximum	10	37	75

1 Unit of measure for standards is in micrograms per cubic meters of air (µg/m3)

2 Maximum allowable increases over baseline concentrations

3.6.2 State and Local Air Quality Requirements

In September 2006, USEPA established new PM10 (dust particles less than 10 µg/m^3) and PM2.5 (dust particles less than 2.5 µg/m^3) standards for future implementation. Additionally, each state must develop an implementation plan describing how it will attain and maintain the NAAQS. Some states have developed more stringent ambient air quality standards for PM10 and PM2.5, as listed in Table 3.6-3. California has a more stringent PM standard than the national standard. Arizona, Nevada, and Utah have adopted PM standards to meet the NAAQS (CalEPA 2006; Clark County AQEM 2006; MDAQMD 2006; Utah 2006; UDEQ 2006). These state standards were adopted prior to the new 2006 NAAQS.

Table 3.6-3
National and State Ambient Air Quality Standards for Particulate Matter

Jurisdiction	PM 10 (µg/m^3)	PM 2.5 (µg/m^3)	Averaging Times
2006 NAAQS	150	35	24-hours
	None [1]	15	Annual Arithmetic Mean
Arizona	150	65	24-hours
	50	15	Annual Arithmetic Mean
California	50	65	24-hours
	20	12	Annual Arithmetic Mean
Nevada	150	65	24-hours
	50	15	Annual Arithmetic Mean
Utah	150	65	24-hours
	50	15	Annual Arithmetic Mean

1 Revoked in 2006 due to a lack of evidence linking health problems (effective December 17, 2006).

Eight state and local air quality agencies are responsible for attaining the state and federal standards within the study area, as listed in Table 3.6-4.

Table 3.6-4
State and Local Air Pollution Control Agencies Having Jurisdiction within the Lake Powell and Lake Mead Areas

Agency	Location	Colorado River Reaches
Arizona Department of Environmental Quality	Arizona	Lake Powell and Glen Canyon Dam Glen Canyon Dam to Lake Mead
Utah Department of Environmental Quality, Division of Air Quality	Utah	Lake Powell and Glen Canyon Dam
Clark County Air and Environmental Management	Nevada	Lake Mead and Hoover Dam Hoover Dam to Davis Dam

3.6.3 Ambient Air Quality by River Reach

A description of the PSD classification and the air quality standards within the reaches provides a means of characterizing the standards applied to the affected environment. Reaches meeting regulatory standards are classified as attaining a pollutant standard. The attainment status provides a qualitative characterization of a reach as compliant with the standards; attainment characterizes the specific pollutant as not a significant concern within the reach. Consequently, characterizing the PM attainment status in the reaches provides a qualitative assessment of the significance of fugitive emissions within the reach. The Glen Canyon to Lake Mead reach is included because particulate matter generated at the Lake Mead delta may be dispersed into this reach.

3.6.3.1 Lake Powell and Glen Canyon Dam

The Lake Powell and Glen Canyon Dam reach is a PSD Class II Area. North central Arizona and southern Utah, including Lake Powell, is in attainment of the PM10 and PM2.5 standards (USEPA 2006a; 2006b). This attainment status corresponds with windrose information for both areas (i.e., relatively low average wind speeds implying low wind-blown fugitive emissions on average) and the relatively low levels of fugitive emissions generated from human activities.

3.6.3.2 Glen Canyon to Lake Mead

This reach is located in northern portions of Mohave County and Coconino County and encompasses the Grand Canyon National Park. Consistent with the federal air quality designations for national parks, the Grand Canyon National Park is designated as a PSD Class I Area. Mohave County and Coconino County, including the Glen Canyon Dam to Lake Mead reach, is in attainment of the PM10 and PM2.5 standards (EPA 2006a). Within the Grand Canyon National Park, wind velocities with the greatest potential for particulate transport from the Lake Mead delta occur during the April and May windy season.

3.6.3.3 Lake Mead and Hoover Dam

Lake Mead is located in the LMNRA on the Nevada and Arizona boundary in Clark County and Mohave County, respectively, and is a PSD Class II Area. The Lake Mead and Hoover Dam reach is in attainment (criteria air pollutant meets the corresponding NAAQS) of the PM10 and PM2.5 standards (EPA 2006a; 2006c). While some urban areas (including Las Vegas, North Las Vegas, and Henderson) within Clark County are in non-attainment of the NAAQS for PM10, the remaining county, including Lake Mead, is in attainment of the standard. That portion of Mohave County, Arizona adjacent to Lake Mead is also in attainment of the PM10 standard (Reclamation 2000).

3.7 Visual Resources

This section discusses the visual resources within the study area that may be affected by the proposed federal action. Topics include:

- Attraction features;
- Extent (height) of visible calcium carbonate ring; and
- Exposure of sediment deltas at reservoir in-flow areas.

3.7.1 Lake Powell and Glen Canyon Dam Reach

3.7.1.1 Attraction Features

The general visual/scenic resources of the Glen Canyon/Lake Powell area are dominated by the presence of Navajo Sandstone and desert varnish. Resources include sweeping vistas of red rock towers, buttes, and mesa framed by Lake Powell. One geologic attraction feature within this Reach is Rainbow Bridge. It is contained within the Rainbow Bridge National Monument that was established in 1910. At that time, it was accessible only by the rugged Wetherill Trail from Navajo Mountain. Today, it is estimated that more than 82,000 visitors see this attraction on an annual basis. Current low water conditions have reduced visitation to the monument by about half. The Lake Powell elevations change the view of Rainbow Bridge. At a Lake Powell elevation of 3,700 feet msl, visitors see the bridge with water in Bridge Canyon. At lower elevations, the view is one of Navajo Sandstone, with the water in Bridge Canyon further away.

Another geologic attraction is Cathedral in the Desert. This feature was inundated by the waters of Lake Powell as the reservoir filled. This geologic feature is now only exposed at low Lake Powell elevations; it is completely visible and accessible at elevations below 3,550 feet msl.

Glen Canyon Dam is also an attraction feature. The American Society of Civil Engineers considers it one of the finest examples of concrete thin arch dams in the United States.

3.7.1.2 Calcium Carbonate Ring

Lake Powell has deposits of calcium carbonate surrounding the reservoir that become visible as the reservoir is drawn down. At lower reservoir elevations the colorful sandstone canyon walls show a white band of calcium carbonate deposit between the full reservoir elevation and the lower reservoir elevation, which change the visual contrast of rock and water.

3.7.1.3 Sediment Deltas

Sediment deltas appear as expansive, deep and eroding mud flats, cut by river channels. Sediment exposed for more than a few months is soon colonized by tamarisk. Sediment that is carried by the Colorado River and the San Juan River are deposited near the inflow areas of Lake Powell, forming downstream-progressing deltas. These sediment deltas

may be considered a visual detraction. Ferrari (2006) and Mussetter (not dated) indicate the sediment elevation at Hite Marina is about 100 feet above the original riverbed.

3.7.2 Glen Canyon Dam to Lake Mead

River trips down the Colorado River through Marble Canyon and the Grand Canyon are renowned for their visual character. The proposed federal action will not have any visual effects on this reach.

3.7.3 Lake Mead and Hoover Dam

3.7.3.1 Attraction Features

Hoover Dam is a major destination and a national landmark. In 1955 it was selected as one of the seven engineering wonders in the United States by the American Society of Civil Engineers. The dam is located in a narrow, steep-walled canyon. Only a small portion of Lake Mead within Black Canyon can be viewed from Hoover Dam and the adjacent visitor facilities.

3.7.3.2 Calcium Carbonate Ring

Lake Mead also has deposits of calcium carbonate surrounding the reservoir that become visible as the reservoir is drawn down. At lower reservoir elevations the steep rock slopes, canyon walls, and islands show a white band of calcium carbonate deposit between the full reservoir elevation and the lower reservoir elevation, that changes the visual contrast of rock and water. The ring is primarily noticeable to travelers on US Highway 93 between Boulder City, Nevada and Hoover Dam, and to boaters and hikers. The main view shed affected is the 56 square mile Boulder Basin.

3.7.3.3 Sediment Deltas

Sediment deltas have built up at the confluence of the Virgin River and Muddy River at the upper Overton Arm and at Upper Lake Mead (Iceberg Canyon, Pearce Basin, and Lower Granite Gorge). Sediment deltas are visible primarily to water-based recreationists, though they can also be viewed by visitors of the Lake Mead National Recreation Area (NRA) at Overton Beach and Pearce Ferry.

3.8 Biological Resources

This section describes the existing conditions related to biological resources within the study area that could be affected by implementation of the proposed federal action, including vegetation, wildlife and special status species associated with the Colorado River, its mainstream reservoirs, and historic floodplain.

Water deliveries are made to the service areas of the CAP, SNWA and MWD through a series of pumps, pipelines, diversions, and lined canals. Accordingly, the vegetation and wildlife habitat potential of this infrastructure is essentially absent. Therefore, no impacts to biological resources within these facilities are expected, and they are not analyzed in this Draft EIS. Furthermore, Reclamation does not have the authority to decide how these agencies will operate under a Shortage condition. For example, Reclamation does not control, and cannot anticipate which specific agricultural acreages may be planted or fallowed as a result of changes in water deliveries under the alternatives, nor are individual farm operator's response to various water delivery conditions predictable over the long-term given access to alternative sources of water, economic conditions, and other factors. While this EIS has identified the potential for fallowing agricultural lands, it cannot identify specific acreages which would be fallowed as a result of the proposed federal action. Therefore, it would be speculative to attempt to identify potential biological effects within the broader limits of the service areas, and thus these effects are not analyzed in this Draft EIS.

Reclamation is involved with numerous ongoing activities aimed at reducing the impact its operations have on biological resources, particularly on endangered species. For example, Reclamation is implementing the Glen Canyon Dam Adaptive Management Program, aimed at protecting and improving the environment downstream of Glen Canyon Dam, and the LCR MSCP, aimed at enhancing habitat for several endangered species and providing comprehensive mitigation to offset impacts from a range of conditions below Hoover Dam.

3.8.1 Vegetation

Plant communities in the study area can be broadly categorized as riparian. The riparian vegetation along the Colorado River is among the most important wildlife habitat in the region. Riparian habitats, or vegetated areas along streams and rivers, in the Western United States typically support a disproportionately large number of wildlife species.

Much of the information in this section comes from the Final Environmental Impact Statement on the Colorado River Interim Surplus Criteria (USBR 2000) and various LCR MSCP documents (LCR MSCP 2005).

3.8.1.1 Lake Powell and Glen Canyon Dam

Riparian vegetation around Lake Powell is extremely restricted because of the desert terrain that extends directly to the water's edge, and the continuously fluctuating lake levels. Tamarisk or salt cedar (*Tamarix ramosissima*), a nonnative invasive shrub along the Lake Powell shoreline is still becoming established and has not yet formed stable communities. These communities may attain some level of importance as insect and

wildlife (particularly bird) habitat in the future, and provide habitat for fish during high lake levels when the plants are inundated.

Fluctuations in lake levels may result in standing water in the side canyons of Lake Powell where riparian vegetation has become established. Dominant plants found in these canyons include Fremont cottonwood (*Populus fremontii*), tamarisk (*Tamarix ramosissima*), and cattail (*Typha sp.*). The GCNRA has many springs, seeps that are common in alcoves along Glen Canyon walls, and waterpockets located in canyons and uplands. These areas are recognized for their significance as wetland habitats and as unique ecosystems within the desert. These seeps support hanging gardens which are a specialized vegetation community (Welsh et. al. 1987:7). The water sources that support hanging gardens originate from natural springs and seeps within the Navajo Sandstone formation and are independent of Lake Powell. This plant community will not be affected by the proposed federal action and as such it is not considered further in this EIS.

3.8.1.2 Glen Canyon Dam to Lake Mead

There is a change in the composition of the riparian community in this reach from Intermountian flora to that of the southern Basin and Range. Total area associated with the riparian community measures at least 10 square miles (6,400 acres).

Today, tamarisk (*Tamarix ramosissima*), arrowweed (*Pluchea sericea*), black willow or Gooding willow (*Salix goodingii*), coyote willow (*Salix exigua*), and Emory seepwillow (*Baccharis emeroyi*) are the primary phreatophytes in the riparian zone (taxonomy is after Welsh et. al. 1987). Those species that are more adapted to dry conditions may also be found further upslope on the terraces. Terrace dominants including four-wing saltbush (*Atriplex canescens*), arrowweed (*Pluchea sericea*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and netleaf hackberry (*Celtis reticulata*), may also be located closer to the riverbank.

Marshes composed of emergent aquatics such as common cattail (*Typha domingensis*), broad-leaved cattail (*Typha latifolia*), and bulrushes (*Scirpus spp.*) have become established in return-current channels (backwaters), channel margins, and mouths of tributary streams from Glen Canyon Dam downstream to Lake Mead. Stands of emergent marsh vegetation in the riparian zone tend to be dominated by a few species, depending on soil texture and drainage. A cattail (*Typha domingensis*) and common reed (*Phragmities australis*) association grows on fine-grained silty loams while a horseweed (*Conyza canadensis*), knotweed (*Polygonum aviculare*), and Bermuda grass (*Cynodon dactylon*) association grows on loamy sands.

Since 1995, there has been a modest increase in woody vegetation and an increase in marsh communities under modified Glen Canyon Dam operations (Gloss et. al. 2005). However, the increase in woody vegetation is partially due to expansion of the non-native tamarisk and arrowweed into the riparian zone. The United States Geological Survey (USGS) has indicated that there has been a decrease in wet marsh and an increase in dry marsh (Gloss et. al. 2005).

3.8.1.3 Lake Mead to SIB

The highest concentration of vegetated habitat associated with Lake Mead is found in the Lake Mead and Virgin River deltas. Fluctuating water levels limit the shoreline vegetation. Riparian vegetation that does develop within the range of lake level fluctuation is temporary as fluctuating lake levels either dewater or inundate these areas through time. Linear riparian woodlands may be present along the shoreline of the Lake Mead delta following high water flows, and associated sediment deposition and exposure. The sediment deposition and the associated growth of riparian vegetation at the Lake Mead delta has occurred for decades. As lake levels decline, vegetation in the Lake Mead and Virgin River deltas begins to establish on clay/silt deposits. The dynamic nature of fluctuating lake levels and deposition of sediment in the Lake Mead delta is expressed as a change in plant species composition and relative abundance over time. An increase in sediment deposition in the deltas followed by lower lake levels allows establishment of native riparian habitat if the lowering of the lake is timed to match native seed dispersal.

Vegetation for this reach is categorized using the methodology outlined in the LCR MSCP. Detailed descriptions of the vegetation resources can be found in the LCR MSCP documents. A summary of the vegetation cover types and their characteristics found from Lake Mead to the SIB is provided below in Table 3.8-1.

Table 3.8-1
Summary of Vegetation Cover Types from Lake Mead to the SIB

Vegetation Cover Type	Characteristics
Woody Riparian	
Cottonwood-willow (6 structural types)	Gooding willow and cottonwood at least 10% of total trees
Saltcedar (6 structural types)	Saltcedar species constituting 80-90% of total trees
Honey Mesquite (4 structural types)	Honey mesquite constituting 90-100% of trees
Saltcedar-honey mesquite (4 structural types)	Honey mesquite at least 10% of total trees (usually <40%)
Saltcedar-screwbean mesquite (5 structural types)	Screwbean mesquite at least 20% of total trees
Arrowweed	Arrowweed at least 90-100% of total vegetation
Atriplex	Saltbush species constituting 90-100% of total vegetation
Marsh (7 compositional types)	Cattail/bulrush; little common reed, trees and grasses, and open water
Aquatic	
River	Mainstream plus tributaries and natural/artificial channels
Reservoir	"Lakes" formed by dams with variable water levels
Backwater	Open water plus marsh, temporary to permanent
Desert Scrub	Adjacent to riparian and aquatic land cover types
Agriculture	Active or fallow, adjacent to riparian and aquatic land cover types
Developed	Buildings, roads, campgrounds, landscaped areas

Table 3.8-2 provides a summary of the vegetation cover type acreage by river sub-reach that was determined to be present for the LCR MSCP analysis. A detailed breakdown of the sub-categories of cover types, is provided in Table 4-8 of the LCR MSCP Biological Assessment (BA).

Table 3.8-2
Summary of Vegetation Cover Types from Lake Mead to the NIB (acres)[a]

Type	Lake Mead and Hoover Dam	Hoover Dam to Davis Dam	Davis Dam to Park Dam	Park Dam to Cibola Gage	Cibola Gage to Imperial Dam	Imperial Dam to NIB
Cottonwood-willow	1,721	1	1,541	889	616	1,325
Saltcedar	2,254	838	13,647	26,923	5,581	6,257
Honey Mesquite	0	4	627	6,443	175	5
Saltcedar-Honey Mesquite	58	359	3,463	13,398	778	234
Saltcedar-Screwbean Mesquite	0	32	5,058	4,654	579	786
Marsh	137	22	4,358	2,091	3,762	1,414
Atriplex	0	0	19	582	0	177
Arrow weed	0	0	496	6,541	48	1,069
Desert Scrub	353	31	7,676	11,710	397	3,151
Agriculture	0	0	19,166	169,664	260	36,799
Undetermined Riparian	0	0	6,634	6,268	0	2,337

[a] *From LCR MSCP BA Table 4-8*

For reference, further description of the LCR MSCP vegetation types present in this reach are provided below. The vegetation is classified according to the Anderson and Ohmart system, which is further described in the LCR MSCP documents (LCR MSCP 2005).

3.8.1.4 NIB to SIB

Riparian communities comprise approximately 6,974 acres of the land cover present below Morelos Diversion Dam; 3,638 acres of which is in the United States. Approximately 77 percent of these communities are dominated by non-native saltcedar. The types of riparian communities present in this reach are described above in Table 3.8-1. Table 3.8-3 below summarizes the extent of riparian communities in the United States below Morelos Diversion Dam.

Table 3.8-3
Summary of Vegetation Cover Types in the United States from NIB to SIB[a]

Type	Acreage
Arrow weed	33
Atriplex	38
Cottonwood-Willow-I	14
Cottonwood-Willow-II	38
Cottonwood-Willow-III	212

Table 3.8-3
Summary of Vegetation Cover Types in the United States from NIB to SIB[a]

Type	Acreage
Cottonwood-Willow-IV	165
Cottonwood-Willow-V	27
Subtotal	*527*
Marsh	50
Saltcedar	2,996
Saltcedar-screwbean mesquite	65
TOTAL	3,638

[a] *Reclamation, July-September 2005 surveys.*

The Borderlands Task Force consisting of the BLM, the Border Patrol, the USACE, FWS, Reclamation, and the Cocopah Indian Tribe is planning a vegetation clearing project along this reach aimed at improving security along this section of the United States and Mexico border. BLM is the lead federal agency responsible for compliance on this proposed effort.

3.8.2 Wildlife

The Colorado River and its associated riparian vegetation provide important habitat for a variety of wildlife. Table 3.8-4 lists the native and non-native fish species that occur in the study area. The study area extends from the northern tip of Lake Powell in Utah south to the SIB (RM 0.0).

Table 3.8-4
Native and Non-Native Fish Species Present in the Study Area by Reach

Species	Reach	Native/ Non-native
Black bullhead *(Ictalurus melas)*	All	Non-native
Black crappie *(Pomoxis nigromaculatus)*	All	Non-native
Bluegill *(Lepomis macrochirus)*	All	Non-native
*Bluehead sucker *(Catastomus discobolus)*	Glen Canyon Dam to Hoover Dam	Native
*Bonytail *(Gila elegans)*	Lake Powell (rare), Hoover Dam to Imperial Dam	Native
Carp *(Cyprinus carpio)*	All	Non-native
Channel catfish*(Ictalurus punctatus)*	All	Non-native
*Colorado pikeminnow *(Ptychocheilus lucius)*	Lake Powell to Glen Canyon Dam (rare)	Native
Fathead minnow *(Pimephales promelas)*	All	Non-native
*Flannelmouth sucker *(Catostomus latipinnis)*	Lake Powell, Separation Canyon, Lake Mead, immediately below Davis Dam	Native
Flathead catfish *(Pylodictis olivaris)*	Davis Dam to NIB	Non-native
Green sunfish *(Lepomis cyanellus)*	Lake Powell to Glen Canyon Dam,Lake Mead to SIB	Non-native
*Humpback chub *(Gila cypha)*	Lake Powell (rare) Glen Canyon Dam to Separation Canyon	Native
Largemouth bass *(Micropterus salmoides)*	Lake Powell to NIB	Non-native
Mosquitofish *(Gambusia affinis)*	Glen Canyon Dam to SIB	Non-native

Table 3.8-4
Native and Non-Native Fish Species Present in the Study Area by Reach

Species	Reach	Native/ Non-native
Plains killifish *(Fundulus zebrinus)*	Glen Canyon Dam to Hoover Dam	Non-native
Rainbow trout *(Oncorhynchus mykiss)*	Glen Canyon Dam to Below Davis Dam	Non-native
*Razorback sucker *(Xyrauchen texanus)*	Lake Powell to Imperial Dam (rare above Lake Mead)	Native
Red shiner *(Notropis lutrensis)*	All	Non-native
Shortfin mollies *(Poecilia mexicana)*	Lake Mead, Laguna Dam to SIB	Non-native
Smallmouth bass *(Micropterus dolomieui)*	Lake Powell, Separation Canyon (rare), Lake Mead to Imperial Dam	Non-native
Striped bass *(Morone saxatilis)*	Lake Powell to NIB	Non-native
Threadfin shad *(Dorosoma petenense)*	Lake Powell to SIB	Non-native
Tilapia *(Oreochromis aureus)*	Lake Mead to SIB	Non-native
Walleye *(Stizostedion vitreum)*	Lake Powell to Glen Canyon Dam	Non-native
Redear Sunfish *(Lepomis Microlophus)*	Davis Dam to NIB	Non-Native
Warmouth *(Chaenobryttus gulosus)*	Parker Dam to NIB	Non-Native
Sailfin Molly *(Poecillia latipinna)*	Palo Verde Diversion Dam to SIB	Non-native
Striped Mullet *(Mugil cephalus)*	Laguna Dam to SIB	Native
Goldfish *(Carassius auratus)*	Lake Mead to SIB	Non-native
Yellow bullhead *(Ameiurus natalis)*	Lake Powell to SIB	Non-native

Distribution Information from: CDFG 2000; Colorado Division of Wildlife no date; Fuller 2006; Mexico Game and Fish 2004; NatureServe 2006; Pima County no date; Ptacek et al 2005; Rees et al 2005a; Rees et al 2005b; FWSa no date; FWSb no date; FWSc no date; Valdez 2006.

**Note: These fish species are discussed further below under Special Status Species.*

3.8.2.1 Lake Powell and Glen Canyon Dam

Fifteen fish species reside in Lake Powell and include 14 non-native fish species and one native fish species (flannelmouth sucker).

Common fish species in Lake Powell include walleye, bluegill, green sunfish, carp and channel catfish. Species that occur in the reservoir, but that are mainly associated with tributaries and inflow, include fathead minnow, mosquitofish, red shiner and plains killifish (NPS 1996). Mueller and Horn (1999) reported large numbers of fish in the reservoir upstream of the dam, but Budy et. al. (2005) found large seasonal variances in fish abundances with low numbers of striped bass, threadfin shad and gizzard shad present at Wahweap Bay in May and July.

Non-native fish species became established by intentional and unintentional introductions. Lake Powell was stocked with non-native sport and forage fish and movement of stocked non-native fish into the lake has also taken place. Largemouth bass and crappie populations were stocked initially and proliferated to provide the bulk of the sport fisheries. Both species have declined in recent years due to lack of habitat structure for young fish. Filling, fluctuation, and aging of the reservoir resulted in changing habitat that eliminated most of the vegetation and favored many species. The habitat change led to the introduction of smallmouth bass and striped bass, presently the two dominant

predator species in the reservoir, with striped bass being the most dominant. Threadfin shad were introduced to provide an additional forage base and quickly became the predominant prey species (NPS 1996).

The sport fishery in Lake Powell is primarily based on striped bass. Other sport fish found in Lake Powell include largemouth bass, catfish and trout. Threadfin shad in Lake Powell exist in the northernmost portion of their range, and are the primary food source for striped bass.

At least six species of amphibians are currently known to live in Glen Canyon National Recreation Area. The Canyon tree frog (*Hyla arenicolor*) is common along the shores of Lake Powell (Spence 1996). All other herpetofauna, including the declining northern leopard frog (*Rana pipiens*), are associated with side canyons off Lake Powell and are therefore outside the area of influence of the proposed federal action.

Common waterfowl of the Lake Powell area include American widgeon (*Anas americana*), northern pintail (*Anas acuta*), bufflehead (*Bucephala albeola*) common goldeneye (*Bucephala clangula*), common merganser (*Mergus merganser*), green-winged teal (*Anas crecca*), lesser scaup (*Aythya affini*), eared grebe (*Podiceps nigricollis*), and mallard (*Anas platyrhynchos*). The majority of these are winter residents or spring and fall migrants. Most shorebirds are summer residents. Common shorebird species include western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), American avocet (*Recurvirostra americana*), long-billed dowitcher (*Limnodromus scolopaceus*), snowy egret (*Egretta thula*), and great blue heron (*Ardrea herodias*). Ring-billed gulls (*Larus delarwarensis*) are common year-round residents.

Larger mammals inhabiting the study area include beavers, desert bighorn sheep, mule deer, coyotes, mountain lions, and bobcats (U.S. Department of Interior, 2004b). Mountain lions and bobcats are rare. Smaller mammals include ringtail and western spotted skunks and six bat species (Carothers and Brown 1991).Two skunk species are some of the most common to the area.

3.8.2.2 Glen Canyon Dam to Lake Mead

A total of 18 non-native fish species have been reported between Glen Canyon Dam and Lake Mead during the period of 1957 through 2006 (Lauretta and Johnstone 2005; Lauretta and Seratto 2006; Trammell and Valdez 2003; Valdez and Ryel 1995). Non-native fish infrequently occurring in this reach include the golden shiner, redside shiner, striped bass, and threadfin shad.

The Glen Canyon Dam to Lake Mead reach supports six native fish species which include small numbers of the three non-ESA listed species: flannelmouth sucker, bluehead sucker, and speckled dace. The flannelmouth sucker spawns in the Colorado River (McIvor and Thieme 2000; Thieme 1998), although the water generally is too cold for survival of eggs and larvae. Populations of bluehead and flannelmouth suckers are protected under a multi-state cooperative agreement between Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming (Utah Department of Natural Resources 2004). Their

populations appear to have remained relatively stable under the MLFF operating policy of Glen Canyon Dam.

The primary sport fish in the Colorado River between Glen Canyon Dam and Lake Mead inflow is rainbow trout. Natural reproduction of rainbow trout in the Grand Canyon is dependent on cool water temperatures, access to tributaries for spawning and continued availability of suitable mainstream habitat. These variables are directly related to patterns of flow releases from Lake Powell. McKinney and Speas (2001) conducted a study analyzing 658 rainbow trout around Lees Ferry to determine the predominant food sources. It was found that *Gammarus*, chironomids, and *Cladophora* constituted about 90 percent of the food by volume.

Humpback chub have also been reported to rely on *Gammarus* and chironomids, but also rely on larval simuliids, which become more common downstream of the Paria River (Gloss et. al. 2005). *Cladophora, Oscillatoria spp* and terrestrial organic matter serve as key energy sources for aquatic invertebrates between Glen Canyon Dam and Lake Mead. *Cladophora and Oscillatoria* are also consumed by fish (Gloss et. al. 2005).

Over 27 species of herpetofauna have been documented in the riparian zone of the Grand Canyon. Within this reach, herpetofauna densities are generally highest in the new high water zone of riparian vegetation that has developed since emplacement of Glen Canyon Dam. The old high water zone is situated higher in elevation, a result of pre-dam flooding. However, Carpenter (2006) found that, other than the resident frog species, all herpetofuana observed in the canyon utilized all three hydrologic zones - shoreline, the new high water zone and the old high water zone. Toads and tree lizards used the shoreline proportionally more than any of the other species and were observed more in the new, than in the old high water zone.

The most common lizards in the riparian zone are the side-blotched lizard (*Uta stansburiana*), the Western whiptail (*Cnemidophorus tigris*), the desert spiny lizard (*Sceloporus magister*), and the tree lizard (*Urosaurus ornatus*). The collared lizard (*Crotaphylus insularis*) and the chuckwalla (*Sauromalus obesus*) are less common in the riparian zone than in the old high water zone. Warren and Schwalbe (1986) reported lizard densities during June averaged 858 per hectare in the riparian zone versus 300 per hectare in the old high water zone. Kearsley et. al. (2006) suggested that the high density of lizards in the riparian zone may be attributed to increased abundance of food resources (insects) and to some degree to organic debris left on popular camping beaches.

Snakes are common in the higher and drier elevations of the riparian zone and in the more xeric terraces and hillsides. Eight snake species have been documented within the riparian zone; the most common of these are the Grand Canyon rattlesnake (*Crotalus viridis abyssus*), the southwestern speckled rattlesnake (*C. mitchellii pyrrhus*) and the desert striped whipsnake (*Masticophis taeniatus*).

Listed as a species of special concern in Arizona, the northern leopard frog is declining throughout its range. Recent surveys have found healthy populations of the Woodhouse's toad (*Bufo woodhousii*), the red-spotted toad, (*B. punctatus*), the canyon treefrog, and the tiger salamander (*Ambystoma tigrinum*) (Gloss et. al. 2005).Northern leopard frog populations have declined substantially (Drost 2004).

The canyon tree frog is confined mostly to relatively steep side canyons while the two toad species are generally found in the active riparian zone in spring and fall but appear to favor the shore zone in summer (Kearsley et. al. 2003). For riverside dwellers, egg deposition and larval development generally occurs in the backwaters or along the shallow waters at the boundary of the aquatic and riparian ecosystems.

Listed as a species of special concern in Arizona, the northern leopard frog is declining throughout its range. Leopard frogs have disappeared from 70 percent of the known sites above and below Glen Canyon Dam and there appear to be declines among some of the remaining populations (Gloss et. al. 2005). The only known remaining population below Glen Canyon Dam is located between Glen Canyon Dam and the Paria River in a series of off-channel pools. Inundation at this site occurs at approximately 21,000 cfs. This population has experienced wide year-to-year fluctuations in numbers, but recent survey efforts indicate a sharp decline in population size with only two adult individuals found in 2004 (Drost 2004).

In 2004, a previously unknown small population of a second leopard frog species was found in Surprise Canyon. Although genetic studies are still in progress, the frogs appear to be an ever rarer species, the lowland leopard frog (*Rana yavapaiensis*). This small population is located well up the canyon and outside the influence of flows in the Colorado River (Drost 2005).

More than 30 bird species have been recorded breeding in the riparian zone along the Colorado River in Grand Canyon. Most nest and forage for insects within the riparian zone and the adjacent upland area. Of the 15 most common riparian breeding bird species, 10 are neotropical migrants that breed in the study area but winter primarily south of the United States-Mexico border. The rest of the breeding birds that use the canyon are year-round residents or short-distance migrants that primarily winter in the region or in nearby southern Arizona (Brown et. al. 1987).

Eleven of these nesting bird species are referred to as obligate riparian birds due to their complete dependence on the riparian zone. Obligate riparian birds nesting within the riparian zone include the neotropical migrants Lucy's warbler (*Vermivora luciae*) and Bell's vireo (*Vireo bellii*), two species identified as "high priority" under regional Partners-in-Flight bird plans and area state bird plans, Common yellowthroat (*Geothlypis trichas*), yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Icteria virens*), black-chinned hummingbirds (*Archilochus alexandri*), the endangered Southwestern willow flycatcher (*Empidonax trailii extimus*), and Bewick's wren (*Thryomanes bewickii*), a sometimes permanent resident of Grand Canyon. Black Phoebe (*Sayornis*

nigricans) is a common permanent resident of the canyon having a close association with water.

The riparian breeding bird community appears little changed since the riparian plant community stabilized in the 1970s and bird studies were initiated in the 1980s. Exceptions are Bell's vireo and song sparrow (*Melospiza melodia*), which appear to have expanded their breeding ranges, and Bullock's oriole (*Icterus bullockii*) and yellow warbler which have increased in number. The blue-gray gnatcatcher (*Polioptila caerulea*) has shown a steady decline in numbers (Brown et. al. 1987; Spence 2004; Yard and Blake 2004).

Winter songbirds include ruby-crowned kinglet, white-crowned sparrow, dark-eyed junco, and song sparrow (Spence 2004). Spence (2004) found that winter species diversity increased below RM 205.

The aquatic bird community is almost exclusively made up of winter residents. Thirty-four species of wintering waterfowl along with loons, cormorants, grebes, herons, rails, and sandpipers utilize the Colorado River corridor. Increases in abundance and species richness have been attributed to the increased river clarity and productivity associated with the presence of Glen Canyon Dam (Spence 2004; Stevens et. al. 1997a). The majority of waterfowl tends to concentrate above the Little Colorado River due to the greater primary productivity that benefits dabbling ducks and greater clarity for diving, piscivorous ducks. Common waterfowl species include American coot (*Fulica americana*), American widgeon, bufflehead, common goldeneye, common merganser, gadwall (*Anas strepera*), green-winged teal, lesser scaup (*Aythya affinis*), mallard, and ring-necked duck (*Aythya collaris*). Shorebirds other than great blue heron and spotted sandpiper (*Actitis macularia*) are rare in the action area. These species are fairly common winter and summer residents along the river.

The American peregrine falcon (*Falco peregrinus*) are uncommon year-round residents in the action area. In recent years, as many as twelve active eyries have been found in the canyon. Nest sites are usually associated with water. In the Grand Canyon, common prey items in summer include white-throated swift (*Aeronautes saxatalis*), swallows, other song birds, and bats (Brown 1991), many of which feed on invertebrate species (especially Diptera) that emerge out of the Colorado River (Stevens et. al. 1997b). In winter, a common prey item is waterfowl.

The common bird species found in this reach (Gloss et. al. 2005) are summarized in Table 3.8-5 and Table 3.8-6.

Table 3.8-5
The Fifteen Generally Most Common Terrestrial Breeding Bird Species
Found in Riparian Habitats Along the Colorado River in Grand Canyon

Common Name	Scientific Name
Ash-throated flycatcher	*Myiarchus cinerascens*
Bell's vireo	*Vireo bellii*
Bewick's wren	*Thryomanes bewickii*
Black-chinned hummingbird	*Archilochus alexandri*
Blue grosbeak	*Passerina caerulea*
Blue-gray gnatcatcher	*Polioptila caerulea*
Bullock's oriole	*Icterus bullockii*
Common yellowthroat	*Geothlypis trichas*
House finch	*Carpodacus mexicanus*
Lesser goldfinch	*Carduelis psaltria*
Lucy's warbler	*Vermivora luciae*
Mourning dove	*Zenaida macroura*
Song sparrow	*Melospiza melodia*
Yellow warbler	*Dendroica petechia*
Yellow-breasted chat	*Icteria virens*

Table 3.8-6
The Ten Generally Most Common Overwintering Aquatic Bird Species
Encountered During Surveys Along the Colorado River below Glen Canyon Dam

Common Name	Scientific Name
American coot	*Fulica Americana*
American wigeon	*Anas Americana*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Common merganser	*Mergus merganser*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Ring-necked duck	*Aythya collaris*

Within the GCNRA and Grand Canyon National Park, 64 and 34 species of mammals, respectively, have been found (Carothers and Aitchison 1976; Warren and Schwable 1986; Frey 2003). Of these mammals only three can be considered obligate aquatic mammals - beaver (*Castor canadensis*), muskrat (*Ondatra canadensis*), and river otter

(*Lutra canadensis*). Despite occasional reported sightings of river otters in the Grand Canyon, river otters are classified as extirpated and muskrats are considered extremely rare.

An increase in the population size and distribution of beavers in Glen Canyon and Grand Canyon has occurred since the construction of Glen Canyon Dam, likely due to the increase in riparian vegetation and relatively stable flows. Beavers cut willows, cottonwoods, and shrubs for food and can significantly affect the riparian vegetation. Bats in the Grand Canyon typically roost in desert uplands, but forage on abundant insects along Lake Powell, the Colorado River and its tributaries. The deer mouse (*Peromyscus maniculatus*) is restricted to the riparian zone. Larger mammals included coyotes (*Canis latrans*), bighorn sheep, mule deer (*Odocoileus rafinesque*), mountain lions (*Puma concolor*), and bobcats (*Lynx rufus*). Mountain lions and bobcats are rarely seen (Gloss et. al. 2005).

3.8.2.3 Lake Mead and Hoover Dam

The sport fishery in Lake Mead is primarily for striped bass and largemouth bass. Other sport fish found in the lakes include catfish and hatchery reared rainbow trout (USBR 2000).

Native fishes in this reach include the razorback sucker, and the flannelmouth sucker. Non-native fishes inhabiting this reach include red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), and mosquitofish, among others (USBR 1982a).

A large number of non-native fish species are present, predominantly downstream of the Warm Springs area and continuing into Lake Mead (FWS 1995). Non-native species that co-occur with native fishes in spring-fed pools include shortfin mollies (*Poecilia mexicana*), mosquitofish, and tilapia (*Oreochromis aureus*) (Scoppettone et. al. 1998).

The herpetofauna and their habitat use of upper Lake Mead is an extension of the more common species and habitat use described above for the Glen Canyon Dam to Lake Mead reach. The two relict leopard frog (*Rana onca*) populations within LMNRA are associated with isolated springs and are outside the area of influence of the proposed federal action. The spiny soft-shelled turtle (*Trionyx spiniferus*) has also been introduced and it is present in Lake Mead (Allan and Roden 1978).

Avifuana for upper Lake Mead is similar to that discussed for the previous river reaches. Songbird species are similar to those of the canyons upstream with greater diversity than in Glen Canyon and Grand Canyon. Waterfowl species are similar to those described above for Lake Powell. Waterfowl use is highest in winter months.

Mammalian use of this reach is similar to that discussed for the previous reaches.

3.8.2.4 Hoover Dam to NIB

This section of the lower Colorado River supports several hundred species of wildlife (birds, mammals, fish, reptiles, and amphibians), including both resident species and migratory visitors, that use the land cover types described above. Common mammals

include mule deer (*Odocoileus hemionus*), burro (*Equus asinus*) (a non-native mammal), coyote (*Canis latrans*), bobcat (*Felis rufus*), Audubon cottontail (*Sylvilagus audubonii*), several species of rodents and bats, striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*) (Anderson and Ohmart 1984b). Reptiles and amphibians are represented by several species of lizards, snakes, toads, and frogs, many of which are native to the area. Most of these use upland and riparian areas, but the amphibians require water for reproduction. The spiny soft-shelled turtle (*Trionyx spiniferus*) has also been introduced in Lake Mohave (Allan and Roden 1978). A variety of aquatic invertebrates inhabit the reservoirs and river. Fourteen species of zooplankton have been reported in Lake Mead and Lake Mohave as well as mollusks, crustaceans, aquatic and terrestrial insects, and a freshwater jellyfish (Allan and Roden 1978).

The Colorado River corridor provides important habitat for migratory birds, both neotropical songbirds and waterfowl and other wetland dependent species, as well as habitat for resident species. These migratory species include such songbirds as humming birds, cuckoos, flycatchers, vireos, warblers, tanagers, orioles, buntings, waterfowl and wetland birds such as geese, ducks, cranes, rail, killdeer and other plovers, stilts, avocets, yellowlegs, dowitchers, and sandpipers.Woody riparian vegetation and wetlands provide habitat for a variety of raptors that include sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus johannis*), common black hawk (*Buteogallus anthracinus*), Harris' hawk (*Parabuteo unicinctus*), bald eagle (*Haliaeetus luecocephalus*), golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus leucurus*), American kestrel (*Falco sparverius*), peregrine falcon (*Falco peregrinus*), and osprey (Pandion haliaetus). Other common birds include egrets, herons, and woodpeckers. Backwaters and reservoirs provide resting and foraging habitat for waterfowl and shorebirds.

3.8.2.5 NIB to SIB

This reach, known as the Limitrophe Reach, is inhabited by warm water fish and wildlife species similar to those found upstream. As identified in Table 3.8-4, sixteen species of fish, primarily non-native, may be found in this reach."

3.8.3 Special Status Species

Special status species are species that are listed, or those that are proposed for listing as threatened or endangered under the ESA that may be present in the study area, and include species of special concern to states and other entities responsible for management of resources within the study area. This includes special status species and their habitat from Lake Powell to the SIB that may be affected by the proposed federal action. Special status species not associated with the Colorado River, or which otherwise are not likely to be affected, are not described in this EIS.

Reclamation is consulting with the FWS to meet its responsibilities under Section 7 of the ESA on the potential effects of the proposed federal action to ESA-listed species. A considerable amount of information pertinent to this analysis is available from various recent

documents prepared by Reclamation and the FWS under NEPA and/or the ESA. These documents were relied upon for much of the information for this section.

Reclamation prepared a biological assessment (BA) on the ISG and Secretarial Implementation Agreement (SIA), which analyzed the potential effects on special status species, including ESA-listed species which may occur in the study area from the full pool elevation of Lake Powell to the SIB (Reclamation 2000).

More recently, Reclamation completed consultation under ESA for various current and projected federal and non-federal activities covered by the LCR MSCP. The purpose of the LCR MSCP was to provide for conservation of several federally listed species and many non-listed species, while allowing the federal and non-federal MSCP partners to continue their ongoing and future operations below Lake Mead. The geographic scope of the LCR MSCP includes the full pool elevation of Lake Mead and the floodplain downstream to the SIB. Among the activities covered by the consultation were future water delivery reductions under shortage conditions.

Reclamation is consulting with the FWS to meet its responsibilities under Section 7 of the ESA on the potential effects beyond the LCR MSCP coverage, of the proposed federal action to federally listed species. This includes: 1) Lake Powell to Lake Mead (outside LCR MSCP coverage); and 2) Incremental effects beyond LCR MSCP coverage, if any, from Lake Mead to the SIB.

Table 3.8-7 lists those special status species potentially affected by the proposed federal action. Further description of special status species is available in several existing documents including the LCR MSCP (2004, 2005) and Colorado River Interim Surplus Guidelines Final EIS (USBR 2000).

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCS to Lake Mead	Lake Mead to SIB
Fish					
Colorado pikeminnow	Ptychocheilus lucius	FE CH CA E UT SP AZ SC	X		
Flannelmouth sucker	Catostomus latipinnis	AZ SC BLM S UT CS	X	X	X
Humpback chub	Gila cypha	FE CH UT State Protected AZ SC	X	X	

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCS to Lake Mead	Lake Mead to SIB
Bonytail	Gila elegans	FE CH AZ SC CA E	X		X
Razorback sucker	Xyrauchen texanus	FE CH CA E UT SP AZ SC	X	X	X
Bluehead sucker	Catostomus discobolus	FC AZ SC UT CS		X	X
Birds					
California Condor	Gymnogyps californianus	FE EX AZ SC CA E	X	X	
Bald eagle	Haliaeetus leucocephalus	FT - PDL AZ SC CA E NV SP	X	X	X
Osprey	Pandion haliaetus	AZ SC CA SC	X	X	X
Belted kingfisher	Ceryle alcyon	AZ SC NV SP	X	X	X
American peregrine falcon	Falco peregrinus	FSC AZ SC CA E (fully protected) NV E	X	X	X
Southwestern willow flycatcher	Empidonax traillii extimus	FE CH AZ SC CA E NV SP		X	X
Clark's grebe	Aechmophorus clarkia	AZ SC	X	X	X
Snowy egret	Egretta thula	AZ SC		X	X
Yuma clapper rail	Rallus longirositris yumaniensis	FE AZ SC CA T			X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCS to Lake Mead	Lake Mead to SIB
Western yellow-billed cuckoo	Coccyzus americanus	FC AZ SC CA E NV SP		X	X
California black rail	Laterallus jamaicensis coturniculus	FSC AZ SC CA T			X
Elf owl	Micrathene whitneyi	CA E			X
Gilded flicker	Colaptes chrysoides	CA E			X
Gila woodpecker	Melanerpes uropygialis	CA E			X
Vermillion flycatcher	Pyrocephalus rubinus	CA SC			X
Arizona Bell's vireo	Vireo bellii arizonae	CA E			X
Sonoran yellow warbler	Dendroica petechia sonorana	CA SC			X
Summer tanager	Piranga rubra	CA SC			X
American white pelican	Pelecanus erythrorhynchos	CA SC NV SP UT SC			X
Double-crested cormorant	Phalacrocorax auritus	CA SC			X
Western least bittern	Ixobrychus exilis hesperis	FSC CA SC			X
American bittern	Botaurus lentiginosus	AZ SC			X
Great egret	Ardea alba	AZ SC			X
Black-crowned night-heron	Nycticorax nycticorax	CA SC			X
White-faced ibis	Plegadis chihi	FSC CA SC NV SP			X
Black tern	Chlidonias niger	CA SC			X
Greater sandhill crane	Grus canadensis tabida	CA T			X
Long-eared owl	Asio otus	CA SC NV SP			X
Brown-crested flycatcher	Myiarchis tyrannulus	CA SC			X
Crissal thrasher	Toxostoma crissale	CA SC			X
Lucy's warbler	Vermivora luciae	CA SC			X
Yellow-breasted chat	Icteria virens	CA SC			X
Yellow-headed blackbird	Xanthocephalus xanthocephalus	CA SC			X
Northern cardinal	Cardinalis cardinalis	CA SC			X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCS to Lake Mead	Lake Mead to SIB
Northern harrier	Circus cyaneus	CA SC NV SP			X
Cooper's hawk	Accipiter cooperii	CA SC NV SP			X
American kestrel	Falco sparverius	NV SP			X
Mammals					
Townsend's big-eared bat	Corynorhinus townsendii	UT SC BLM S CA SC	X	X	X
Pale Townsend's Big-Eared Bat	Corynorhinus townsendii pallescens	FSC AZ SC	X	X	X
Spotted Bat	Euderma maculatum	FSC CA SC AZ SC UT SC	X	X	X
Allen's Big-eared Bat	Idionycteris (=Plecotus) phyllotis	UT SC BLM S	X	X	X
Western Red Bat	Lasiurus blossevillii	AZ SC	X	X	X
Yuma myotis	Myotis yumanensis	FSC BLM S	X	X	X
Western Yellow Bat	Lasiurus xanthinus	AZ SC			X
Colorado River Cotton Rat	Sigmodon arizonae plenus	FSC CSC			X
Yuma Hispid Cotton Rat	Sigmodon hispidus eremicus	FSC CA SC			X
Occult little brown bat	Myotis lucifugus occultus	FSC CA SC AZ SC			
Cave Myotis	Myotis velifer	FSC CA SC			X
Greater Western Mastiff Bat	Eumops perotis californicus	FSC CA SC		X	X
Small-footed myotis	Myotis ciliolabrum	BLM S		X	X
Amphibians					
Colorado River Toad	Bufo alvarius	CA SC			X

Table 3.8-7
Special Status Species Potentially Affected by the Proposed Federal Action

Common Name	Scientific Name	Listing Status	Location		
			Lake Powell	GCS to Lake Mead	Lake Mead to SIB
Relict Leopard Frog	Rana onca	FC NV SP AZ SC CA SC			X
Lowland leopard frog	Rana yavapaiensis	FSC AZ SC CA SC		X	X
Northern leopard frog	Rana pipens	AZ SC CA SC	X	X	
Plants					
Grand Canyon evening primrose	Camissonia specuicola	FSC		X	
Sticky buckwheat	Eriogonum viscidulum	FSC			X
Geyer's milkvetch	Astragalus geyeri var triquetrus	NV CE			X
Las Vegas Bear Poppy	Arctomecon californica	NV CE			X
Invertebrates					
Kanab ambersnail	Oxyloma haydeni kanabensis	FE AZ SC		X	
MacNeill's sooty-winged skipper	Hesperopsis gracielae	FSC BLM S		X	X
Niobrara ambersnail	Oxyloma haydeni haydeni	BLM S		X	

Listing Status Legend

FT – Federally threatened under Endangered Species Act (ESA)

FT PDL – Federally threatened under ESA, proposed for de-listing

FE – Federally endangered under ESA

FE CH – Federally endangered under ESA with designated Critical Habitat (CH)

FE EX – Federally endangered under ESA, experimental population

FC – Federal candidate for listing under ESA

FSC – Federal Species of Concern (non-ESA)

BLM S – Bureau of Land Management Sensitive

NV E – Nevada Endangered

NV CE – Nevada Critically Endangered

NV SP – Nevada State Protected

AZ SC – Arizona Wildlife of Special Concern

CA T – California Threatened

CA E – California Endangered

CA SC – California Species of Special Concern

UT CS – Utah special management under Conservation Agreement to preclude the need for Federal listing

UT SC – Utah Species of Concern

UT SP – Utah State Protected

3.9 Cultural Resources

This section describes the cultural resources that may be affected by the proposed federal action. The cultural resources include historic and prehistoric buildings, structures, sites, and objects, including Indian sacred sites and traditional cultural properties. Historic properties are the subset of cultural resources that are either listed or determined eligible for listing on the National Register of Historic Places (NRHP). Eligibility to the NRHP is determined by the ability of a property to convey its significance or importance in American history, prehistory, culture, or engineering, and by its integrity, essentially its preservation (36 C.F.R. pt. 60.4).

Section 106 of the National Historic Preservation Act of 1966 (NHPA) as amended, and its implementing regulations (36 C.F.R. pt. 800) require federal agencies to take into account the effects of their actions (undertakings) on historic properties and to allow the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Exec. Order No. 13007 requires consultation with Indian tribes regarding Indian sacred sites. Executive Memorandum from the White House of April 29, 1994 requires government-to-government consultation on other issues of Tribal concern. These concerns may also involve cultural resources. Reclamation has initiated consultation with concerned Indian tribes, State Historic Preservation Officers (SHPO), Tribal Historic Preservation Officers (THPO), and other interested parties regarding cultural resources.

3.9.1 Undertaking Determination

Reclamation has determined that the proposed federal action is an undertaking subject to compliance with Section 106 of the NHPA. This is because it adds a new element to the existing program of on-going operations of the Colorado River that could lead to changes in the manner in which Lake Powell and Lake Mead have been operated historically. Specifically, the alternatives address operation of these two reservoirs at low elevations that might result in the emergence of cultural resources that have been submerged since the creation of the reservoirs. A reduction in the amount of water to be delivered downstream of Lake Mead could result in lower river levels, which could lead to changes in stream dynamics and patterns of deposition and erosion that could potentially affect cultural resources.

3.9.2 Definition of the Area of Potential Effects and Identification Efforts

The area of potential effects (APE) of an undertaking is defined at 36 C.F.R. pt. 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist." This section goes on to state that "the APE is influenced by the scale of the undertaking and may be different for different kinds of effects caused by the undertaking." Reclamation defines the APE to be the reaches of the Colorado River from Lake Powell downstream to Imperial Dam. In the reach from Davis Dam to Imperial Dam, the APE is further defined as the Colorado River channel from bank to bank, and the lateral extent of backwaters, lakes, and marshes directly connected to it.

Reclamation has compiled all available information about previously documented cultural resources in the APE. This information will form the basis of consultation with the SHPO and THPO, as required by 36 C.F.R. pt. 800.

3.9.3 Lake Powell and Glen Canyon Dam

The NPS database indicates that 518 historic properties were recorded within the full reservoir pool of Lake Powell (elevation 3,700 feet msl) during the Upper Colorado River Basin Archaeological Salvage Project (more commonly referred to as the Glen Canyon Project [Jennings 1966]) between 1956 and 1963. All were inundated by 1980 when Lake Powell reached full pool elevation. The Glen Canyon Project was completed prior to the enactment of the NHPA; hence none of the sites were evaluated for eligibility to the NRHP. Of the 518 sites, 61 were excavated and 10 tested for significance under the Historic Sites Act of 1935. This left 447 sites for which documentation was the only form of mitigation.

It is not known whether any of the inundated sites would retain integrity should they be exposed through the lowering of Lake Powell elevation. Inundation studies conducted by the NPS and the USACE (Dunn 1996; Lenihan et. al. 1981; Ware 1989) concluded that cultural resources located within the deep-water zone of reservoirs are least susceptible to impacts of inundation and reservoir operations, while cultural resources within the operational zones of reservoirs are subject to adverse impacts from wave action and the alternating effects of wetting and drying related to fluctuating pool levels. Cultural resources immediately above the full pool elevation have generally been disturbed and damaged by recreation and visitation.

Indian sacred sites and other resources of Tribal concern have been documented in this reach.

3.9.4 Glen Canyon Dam to Lake Mead

The first 15 miles of this reach is within the GCNRA. The remainder of the reach is within the Grand Canyon National Park, the Navajo Indian Reservation and the Hualapai Indian Reservation. An intensive archaeological survey of this reach was conducted during 1991 and 1992 by NPS and the Department of Anthropology, Northern Arizona University (NAU) through funding provided by Reclamation. In all, 475 sites were recorded, 336 of which were potentially subject to impacts from dam operations. Of the 336 sites, 313 were determined NRHP-eligible, 14 not eligible, and nine were recommended for testing (Fairley et. al. 1994). A programmatic agreement was developed to address the possible impacts to cultural resources resultant from the operation of Glen Canyon Dam (USDI 1994). Currently, Reclamation in conjunction with the NPS, Navajo Nation Archaeological Department (NNAD), Utah State University (USU), the Zuni Cultural Resource Enterprise (ZCRE), and Museum of Northern Arizona is developing a treatment plan for mitigation of adverse effects to 160 historic properties. Additional long term monitoring and resource protection is afforded by the Grand Canyon Protection Act of 1992.

The Navajo Nation, Pueblo of Zuni, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, and Paiute Indian Tribe of Utah have been actively monitoring Grand Canyon natural resources, as well as resources of traditional religious and cultural significance. These tribes are currently developing culturally specific long-term monitoring protocols. In

addition, the Pueblo of Zuni has completed a NRHP eligibility nomination for selected historic properties or traditional cultural properties (TCP) as defined by National Register Bulletin 38. The Navajo Nation, Hopi Tribe, and Hualapai Tribe are currently developing TCP nominations. Indian sacred sites and other resources of Tribal concern have been documented in this reach.

3.9.5 Lake Mead and Hoover Dam

Most of the prehistoric cultural resources in this reach were documented by Harrington and the Civilian Conservation Corps in the 1920s and 1930s (Harrington 1925a, b, 1926, 1927; Harrington et. al. 1930), while those of historic and architectural value are compiled in WESTEC Inc. (1980). Property types include: mines, ferry and steamboat landings, roads, ranches, farms, buildings, and town sites (Kaolin, St. Thomas, Rioville, and Callville). Notable ethnographic resources include a Southern Paiute farm observed by Jedediah Smith in 1827, a village site, and the Salt Song Trail, the general location of which is shown in the map that serves as the frontispiece to Laird's work on the Chemehuevi (Laird 1976). Two resources are listed on the NRHP: Lost City/Pueblo Grande de Nevada, and Hoover Dam. Hoover Dam is further distinguished by its status as a National Historic Landmark. Most of these resources have been submerged since 1937 when Lake Mead rose above elevation 1,083 feet msl to an elevation of 1,102 feet msl.

Since its initial filling in the late 1930s, Lake Mead elevations have fluctuated from a high of 1,226 feet msl in 1983 to a low of 1,083 feet msl in 1956. Based on the results of the National Reservoir Inundation Study (Lenihan et. al. 1981; Ware 1989) it is anticipated that most cultural resources located within the historical operational zone of Lake Mead (between the 1,225-foot msl and 1,083-foot msl elevation contours) have lost integrity as a result of repeated, periodic exposure at the margin of the reservoir where they would have been subject to mechanical erosion by wave action. Although some sites in the historical operational zone such as St. Thomas (Wyskup 2006) may continue to retain integrity, the National Reservoir Inundation Study and other reservoir specific studies (Labadie 2001) indicate only cultural resources submerged at depth since initial inundation are likely to retain integrity. Recent sidescan sonar and high-resolution seismic-reflection studies performed at Lake Mead (Harper et. al. 2005; Twichell et. al. 1999, 2003) appear to confirm this finding and suggest that cultural resources submerged in Lake Mead since it reached historic operational levels in 1937 could retain sufficient integrity for listing on the NRHP.

Though some 156 resources appear in agency records, documentary sources, and inventory reports, this analysis concentrates on 108 sites previously identified in agency and repository records. Of these 108 sites it is likely that as many as 73 sites within the operational zone of Lake Mead (that area between elevations 1,226 feet msl and 1,083 feet msl) are likely to have been completely destroyed or damaged to the point where they would not qualify for listing on the NRHP. The remaining 35 sites below elevation 1,083 feet msl may retain sufficient integrity to qualify for listing. Examples of submerged resources in excellent condition are the B-29 bomber that went down in Lake Mead in the 1950s, and features associated with the aggregate classification plant used during the construction of Hoover Dam (Harper et. al. 2005).

Previously undocumented cultural resources in the operational zone of Lake Mead will likely have been impacted to varying degrees and some will probably retain sufficient integrity to qualify for listing on the NRHP. However, as noted above, the excellent condition of the B-29 bomber and the features associated with the aggregate classification plant located in the Boulder Basin suggest there is a good chance previously undocumented cultural resources that have been submerged since 1937, below elevation 1,083 feet msl, could retain sufficient integrity to be considered for listing. Examples of the kinds of cultural resources that are likely to retain some information potential include historic sites with structural remains and archaeological sites with subsurface deposits and features. Information from sidescan sonar studies conducted in the Boulder Basin and other areas of Lake Mead indicate deposition of sediment has been greatest in the area of the delta, and along the old channels of the Colorado River and Virgin River, and the major washes that feed into them. Undocumented cultural resources in these areas are likely buried beneath considerable thickness of sediment or, as is the case with St. Thomas, cultural resources may be covered by a mantle of silt several to tens of inches thick (Wyskup 2006).

3.9.6 Lake Mohave and Davis Dam

Most of the prehistoric cultural resources in this reach were documented by Baldwin (1943, 1948). WESTEC Inc. (1980) reported on historic and architectural resources. Though 196 previously recorded prehistoric and historic period cultural resources are known or suspected to be located in or immediately adjacent to the Lake Mohave and Davis Dam reach, many of the resources documented by Baldwin prior to the construction of Davis Dam (Baldwin 1943, 1948) are features, rather than sites. When Baldwin's clusters are treated as single sites, the total number of sites suspected to be located in and immediately adjacent to the Lake Mohave and Davis Dam reach is reduced to 89.

Types of historic sites include mines, ranches, buildings and structures, ferry and steamboat landings, roads, trails, campsites, and a railroad (the Quartette Mining Company line). One traditional cultural property of importance to several tribes that is listed on the NRHP is located in this reach. Prehistoric property types documented in this reach include pit houses, rock art, rock shelters, lithic and ceramic scatters, rock circles, rock alignments, and rock piles.

With respect to the probable condition of documented and undocumented sites submerged in Lake Mohave, it can be anticipated that the portions of resources located between the 647-foot msl elevation contour and the 628-foot msl elevation contour will have lost integrity as a result of wave action. The results of a recent sidescan sonar and seismic-reflection study (Foster et. al. 2004) suggest portions of sites located below the 628-foot msl elevation contour may retain sufficient integrity to qualify them for consideration for listing on the NRHP.

3.9.7 Davis Dam to Parker Dam

The environment in which cultural resources exist is different in fluvial and lacustrine systems. For this reason, the highly channelized river reach from Davis Dam to Upper Lake Havasu is treated separately from that of Lake Havasu and Parker Dam.

3.9.7.1 Davis Dam to Upper Lake Havasu

The 39-mile reach of the Colorado River from Davis Dam to Upper Lake Havasu is one of its most highly modified and controlled stretches. Within this part of the reach, the Colorado River levels will likely fall rather than rise from a decrease in water deliveries when shortages are declared. For this reason, the APE for this reach is the Colorado River channel from bank to bank, and the lateral extent of backwaters, lakes, and marshy areas directly connected to it.

Information contained in WESTEC Inc. (1980) indicates that at least 22 historic period cultural resources may be present in or located in the immediate vicinity of Davis Dam to Upper Lake Havasu. Property types located in this reach include river crossings, ferry and steamboat landings, town sites or camps, buildings, structures, trails, roads, and highways, railroads, bridges, and the suspected location of the Rose-Brown massacre. This information also indicates that a number of these resources had already been significantly impacted by the 1970s by residential and commercial development, historic flood events, or destroyed during the 1950's when portions of this stretch was confined within levees, channelized, and stabilized with rip-rap. The Arch Bridge/1916 Colorado River Highway Bridge, a part of a multiple property listing on the NRHP, is in this reach. Prehistoric sites include caves and rockshelters, lithic and ceramic scatters, rock alignments, and petroglyphs.

3.9.7.2 Lake Havasu and Parker Dam

This part of the APE includes Lake Havasu from RM 237 downstream to Parker Dam. Information in WESTEC, Inc. (1980) and other sources provide a brief description of eight cultural resources submerged beneath Lake Havasu. These are primarily river landings associated with mills, and commercial and residential structures established to support several local mines active from 1860 to the turn of the century. Historic records indicate that several historic-period Chemehuevi Indian villages were located along both sides of the Colorado River at the upper end of the Chemehuevi Valley. An additional 20 cultural resources appear in repository records as being located at the margin of Lake Havasu or on small islands or peninsulas extending into the reservoir. Prehistoric types include lithic and ceramic scatters, rock alignments, trails, bedrock mortars, petroglyphs, and intaglios. Due to limited information currently available, it is not possible to know the condition of the submerged resources or how much post-impoundment sedimentation has occurred.

Any cultural resources located within the current operational zone of the reservoir (between elevations 450.5 feet msl and 445.8 feet msl), or within the historic operational zone between elevations 451 feet msl and 444 feet msl, will likely have been impacted. Sites located in these zones will likely not be considered as eligible properties. However, it is possible based on results of recent findings in Lake Mead and Lake Mohave that cultural resources consistently submerged beneath Lake Havasu since its creation may retain sufficient integrity to be eligible for the NRHP.

3.9.7.3 Parker Dam to Imperial Dam

This reach extends from Parker Dam to Imperial Dam and covers the 143 miles of river channel (from bank to bank) and the lateral extent of backwaters, lakes, and marshy areas having a direct connection to the river.

Minimal cultural resources inventorying has been conducted in this portion of the APE. Possible cultural resources within and the limits of the APE are described in the Implementation Agreement FEIS (Reclamation 2002). The information provided in this document suggests that numerous historic resources may be present in and around this reach. Twelve sites have been recorded proximate to the boundary of the APE. These consist of a segment of a railway where it crosses the Colorado River, a ceramic scatter, heat altered rock, intaglios, historic mining/milling features, bedrock mortar depressions, a natural cavern used as a jail for the historic gold milling community of Picacho, a lithic scatter, a trail segment, mining cairns, rock art, and cleared circles. Only one of the twelve sites, a prehistoric habitation site, is listed on the National Register and is near the edge of the APE. Only three recorded sites are known to exist within the APE. These are Parker Dam, Imperial Dam, and a portion of the "Old Parker Road" alignment. Parker Dam is a contributing element to the Parker Dam Historic District, which is eligible for listing on the National Register. Imperial Dam is potentially eligible for individual listing on the National Register and is a contributing element to the All-American Canal system.

Though cultural inventories of areas within the historic floodplain of this river reach are extremely limited, it appears that historic site distribution along the river corridor is more random then on the uplands bordering the historic floodplain. Also, prior to construction of Hoover Dam in the 1930s, river flows were extremely dynamic, its course meandering and altering across the floodplain. Trench evaluations reveal that sediments within the floodplain have been laid down under high-energy fluvial conditions, under which it is extremely unlikely to expect in situ cultural remains.

3.9.7.4 Imperial Dam to SIB

There is little to no data relative to the existence of historic properties within the river channel for the river reach that extends from Imperial Dam to the SIB. Nevertheless, any known or as yet undiscovered cultural resources within this reach of the River will not be affected by the No Action Alternative or action alternatives because the current river operations will continue into the future. This is also applies to sites listed on the National Register of Historic Places. One of these sites is the Ocean to Ocean Bridge, constructed in 1915 for Highway 80 in Yuma, Arizona which is the first highway bridge to be constructed across the Colorado River. Another site is Yuma Crossing and associated sites, which has been designated as a National Historic Landmark. The landmark boundaries straddle the River from the St. Thomas Yuma Indian Mission on the north and the Quartermaster Depot and Yuma Territorial Prison on the south.

3.10 Indian Trust Assets

3.10.1 Introduction

Indian Trust Assets (ITAs) are "…'legal interests' in 'assets' held in 'trust' by the federal government for federally recognized Indian tribes or individual Indians" (USBR 1994). The United States, as trustee, is responsible for protecting rights reserved by, or granted to, Indian tribes or individual Indians by treaties, statutes, executive and secretarial orders, and other federal actions. The Department's policy is that when a proposed federal action appears likely to adversely affect an ITA, the action agency should seek ways to minimize or avoid the adverse effect; if adverse effects cannot be avoided, then the action agency should provide appropriate mitigation or compensation. While most ITAs are located on reservation lands, they can also be located off-reservation. Examples of ITAs include, but are not limited to, water rights, land, minerals, and rights to hunt and fish.

Reclamation consulted with potentially affected tribes whose reservations are located along the mainstream Colorado River from Lake Powell to the SIB, as well as with those tribes who have a water service contract (Chapter 6) to identify ITAs and to assess potential effects of the proposed federal action on these ITAs. Reclamation has determined that no tribes or reservations located upstream of Lake Powell will be affected by the proposed federal action.

The trust assets that might potentially be impacted as a result of implementing the proposed federal action are described and discussed below. Impacts to the ITAs are discussed and analyzed in Chapter 4, and cumulative effects are discussed in Chapter 5.

3.10.2 Water Rights and Trust Lands

For this analysis, the Indian water rights and land assets considered include:

- federally reserved Indian rights to Colorado River water including rights established pursuant to *Arizona v. California;*
- Colorado River water Tribal delivery contracts where such contracts are part of a congressionally approved water rights settlement; and
- Indian reservations.

Indian trust lands are areas for which the United States holds title in trust for the benefit of the tribe (Tribal trust land) or for an individual Indian (individual trust land). Trust lands may be located on or off a reservation. While Indian reservations are not technically synonymous with trust lands, the exterior boundaries of Indian reservations are used to define the trust assets for purposes of this NEPA analysis. The BIA and United States Census Bureau identified and provided the data on size and location of reservations analyzed here.

3.10.2.1 Indian Trust Assets Determined under Arizona v. California: Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma, and Cocopah Indian Reservations

The March 9, 1964 Arizona v. California Decree and several supplemental decrees (consolidated in 2006 into the Consolidated Decree) quantified the Indian reserved water rights of the Fort Mojave, Chemehuevi, Colorado River Indian, Fort Yuma, and Cocopah Indian reservations. The amounts of water (diversion entitlements), priority dates for this water, net acres, and the states where the water rights are perfected for these Indian reservations are listed in Table 3.10-1, and discussed below.

Table 3.10-1
Colorado River Mainstream Diversion Entitlement (Water Rights) in Favor of Indian Reservations

Reservation	State	Diversion Entitlement (Water Right) (afy)[1]	Net Acres1	Present Perfected Right Number[1]	Priority Within State	Priority Date[1]
FORT MOJAVE RESERVATION	Arizona	27,969	4.327	3	1	Sept.18,1890
		75,566	11,691			Feb 2, 1911
	California	16,720	2,587	25	1	Sept. 18, 1890
	Nevada	12,534	1,939	81	1	Sept. 18, 1890
Total	--	132,789	--	--	--	
CHEMEHUEVI RESERVATION	California	11,340	1,900	22	1	Feb. 2, 1907
Total	--	11,340	--	--	--	
COLORADO RIVER INDIAN RESERVATION	Arizona	358,400	53,768	2	1	Mar. 3, 1865
		252,016	37,808			Nov. 22, 1873
		51,986	7,799			Nov. 16, 1874
	California	10,745	1,612	24	1	Nov. 22, 1873
		40,241	6,037			Nov. 16, 1874
		5,860	879			May 15, 1876
Total	--	719,248	--	--	--	
FORT YUMA INDIAN RESERVATION	Arizona	6,350	952	3a	1	Jan. 9, 1884
	California	71,616	10,742	23	1	Jan. 9, 1884
Total	--	77,966	--	--	--	
COCOPAH INDIAN RESERVATION	Arizona	1,140	190	8	1	1915
		7,681	1,206	1		Sept. 27, 1917
		2,026	318	--	4	June 24, 1974
Total	--	10,847	--	--	--	
Arizona Total	--	783,134	--	--	--	
California Total	--	156,522	--	--	--	
Nevada Total	--	12,534	--	--	--	

1 Source: Consolidated Decree of March 27, 2006. The quantity of water in each instance is measured by (i) diversions or (ii) consumptive use required for irrigation of the respective acreage and for satisfaction of related uses, whichever of (i) or (ii) is less.

Fort Mojave Reservation (Fort Mojave Indian Tribe of Arizona, California and Nevada). The Fort Mojave Reservation is located in the lower Colorado River basin where Nevada, Arizona, and California meet. The Fort Mojave Reservation possesses present perfected federal reserved water rights from the Colorado River in all three of these states that contain reservation land pursuant to the Consolidated Decree.

Subsequent to recent changes made to the Fort Mojave Reservation's water rights resulting from a boundary adjustment, the reservation has the right to divert up to 103,535 afy in Arizona (2004 diversion of 69,103 af)[1], up to 16,720 afy in California (in 2004 the reservation diverted 16,019 af), and up to 12,534 afy in Nevada (2004 diversion of 3,870 af).

Chemehuevi Reservation (Chemehuevi Indian Tribe of the Chemehuevi Reservation, California). The Chemehuevi Reservation is located in southern California, near Lake Havasu. The Chemehuevi Reservation holds present perfected federal reserved water rights from the mainstream Colorado River pursuant to the Consolidated Decree. The lands of the Chemehuevi Reservation are mostly on the plateau above the shoreline of Lake Havasu. Present agricultural water use is limited. The Chemehuevi Reservation has a right to divert up to 11,340 afy in California; the 2004 reported diversion was 1,444 af.

Colorado River Indian Reservation (Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California). The Colorado River Indian Reservation is located in Arizona and California. The Colorado River provides 90 miles of shoreline for the Colorado River Indian Reservation. The reservation economy centers around agriculture, recreation, and light industry. The Colorado River Indian Reservation was established on March 3, 1865. The Colorado River Indian Reservation's diversion right in Arizona is 662,402 afy (2004 diversion was 585,534 af) and the reservation's diversion right in California is 56,846 afy (2004 diversion was 6,231 af).

Fort Yuma Indian Reservation (Quechan Tribe of the Fort Yuma Indian Reservation, California and Arizona). The Fort Yuma Indian Reservation is located in southwestern Arizona and southern California, near Yuma, Arizona. The Consolidated Decree provided additional water rights to the Fort Yuma Indian Reservation in both Arizona and California. The Fort Yuma Indian Reservation has the right to divert up to 6,350 afy in Arizona (2004 diversion was 1,279 af) and up to 71,616 afy in California (2004 diversion was 46,259 af).

Water for the Fort Yuma Indian Reservation is diverted from the Colorado River at Imperial Dam and delivered through the Yuma Project Reservation Division - Indian Unit. The Fort Yuma Indian Reservation has other small uses at homestead sites south of Yuma, Arizona. The current water uses shown in Table 3.10-1 include only uses within the Fort Yuma Indian Reservation.

[1] 2004 diversions are provided in this section to indicate approximate use of the entitlements for each Indian tribe.

Cocopah Indian Reservation (Cocopah Tribe of Arizona). The Cocopah Indian Reservation is located in southwestern Arizona. The western boundary of the reservation is bordered by Mexico and portions of the Colorado River. The Cocopah Indian Reservation was established through Exec. Order No. 2711 on September 27, 1917, but additional acres were added to the reservation through 1974. The Cocopah Indian Reservation economy is centered on agriculture. The Cocopah Indian Reservation's present perfected federal reserved water rights provide for the diversion of up to 10,847 afy in Arizona. The 2004 reported diversion was 3,878 af.

The 1974 decreed right for the Cocopah Indian Reservation is unique because of its more recent priority date, i.e., post-1968. The 1984 Supplemental Decree in *Arizona v. California* recognized the decreed right for the Cocopah Indian Reservation dated June 24, 1974 and amended paragraph 5 of Article II (D) of the Consolidated Decree to reflect this 1974 right.

3.10.2.2 Seven Central Arizona Indian Tribes

The CAP makes Colorado River water available to Indian tribes located in central Arizona in addition to the ITA entitlements discussed above. Over the years, there have been several Secretarial decisions allocating water to 10 Indian tribes in central Arizona. All of these Indian tribes, with the exception of the Gila River Reservation, have signed a CAP water delivery contract in 1980. The Gila River Reservation, with the largest allocation of CAP water, signed its CAP water delivery contract in 1992. Each of the CAP water delivery contracts contained a provision that the Indian tribes' CAP water would be credited against their Winters right (*Winters v. United States*, 207 U.S. 564 (1908)), if and when such rights were finally determined. Over the years, water rights settlements have been implemented for seven of these 10 Indian tribes. Under these settlements, the seven Indian tribes generally have a right to lease their CAP water within Arizona; the CAP water does not have to have a history of use in order for the water to be leased. A listing of the major water rights settlement legislation for these seven Indian tribes in chronological order follows:

- Settlement of Ak-Chin Indian Community Water Rights Claims of July 28, 1978 (92 Stat. 409) and the Ak-Chin Indian Community Water Rights Settlement Act of October 19, 1984 (96 Stat. 2698)

- Southern Arizona Water Rights Settlement Act of October 12, 1982 (Title III of Public Law 97-293) and Title III of the Arizona Water Settlements Act of December 10, 2004

- Salt River Pima-Maricopa Indian Community Water Rights Settlement Act of 1988 (102 Stat. 2549)

- Fort McDowell Indian Community Water Rights Settlement Act of 1990 (104 Stat. 4469)

- San Carlos Apache Tribe Water Rights Settlement Act of 1992 (Title XXVII of the Reclamation Projects Authorization and Adjustment Act of 1992)
- Yavapai-Prescott Indian Tribe Water Rights Settlement Act of 1994 (108 Stat. 4526) (Indian tribes' CAP water permanently assigned to Scottsdale)
- Gila River Indian Community Water Rights Settlement Act (Title II of the Arizona Water Settlements Act of December 10, 2004)

Table 3.10-2 lists the CAP Tribal water entitlements for the seven Indian tribes discussed above. These entitlements and their priorities are discussed further below.

Table 3.10-2
Central Arizona Project Indian Tribal Diversion Entitlements (Water Rights)

Reservation	Diversion Entitlement (Water Right) (afy)	Land Area (square miles)[1]	Arizona Priority	CAP Priority[2]
Ak-Chin Indian Community of the Maricopa Indian Reservation	47,500	--	2 and 3	Arizona Priority (CAP 1)
	27,500	--	4	Indian Priority (CAP 2)
Ak-Chin Indian Community Total	*75,000*	*32.9*		
Tohono O'odham Nation - San Xavier District	27,000	--	4	Indian Priority (CAP 2)
	23,000	--	4	Non-Indian Agriculture (NIA) Priority (CAP 3)
Tohono O'odham Nation - San Xavier District Total	*50,000*	*111.4*		
Tohono O'odham Nation – Schuk Toak District	10,800	--	4	Indian Priority (CAP 2)
	5,200	--	4	NIA Priority (CAP 3)
Tohono O'odham Nation - Schuk Toak District Total	*16,000*	*4342.0*		
Salt River Reservation	13,300	--	4	Indian Priority (CAP 2)
Salt River Reservation Total	*13,300*	*80.0*		
Fort McDowell Reservation		--		
Contracted in 1980	4,300	--	4	Indian Priority (CAP 2)
Acquired from HVID	13,933	--	4	Indian Priority (CAP 2)
Fort McDowell Reservation Total	*18,233*	*38.6*		
San Carlos Reservation	12,700	--	4	Indian Priority (CAP 2)
M&I Reassignment	18,145	--	4	M&I Priority (CAP 2)
Ak–Chin Settlement	30,800	--	4	Indian Priority (CAP 2)
San Carlos Reservation Total	*61,645*	*2910.6*		
Gila River Reservation	191,200	--	4	Indian Priority (CAP 2)
	120,600	--	4	(NIA) Priority (CAP 3)
Gila River Reservation Total	*311,800*	*583.9*		

1 Source is www.census.gov\geo\www\ezstate\airpov.pdf, accessed December 10, 2006

2 CAP Priority Definitions:

CAP 1: Arizona Priority 2 and Arizona Priority 3 Water
CAP 2: M&I Priority and Indian Priority Water
CAP 3: NIA Priority Water
CAP 4: Excess Agricultural Users
CAP5: Excess Water for Bank

An understanding of the CAP priority system is necessary to discern how shortages could potentially impact the different priorities of CAP water and CAP water users, including Indian tribes. Within CAP, shortages reduce water deliveries to CAP water users in the following order: CAP 5 Bank; CAP 4 Excess Agricultural Users; CAP 3 NIA Priority Water; equally CAP 2 M&I Priority and Indian Priority Water,; and finally CAP 1 Arizona Priority 2 and Arizona Priority 3 Water. A detailed explanation of the CAP water priority rights is included in Appendix E. Modeled reductions are based on what was available to a user under its entitlement in that year based on higher priority use.

Ak-Chin Indian Community of the Maricopa (Ak-Chin) Indian Reservation. In 1912, President Taft created a reservation at Ak-Chin comprised of 21,840 acres. In 1961, the Ak-Chin Tribal Council was formally recognized under the Indian Reorganization Act of 1934. The Ak-Chin Indian Reservation is located in Pinal County 50 miles south of Phoenix. Farming (Ak-Chin Farms) is a major part of the economy of the reservation.

Ak-Chin Reservation's water rights settlement of 1978 was the first of a series of Indian water rights settlements in central Arizona. The 1978 Settlement Act was amended in 1984. Under the 1984 water rights settlement, the Ak-Chin Indian Reservation has the right to receive up to 75,000 afy of water at the southeastern corner of the reservation. In years of shortage on the Colorado River, the United States may deliver no less than 72,000 afy. The 1984 Settlement Act further provides for payment of damages by the United States if these quantities of water are not delivered to the Ak-Chin Indian Reservation. In other years when surplus water is available, the United States may deliver up to an additional 10,000 afy of water to the Ak-Chin Indian Reservation (maximum of 85,000 afy). The Ak-Chin Indian Reservation was also provided with the right to lease some of its CAP water supplies within Arizona, and the Ak-Chin Indian Reservation has leased a portion of its water to the Del Webb Corporation. The Ak-Chin Indian Reservation's water infrastructure is in place, and with the exception of water that the Ak-Chin Indian Reservation leased, the community is using all of its CAP water for farming purposes.

The United States acquired 50,000 afy of Colorado River water entitlement from the Yuma Mesa Division of the Gila Project to partially meet the requirement to deliver required quantities to the Ak-Chin Indian Reservation. This 50,000 afy of water has a priority date that precedes the date of enactment of the CRBPA, and therefore has a higher priority during times of shortage than other CAP water.

Tohono O'odham Nation of Arizona. The Tohono O'odham Nation sits in the heart of the Sonoran Desert, sixty miles west of Tucson, Arizona. The Tohono O'odham Nation is divided into multiple districts totaling more than 4,342 square miles. Under the Tohono O'odham Nation's 1982 water rights settlement, as subsequently amended, the nation's water rights are specific to two of Tohono O'odham Nation's districts, the San Xavier District and the Schuk Toak District.

The San Xavier District has the right to receive a total of 50,000 afy of water, consisting of 27,000 afy of CAP 2 Indian Priority Water, and 23,000 afy of CAP 3 NIA Priority Water (Table 3.10-2). CAP 3 NIA Priority Water is the most vulnerable portion of the CAP water supply, and the United States is required to firm (i.e., provide a backup water supply) the delivery of this water during the next 100 years.

The Schuk Toak District has the right to receive a total of 16,000 afy of water, consisting of 10,800 afy of CAP 2 Indian Priority Water, and 5,200 afy of CAP 3 NIA Priority Water. The United States is required to firm the delivery of CAP 3 NIA Priority Water during the next 100 years as in the case with the San Xavier District.

Yet another Tohono O'odham Nation's district, the Chui-Chi District, has a CAP water delivery contract with the Secretary to receive up to 8,000 afy of CAP 2 Indian Priority Water. As this water is not presently covered by a water rights settlement, it is not considered an ITA.

Construction of the works necessary for the Tohono O'odham Nation to take delivery of its water under the 1982 Settlement Act is ongoing. The works necessary to deliver water to the Schuk Toak and San Xavier Districts have been completed. The Schuk Toak District is currently using a portion of the water provided under this settlement. The San Xavier District has initiated water deliveries and will expand these deliveries upon completion of the rehabilitation of its existing cooperative farm, which is ongoing.

Salt River Reservation (Salt River Pima-Maricopa Indian Community). The Salt River Reservation is located in Arizona, aside the boundaries of Mesa, Tempe, Scottsdale, Fountain Hills, and metropolitan Phoenix. The reservation was created in 1879. The Salt River Reservation is occupied by two tribes, the Pima and the Maricopa; and the combined enrolled population exceeds 7,000. The Salt River Reservation consists of 53,600 acres and maintains 19,000 acres as a natural preserve. Approximately 12,000 acres are under cultivation with cotton, melons, onions, broccoli, and carrots being the major crops.

Under its water rights settlement, the United States obtained the rights to 22,000 afy of Colorado River water entitlement from the Wellton-Mohawk Irrigation and Drainage District, near Yuma, Arizona. This right is senior to CAP. Pursuant to the settlement, this water was contracted by the Secretary to several Phoenix area cities and the tribe agreed to accept delivery of an equivalent amount of Salt River Project (SRP) water. The SRP water deliveries to the tribe will not be affected by the proposed federal action.

The Salt River Reservation has the right to receive up to 13,300 afy of CAP 2 Indian Priority Water. The Salt River Reservation has the right to lease its CAP water under the settlement within Arizona and has leased all of its CAP water to the City of Phoenix for a 100-year period. This water supply is considered an ITA.

Fort McDowell Reservation (Fort McDowell Yavapai Nation). The Fort McDowell Reservation is located in Maricopa County, Arizona about 23 miles northeast of Phoenix. The Verde River flows north to south through the reservation. The Fort McDowell Reservation was created by executive order in 1903 for the Yavapai, Mojave, and Apache Indian tribes. The 38.6 square-mile Fort McDowell Reservation is home to 600 community members, while another 300 members live off the reservation.

Under its water rights settlement, the Fort McDowell Reservation received a combination of water resources from both the SRP and the CAP. With respect to the Colorado River supplies, the Fort McDowell Reservation received the rights to delivery of up to 18,233 afy of water. This consisted of 4,300 afy of CAP water that the Fort McDowell Reservation had contracted for in 1980, plus an additional 13,933 afy of CAP water that the United States acquired from the Harquahala Valley Irrigation District (HVID). The acquired HVID water was converted from its CAP 3 NIA Priority Water to CAP 2 Indian Priority Water through this settlement. The Fort McDowell Reservation has leased 4,300 afy of its CAP water to the City of Phoenix for a 100-year period, and the reservation is presently not using the remaining 13,933 afy of CAP water.

San Carlos Reservation (San Carlos Apache Tribe). The San Carlos Reservation is located in southeastern Arizona. The reservation was established by executive order in 1871 and covers 2,910.6 square miles. Approximately one-third of the San Carlos Apache Tribe's land is forested or wooded. San Carlos Lake is a hub of recreational activity, especially for fishing.

Under its water rights settlement, the San Carlos Reservation has the rights to delivery of up to 61,645 afy of Colorado River water. This consists of 12,700 afy of CAP 2 Indian Priority Water, 18,145 afy of CAP 2 M&I Priority Water (previously allocated to Phelps Dodge and the town of Globe), and 30,800 afy of water made available by the Ak-Chin Indian Community Water Rights Settlement Act of 1984. Given that the San Carlos Reservation is not able to physically divert CAP water, the tribe will need to implement a water exchange to benefit from its CAP water supplies. The San Carlos Reservation has the right to lease CAP water under its 1992 settlement, and has leased up to 14,000 afy to Phelps Dodge through an exchange with the SRP. The San Carlos Reservation has also entered into a lease with the City of Scottsdale for 12,500 afy of CAP 2 M&I Priority Water.

Yavapai Reservation (Yavapai-Prescott Tribe of the Yavapai Reservation). Under its 1994 settlement, the Yavapai Reservation permanently assigned and transferred its CAP contractual right of 500 afy to the City of Scottsdale, Arizona, in return for funds to develop alternative water supplies. Since the Yavapai Reservation no longer has a right to CAP water, no trust asset is attributable to the Yavapai Reservation.

Gila River Reservation (Gila River Indian Community). The Gila River Reservation was established by executive order in 1859 for Pima and Maricopa Indians. The 583.9 square mile reservation is located in Maricopa and Pinal Counties, 35 miles south of the Phoenix metropolitan area. The Gila River Reservation is bounded by the San Tan and Sacaton

Mountains to the east, the Estrella Mountains to the west, and the South Mountains to the north. The Gila River Indian Community established Gila River Farms during the late 1960s, with approximately 16,000 acres in production. The Gila River Reservation is the homeland for two distinct tribes, the Pima and the Maricopa.

The 2004 Gila River Indian Community Water Rights Settlement Act provides the community with 311,800 afy of CAP water. The CAP supply consists of 120,600 afy of CAP 3 NIA Priority Water and 191,200 afy of CAP 2 Indian Priority Water. Under the 2004 Settlement Act, the state of Arizona is required to firm 15,000 afy of the CAP 3 NIA Priority Water so that it has a reliability equivalent to CAP 2 Indian Priority and M&I Priority Water over a 100-year period. Construction of the infrastructure to deliver CAP water to the Gila River Reservation for farming purposes is ongoing. Under the 2004 settlement, the Gila River Reservation has the right to lease its CAP water within Arizona. Approximately 40,000 afy of the Gila River Reservation's CAP water has already been leased to Phoenix area cities. In addition, the Gila River Reservation has entered into effluent exchange agreements with surrounding municipalities, Chandler and Mesa, whereby the Gila River Reservation exchanges some of its CAP water for a larger quantity of treated effluent.

3.10.3 Hydroelectric Power Generation and Distribution

Headgate Rock Dam and Powerplant is owned and operated by the BIA, which supplies energy generated at the Headgate Rock Powerplant to the Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California (CRIT) and other Indian tribes. Western markets any excess power produced at Headgate Rock Powerplant on the open market. Headgate Rock Dam and Powerplant is a run-of-the-river hydroplant, which means it is dependent on Colorado River flow to generate power. For this reason the Headgate Rock Dam is unable to store water in excess of the amount that can flow through its generator turbines or through CRIT's diversion facilities. Any water that is not diverted by CRIT or used by the Headgate Rock Powerplant generators is spilled downstream. Chapter 4 provides a more detailed description of hydroelectric power generation. Reclamation has determined that the water appropriated to non-CRIT entities that flows through Headgate Rock Dam and generates power is not an ITA.

3.10.4 Cultural Resources

Cultural resources located on Indian trust lands are often the property of the tribe or individual Indians beneficially owning those lands; these resources may be ITAs (Reclamation 1994). During consultation, the Hualapai Tribe identified historic and traditional cultural properties, archaeological resources and sacred sites in the Grand Canyon and on the Hualapai Reservation as Tribal trust resources that should be addressed in this EIS. None of the tribes identified cultural resources on- or off-reservation lands that should be considered ITAs for the purposes of this analysis.

3.10.5 Biological Resources

During consultation on this proposed federal action, none of the tribes identified fishing or hunting rights. The Hualapai Indian Tribe raised a concern with fish and wildlife, wildlife habitat, and culturally significant plants located throughout the Grand Canyon and on the Hualapai Reservation.

3.10.6 Other Potentially Affected Tribes Asserting Colorado River Water Rights

Reclamation has determined that no quantified water right trust assets are located within the study area upstream of Lake Mead. However, the following tribes have asserted that they have unquantified water right trust assets and other ITAs that will be affected by the proposed federal action.

3.10.6.1 Navajo Indian Reservation (Navajo Nation, Arizona, New Mexico and Utah)

The Navajo Nation is a federally recognized Indian tribe whose 12.5 million-acre reservation was initially established by treaty in 1868 and expanded by a series of executive orders in 1884, 1900, and 1930. The Navajo Nation economy is historically based on livestock herding and dry farming. Under the Winters doctrine established by the United States Supreme Court, the United States implicitly reserved water in an amount necessary to fulfill the purposes of an Indian Reservation. The existence of a federally reserved right for the Navajo Nation to mainstream Colorado River water has not been judicially determined at this time. Unquantified water rights of the Navajo Nation are considered an ITA.

During consultation on this proposed federal action, the Navajo Nation wrote Reclamation a letter (dated August 21, 2006) identifying a water budget of 76,732 afy that the Navajo Nation believes must be satisfied out of the Colorado River mainstream. The water budget of the Navajo Nation is premised on the use of 63,000 afy from the Little Colorado River which would otherwise contribute to the supply available in Lake Mead. In addition, the Navajo Nation asked Reclamation to consider the effects of the proposed federal action on 6,411 afy of CAP 3 NIA Priority Water identified for use by the Navajo Nation in the Arizona Water Settlements Act of 2004. This water is included in the 76,732 afy that the Navajo Nation believes must be satisfied out of the Colorado River mainstream. Overall, the Navajo Nation has asked the Secretary to account for the needs of the Navajo Nation as the Secretary undertakes the difficult task of developing guidelines to deal with Lake Powell and Lake Mead in time of shortage (Navajo Nation letter dated August 21, 2006).

3.10.6.2 Hualapai Indian Reservation (Hualapai Indian Tribe)

The 992,463-acre Hualapai Indian Reservation is located in northwestern Arizona. The reservation was established by executive order on January 4, 1883. Under the Winters doctrine established by the United States Supreme Court, the United States implicitly reserved water in an amount necessary to fulfill the purposes of an Indian Reservation. The existence of a federally reserved right for the Hualapai Indian Tribe to mainstream Colorado River water has not been judicially determined at this time. Unquantified water rights of the Hualapai Indian Tribe are considered an ITA.

During consultation on this proposed federal action, the Hualapai Indian Tribe has asserted in a letter (dated August 28, 2006) that it has Tribal trust resources and other Tribal assets in the Grand Canyon and on the Hualapai Indian Reservation that may be adversely affected by the proposed federal action. The Hualapai Indian Tribe's claimed resources include:

> "…tribal lands, the Tribe's senior, federal reserved water rights to the use and flows of the Colorado River, historic and traditional cultural properties, archaeological resources and sacred sites, fish and wildlife habitat, sensitive beaches, and culturally significant plants located throughout the Grand Canyon and on the Hualapai Reservation" (Hualapai Indian Tribe letter dated August 28, 2006).

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3.11 Electrical Power Resources

This section provides an overview of electrical power (i.e., hydropower) generation, power marketing, and the River Basin power funds used to manage electrical power revenues and expenditure requirements for mainstream Colorado River dams. A description of potentially affected electrical power generation facilities and energy dependent infrastructure within the study area is provided below. The electrical power resources that could potentially be affected by implementation of the proposed federal action include:

- Amount of electrical power generated,
- Available generation capacity,
- Economic value of electrical power produced,
- Electrical power related revenues and contributions to the different basin power funds and programs supported by these funds, and
- Electrical costs for entities that pump water directly from Lake Powell and Lake Mead.

3.11.1 Overview

The primary electrical power resources that could be affected by the proposed federal action include the Glen Canyon Powerplant, Hoover Powerplant, Parker/Davis Project (P-DP) generation systems, and the Headgate Rock Dam Powerplant. Reclamation operates and maintains the Glen Canyon, Hoover, and P-DP power generation facilities. Western is responsible for marketing and transmitting the power. The Headgate Rock Dam Powerplant is operated by the BIA.

3.11.1.1 Hydropower Generation

Hydropower generation is directly related to the net effective head on the generating units and the quantity of water flowing through the turbines. The net effective head is the difference between the elevation of the forebay behind a dam and in the tail water below the dam. The head influences the maximum power output capability of the power plant, measured in megawatts (MW). In general, the powerplant capability increases as a function of increasing head. However, turbine capacities or other equipment limitations, such as switches or transformer ratings, cap maximum power plant output levels.

The turbines at a powerplant are designed to produce maximum efficiency at a design head. At design head, the powerplant can produce the maximum capacity and the most energy per acre-foot of water passing through the turbine. As the net effective head on the powerplant is reduced from the design head because of reduced forebay (upstream reservoir) elevation, the power output of the turbine, the electrical capacity of the generator attached to the turbine, and the efficiency of the turbine are all reduced. This reduction continues as net effective head decreases until, below the minimum elevation for power generation, the turbines cannot be operated safely and must be bypassed for

downstream water deliveries. Minimum power elevation generally occurs at a point where cavitation within the turbine causes extremely rough operation, air becomes entrained in the water, and/or vortices appear in the forebay.

Ramping is the change in the water release from the reservoir to meet the electrical load. Both scheduled and unscheduled ramping are crucial in load following, ancillary services, emergency situations, and variations in real time (what actually happens compared to what was scheduled) operations. North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council (WECC) operating criteria require Western and Reclamation to meet scheduled load changes by ramping the generators up or down beginning at 10 minutes before the hour and ending at 10 minutes after the hour.

Hydropower generation can react instantaneously to the load (or power demand) - a pattern called load following. By comparison, coal- and nuclear-based resources have a relatively slow response time; consequently, they generally are not used for load following in the WECC.

As a control area operator, Western regulates the transmission system within a prescribed geographic area. Western is required to react to moment-by-moment changes in electrical demand within this area, adjusting the electrical power output of hydroelectric generators within the area in response to changes in the generation and transmission system to maintain the scheduled level of generation in accordance with prescribed NERC criteria. Automatic Generation Control (AGC) is a process whereby the control system automates the water releases in a manner that follows the power system's actual dynamic demands on a moment-to-moment (typically a four-second-interval) basis.

Regulation depends on being able to ramp releases up or down quickly in response to system conditions. In addition, each utility is required to have sufficient generating capacity - in varying forms of readiness - to continue serving its customer load, even if the utility loses all or part of its own largest generating unit or largest capacity transmission line. This reserve capacity ensures electrical service reliability and an uninterrupted power supply.

Generating capacity that is in excess of the load on the system is called spinning reserve. Spinning reserves are used to quickly replace lost electrical generation resulting from a forced outage, such as the sudden loss of a major transmission line or generating unit. Additional off-line generating units are also used to replace generation shortages, but they cannot replace lost generation capacity as quickly as spinning reserves.

3.11.1.2 Power Marketing and Customers

Western markets the power and administers the power contracts for power generated from Reclamation-owned and operated hydropower facilities, i.e. Glen Canyon, Hoover, P-DP and the smaller generation facilities.

Marketing of electricity is based on two concepts: capacity and energy. In power marketing, capacity is the rate of delivery or demand of electricity and is measured in kilowatts (kw) or megawatts. Electricity must be available the instant consumers need it. Capacity is more important to meet consumers' instantaneous demand as they turn on lights, appliances and motors. Energy is the amount of electricity delivered over time and is measured in kilowatt-hours (kwh)or megawatt-hours. One kilowatt-hour of energy delivered over one hour requires one kilowatt of capacity. Energy is important to meeting consumers' continuing need for electricity. With the delivery of electricity, capacity and energy are both present; however, they can be marketed and billed separately. Power rates usually include individual charges for capacity and energy.

Power is marketed in terms of firm and nonfirm power. Firm power is capacity and energy that is guaranteed to be available. A sufficient portion of the generation capacity is held in reserve to enable continued delivery of firm power even if an outage occurs at a power plant. The amount of power that is held in reserve is established by various power pooling agreements and reliability criteria.

Nonfirm power is sold to power contractors that would rather purchase nonfirm energy that is less expensive than the cost of their own generation or cost of alternative sources of supply. Nonfirm energy is usually sold with the requirement that the sale can be stopped on short notice and the buyer must have the resource available to meet its own load. Rates for nonfirm energy only include a charge for the energy delivered, since the customer has the capacity to meet its loads, if necessary.

Any power surplus or deficit affects all WECC power customers since the WECC region is one large interconnected system. However, customers most affected are those that have an allocation of hydropower resources sold by Western through various contractual arrangements.

The contracts for power from Glen Canyon Dam terminate in 2025, from Hoover Dam in 2017, and from the P-DP in 2008. After these dates, the identity of the recipients of power from these resources is not known. Recognizing that contracts for power will exist in some form in the future, an analysis of the effects of the action alternatives compared with those of the No Action Alternative consider the general effects in the overall areas served by the power facilities.

The states that could be potentially affected by changes in energy production and capacity changes at Glen Canyon and Hoover power plants are Arizona, California, Nevada, Utah, Wyoming, New Mexico and Colorado. These states make up the Rocky Mountain, Arizona-New Mexico-Southern Nevada, and California-Mexico areas of the WECC. Electrical energy produced in each of these areas is derived from a variety of sources including the subject facilities. The total generation capability of the areas as of January 1, 1999, is 86,348 MW. The generation capability of each WECC area is listed in Table 3.11-1.

Table 3.11-1
Generation Capability in WECC Areas

WECC Area	Available Capacity, MW
Rocky Mountain	10,584
Arizona-New Mexico-Southern Nevada	22,272
California-Mexico	53,492

The capacity of Glen Canyon and Hoover Powerplants represents approximately 3.6 percent of the total generating capability of these three areas of WECC (WSCC 1999).

3.11.2 Lake Powell and Glen Canyon Dam

Glen Canyon Powerplant has eight generators with a maximum combined capacity of 1,320 MW when the reservoir elevation is 3,700 feet msl. The maximum combined discharge capacity of the eight turbines is approximately 31,500 cfs. Due to environmental restrictions, the maximum release is limited to 25,000 cfs except for extreme hydrologic or emergency conditions, limiting Glen Canyon power generation capacity to approximately 1,000 MW, depending on reservoir elevation. The generators require a minimum Lake Powell elevation of 3,490 feet msl to operate. At this elevation, Glen Canyon Powerplant has a maximum capacity of about 630 MW. The annual gross generation has averaged approximately 4,951,918 MWh for the last 25 years and has averaged approximately 3,453,806 MWh over the past 5 years.

Glen Canyon Powerplant is part of the Salt Lake City Area Integrated Projects (SLCA/IP), which is a group of hydroelectric facilities marketed by Western. The SLCA/IP consists of hydroelectric facilities of Colorado River Storage Project (CRSP), Rio Grande Project, and Collbran Project.

Changes to reservoir elevations or releases could affect generation at Glen Canyon Dam.

3.11.3 Lake Mead and Hoover Dam

The Hoover Powerplant is located at the toe of the dam, and extends downstream 650 feet along each canyon wall. The turbines are designed to operate at heads ranging from 420 to 590 feet. The minimum water level for efficient power generation is currently estimated to be approximately 1,050 feet msl. The final generating unit, N-8, was installed at Hoover Dam in 1961, giving the Hoover Powerplant a total of 17 commercial generating units with a rated capacity of 1,850,000 horsepower. Two station-service units, rated at 3,500 horsepower each, increased the powerplant total rated capacity to 1,344.8 MW.

Between 1982 and 1993, the 17 commercial generating units were uprated with new turbines, and new transformers and breakers were installed, raising the Hoover Powerplant's maximum capacity to 2,074 MW. The annual gross generation has averaged approximately 4,819,524 MWh for the last 25 years and has averaged approximately 4,014,655 MWh over the past 5 years.

Western markets the power to 15 customers in three states (Arizona, California, and Nevada); these are non-firm contracts. Any excess energy generated at the Hoover Powerplant is distributed to Hoover Powerplant contractors in accordance with their contracts.

Changes to reservoir elevations or releases could affect electrical power generation at Hoover Powerplant.

3.11.4 Parker/Davis Projects

The Davis Powerplant has five generators and a 256 MW maximum operating capacity. Between 1987 and 2005, the average annual net energy generated from Davis was 1,166,286 MWh.

Parker Powerplant has four generators and a 108 MW maximum operating capacity. Between 1987 and 2005, the average annual net energy generated from the Parker Powerplant was 487,649 MWh. MWD has a perpetual contract right to 50 percent of the electric power generated at Parker Powerplant. Reclamation's 50 percent share of power generated by the Parker Powerplant is part of the P-DP.

The P-DP was formed in 1954 by consolidating the Parker Dam power project and the Davis Dam power project. Western markets the power generated by the P-DP. The P-DP supplies power to five Priority Use Projects (PUP) customers and 25 firm electric service contractors. The P-DP has 283 MW of capacity under contract to PUP and to firm electric service customers. The total annual energy committed to the five PUP and 25 firm electric service customers is 1,345,801 MWh (the PUP commitment is 195,266 MWh and the firm commitment is 1,150,534 MWh). The contracted capacity and energy for the P-DP, including system losses and reserves, is based on Davis Powerplant capacity and energy and Reclamation's half of Parker Powerplant's capacity and energy. The current P-DP firm electric service commitments are in effect until September 30, 2008. Western is close to concluding the process of finalizing the contractual commitments through September 30, 2028.

Under the existing P-DP firm electric service contracts, the amounts of power per month and per season are guaranteed. This means if the power is not available, Western would purchase the additional power required to fulfill the contracts.

Power generated at the P-DP, over and above what has been guaranteed to PUP and preference customers having firm electric service contracts, is referred to as surplus energy. A portion of the surplus energy, referred to as excess energy, is offered to P-DP customers for purchase at an "at cost" rate or for "banking" of energy up to the limit of the contractor's contract rate of delivery. Any remaining surplus energy may be sold at market rates to interested parties or may be "banked" for future use.

Changes to dam releases could affect electrical power generation at the P-DP.

3.11.5 Other Small Hydropower Facilities

Headgate Rock Dam and Powerplant, which is owned and operated by the BIA and is located downstream of Parker Dam, is a run-of-the-river powerplant that generates power through three turbines with a total generator capacity of 19.5 MW. Between CY 2001 through CY 2005, the average net energy generated annually from Headgate Rock Dam power plant was 76,157 MWh. Changes to downstream water demand could affect generation at Headgate Rock Powerplant.

There are other small hydropower facilities located below Parker Dam. These facilities include Senator Wash, Siphon Drop, and Pilot Knob. In addition, there are several hydropower facilities owned by IID located at various drop structures along the All American Canal and on various other canals.

3.11.6 Basin Power Funds

3.11.6.1 Upper Colorado River Basin Fund

The Upper Colorado River Basin Fund (Basin Fund) was established under Section 5 of the CRSP Act. The CRSP Act "authorized a separate fund in the Treasury of the United States to be known as the Upper Colorado River Basin Fund for carrying out provisions of this Act other than Section 8". Money appropriated for construction of CRSP facilities and Section 8 funding is credited in the Basin Fund. Revenues derived from operation of the CRSP and participating projects are deposited in the Basin Fund. Most of the revenues come from sales of hydroelectric power and transmission services. The Basin Fund also receives revenues from M&I water service sales, rents, salinity funds from the Lower Colorado Basin (as a pass-through for the Colorado River Basin Salinity Control Program), and miscellaneous revenues collected in connection with the operation of the CRSP and participating projects.

Basin Fund revenues must first be used to repay costs associated with the operation and maintenance of the CRSP units and used to repay the United States Treasury Department the reimbursable investment costs previously spent on construction of the CRSP units and costs allocated to the irrigation investment above the irrigator's ability to pay. The Basin Fund is managed by Western. Approximately $ 175 million is needed each year to fund Reclamation and Western operation and maintenance needs. Of this amount, approximately $20 million is used to support environmental programs. Reclamation's allocation of its portion of the Basin Fund, approximately $62 million, is shown in parentheses below.

- Reclamation and Western's costs associated with the operation, maintenance, equipment replacements, and emergency expenditures for all facilities of the CRSP and participating projects, provided, that with respect to each participating project, such costs shall be paid from revenues received from each such project. (Reclamation - $42.9 million);

- Cost sharing for Colorado River Basin Salinity Control Program (Reclamation - $2 million);

- The major portion of the cost of the Glen Canyon Adaptive Management Program (Reclamation - $9 million);
- Cost sharing for Endangered Fish Recovery Implementation Program (Reclamation - $7 million);
- Water quality studies (Reclamation - $0.8 million); and
- Consumptive use studies (Reclamation - $0.3 million).

Basin Fund revenues may not be appropriated and used for construction projects. Also, they may not be used for construction, operation and maintenance of public recreational facilities or facilities to mitigate losses of and improve conditions for the propagation of fish and wildlife (Section 8 of the CRSP Act authorizes Congressional appropriations for these purposes).

Western is responsible for transmission and marketing of CRSP power, collecting payment for the power, and transfer of revenues for repayment to the United States Treasury Department. A change in the amount of available capacity or energy could potentially affect the revenue derived from the sale of energy and the contributions to the Basin Fund, or rates charged to power customers.

3.11.6.2 Lower Colorado River Basin Funds

Currently there are three funds that are used to manage revenue and expenditure requirements of Lower Colorado Region power projects for the CAP, Boulder Canyon Project (Hoover) and the P-DP. Two are legislated funds and one is an account fund. A change in the amount of available capacity or energy could potentially affect the revenue derived from the sale of energy and the contributions to these funds, or rates charged to power customers.

The Lower Colorado River Basin Development Fund (Development Fund) was established by the CRBPA. The Colorado River Dam Fund (Dam Fund) was established by the BCPA. The Parker-Davis Account was established to enable the P-DP to fund in advance capital improvements and other expenses.

Lower Colorado River Basin Development Fund. In a manner similar to the Basin Fund, the Development Fund defrays costs of operation, maintenance and replacements of all project facilities, salinity control programs, repayment of CAP construction, and, as amended by the Arizona Water Settlements Act, of certain Tribal projects. It also reimburses water users in Arizona for losses sustained as a result of diminution of the production of hydroelectric power at Coolidge Dam, Arizona, resulting from exchanges of water between users in the States of Arizona and New Mexico. The Development Fund is composed of revenue deposited from:

- Surplus power sales of the United States entitlement of the Navajo Generating Station;

- CAP surcharge revenues from the Boulder Canyon and Parker Davis projects; and
- Certain other CAP revenue receipts.

Colorado River Dam Fund. The Dam Fund is utilized to fund operation and maintenance (O&M) of Hoover Dam, payments to states, visitor services, up-rating program, replacements, investment repayment and interest expenses of the Boulder Canyon Project (BCP). The Dam Fund is composed of:

- Power revenues collected from the BCP power contractors;
- Revenues collected from the BCP Visitor Center; and
- Revenues from other BCP revenue receipts.

The BCP annual revenue requirement, base charge and rates, are determined annually to provide sufficient revenue to pay all annual costs, including interest expense and to repay investments, within the allowable period.

Parker-Davis Account. The Parker-Davis Account is utilized to advance-fund the costs of the P-DP, including operation, maintenance, and capital improvements. The funds are drawn from the customers' account into Reclamation on a monthly basis throughout the year. The advances are reconciled to the actual expenditures and the customers get credit for any remaining balance in the following period.

3.11.7 Water Supply System

3.11.7.1 Navajo Generating Station

The Navajo Generating Station (NGS) is a 2,250 MW coal-fired powerplant located on the Navajo Indian Reservation near Page, Arizona, and serves electric customers in Arizona, Nevada and California. The coal-fired powerplant is jointly owned by Reclamation, Salt River Project, Los Angeles Department of Water and Power, Arizona Public Service Company, Nevada Power Company and the Tucson Electric Power Company. The Salt River Project (SRP) operates the plant. The station supplies energy to pump water through the CAP. NGS was constructed near Lake Powell to ensure it had a dependable supply of cooling water for its three generators.

When NGS was constructed, it received an annual allotment of 34,100 af of water, and the intakes that pump water from Lake Powell to the powerplant were installed at an approximate elevation of 3,470 feet msl, or 230 feet below the lake's full pool level of 3,700 feet msl. Changes in drops in the elevation of Lake Powell could cause an increase in the cost of power for the NGS.

To ensure that cooling water will be available for the continued operation of NGS, a proposal is being advanced to modify the water intake system of NGS by installing new intake structures at an elevation below that of the current intakes. The planning for this proposal is ongoing.

3.11.7.2 City of Page Water Supply Intake

The City of Page provides municipal water to approximately 7,800 residents from Lake Powell. The intake pump station is operated by Reclamation using power produced at the Glen Canyon Powerplant. Municipal water use in the City of Page is dominated by residential use with substantial residential landscape irrigation. The average annual use of water by the City of Page in recent years has been about 2,650 afy. Under contract with Reclamation, the City of Page pays energy costs associated with pumping the water plus costs associated with operation and maintenance of the pump station by Reclamation. Annual energy usage has averaged around 3,900,000 kWh per year over the past 10 years. At the current rate of $0.03286 per kWh, the annual cost of energy for pumping the water is around $130,000 per year. Changes in CRSP power generation or drops in the elevation of Lake Powell could cause an increase in the cost of power for the City of Page's intake pump station.

3.11.7.3 SNWA Lake Mead Intake

The largest diverter of Colorado River water in Nevada is the SNWA. It diverts most of its allocation of Colorado River water from Lake Mead through the SNWA pumping plant located at Saddle Island within Lake Mead. The power-consuming features of this system are the pumping plants that are used to pump water from Lake Mead to the water treatment facility that is also owned and operated by SNWA.

The minimum required Lake Mead elevations necessary to operate the pumping units for SNWA's upper and lower intakes are 1,050 and 1,000 feet msl, respectively. Changes in the elevation of Lake Mead could cause a change in the cost of power for SNWA's intakes.

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3.12 Recreation

Key recreation resources or issues include reservoir or riverine recreational activities or facilities that might be affected by changes in reservoir level or river flow. The affected environment for recreation resources includes:

- shoreline public use;
- reservoir boating;
- river and whitewater boating; and
- sport fishing.

Information in this section was compiled after review of published and unpublished sources and through personal communications with Reclamation, NPS, and resource specialists. Key published sources of information used in the preparation of this section include:

- Lake Mead National Recreation Area, General Management Plan Amendment/EA (NPS 2005a);
- Grand Canyon National Park Final EIS, Colorado River Management Plan, Volume I (NPS 2005b);
- Glen Canyon National Recreation Area Final EIS, Personal Watercraft Rulemaking, Volume I (NPS 2003);
- Lower Colorado River Multi-Species Conservation Program, Final PEIS/EIR (Reclamation 2004);
- Colorado River Interim Surplus Criteria Final EIS (Reclamation 2000); and
- Operation of Glen Canyon Dam Final EIS (Reclamation 1995).

3.12.1 Shoreline Public Use

The following sections describe shoreline public use associated with boating facilities (marinas, boat docks, and boat launch ramps), access to points of interest, and other opportunities within each Colorado River reach. Where available, the number and type of facilities at each marina, boat dock, and boat launch ramp are included for major shoreline access points. Recreational boating in the study area is dependent on these major shoreline access points. Fluctuation in water levels is a normal aspect of reservoir operations, and facilities have been designed and operated to accommodate these fluctuations. However, changes in pool elevations or increased variations or rates in pool elevation fluctuation could result in changes in operation costs and temporary closures.

Representative threshold pool elevations and river flows were selected for the boating facilities, at or below which certain facilities may be rendered inoperable or relocation of facilities could be required to maintain their operation. These thresholds were chosen based on either information provided in studies or communications with NPS personnel.

3.12.1.1 Lake Powell and Glen Canyon Dam

Lake Powell is located entirely within the GCNRA, which receives approximately two million visitors each year (NPS 2006f). Table 3.12-1 summarizes visitation to GCNRA for the most recent six years. The data indicate a gradual decrease in the number of visitors.

Table 3.12-1
Glen Canyon National Recreation Area Recreational Visitors

Year	Recreational Visitors
2000	2,568,111
2001	2,340,031
2002	2,106,896
2003	1,876,984
2004	1,841,845
2005	1,908,726

Source: NPS, 2006f.

Table 3.12-2 summarizes the total number of visits to GNCRA by visitor segment for 2003, the most recent year for which data are available.

Table 3.12-2
Glen Canyon National Recreation Area Visits by Visitor Segment for 2003

	Local Day Trips	Non-Local Day Trips	Hotel	Camp	Total
Number of Recreational Visits	187,698	656,944	218,548	750,794	1,876,984
Percent Segment Shares in Recreational Visits	10	35	15	40	100
Party Days[1]	81,608	252,671	196,886	870,804	1,415,939

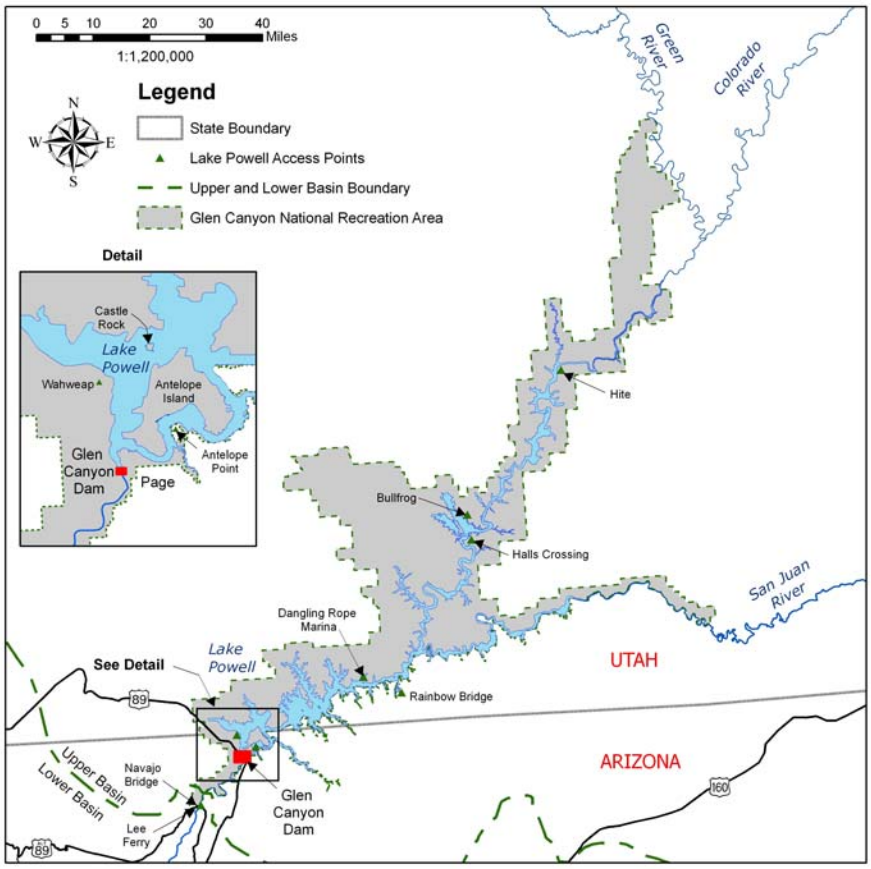
Source: NPS 2006b.

1 Party days equal the number of days each visitor party spends in the local region. Party days are estimated by converting recreation visits using estimates of the average party size, length of stay in the area, and number of park entries per trip (re-entry rate).

Lake Powell, its many side canyons, and related natural, cultural, and geologic resources are the primary recreation features of GCNRA. Recreation activities that occur at Lake Powell include swimming and sunbathing, power boating, waterskiing, fishing, off-beach activities associated with boat trips (such as hiking and exploring ruins), house boating, personal water craft use, canoeing, kayaking, sailing, wildlife viewing, photography, sightseeing, and other activities. Visitors can enjoy camping opportunities ranging from remote and undeveloped campsites to fully developed campgrounds. Visitors can also see archeologically and culturally important sites throughout the recreation area.

Boating Facilities. Recreation boating is the most important recreational activity on Lake Powell, with more than 831,000 boater days in 2001 (NPS 2003). Specific boating facilities, and reservoir elevations important to their operation, are discussed in the following sections. Figure 3.12-1 shows Lake Powell and the locations of its shoreline access points.

Figure 3.12-1
Lake Powell Shoreline Access Points



Water-based recreational facilities at Lake Powell are located at Wahweap, Dangling Rope, Halls Crossing, Bullfrog, Hite, and Antelope Point marinas. Table 3.12-3 lists critical lake elevations, identified by the NPS for Lake Powell, below which marinas, boat docks, or boat launch ramps become inoperable. Dangling Rope Marina is only accessible by boat, and it is used primarily for accessing Rainbow Bridge National Monument. There are no known reservoir elevations that would impair operation of Dangling Rope Marina.

Table 3.12-3
Critical Elevations for Lake Powell by Boating Facility

Lake Elevation (feet msl)	Impact and Facility
3,700	Full pool
3,620	Castle Rock Cut closed; Hite Marina and Public Launch Ramp closed
3,588	Antelope Point Public Launch Ramp closed
3,580	Main Bullfrog Launch Ramp closed
3,560	Wahweap and Stateline Public Launch Ramps closed; Bullfrog Low Water Alternative Launch Ramp closed; Halls Crossing Public Launch Ramps closed
3,555	Wahweap Marina closed; Antelope Point Marina closed; Bullfrog Marina closed; Halls Crossing Marina closed

Source: Henderson 2006

Access to Points of Interest. The facilities at Rainbow Bridge National Monument include courtesy docks, restrooms, a floating walkway, and a floating interpretive platform. Trails from the dock lead to viewing areas. One viewing area is used when Lake Powell is at the full-pool elevation of 3,700 feet msl, and the other is used when the reservoir is below full-pool elevation. The docks and trail system are designed to accommodate Lake Powell elevation fluctuations from 3,490 feet msl to 3,700 feet msl (NPS 1993). Boat tours to the Rainbow Bridge National Monument originate at Dangling Rope Marina.

When Lake Powell elevations fall below 3,650 feet msl, the floating walkway and interpretive platforms would be removed and stored, dock facilities would be moved to a lower elevation, dock facilities would be connected to the trail with a short walkway, and the old land trail through Bridge Canyon (submerged at full pool) would be exposed, hardened, and used for access (NPS 1990).

3.12.1.2 Glen Canyon Dam to Lake Mead

The 15.5 miles of river below Glen Canyon Dam to Lees Ferry are managed by GCNRA and are used by anglers; campers; and commercial float trip operators, kayakers, and other boaters. Fishing opportunities (with an Arizona state non-native fishing license and a trout stamp) for rainbow and brown trout also occur below this reach.

Grand Canyon National Park begins at Lees Ferry and the NPS manages most of the reach, except where it is bordered on the east by the Navajo Indian Reservation and the south by the Hualapai Indian Reservation. The Grand Canyon National Park regulates visitor use of the Colorado River in accordance with the Colorado River Management Plan (NPS 2005b).

Lees Ferry to Diamond Creek has relatively low use densities and levels of development, providing opportunities for solitude on the Colorado River and at many camps and attraction sites. This section of the river is where the majority of whitewater boating occurs. Take-outs are located at Diamond Creek and Pearce Ferry, and the reach below Diamond Creek offers different recreation opportunities than upstream as it transitions to a more populated and developed setting. The Pearce Bay take-out is closed at elevation 1,175 feet msl. Whitewater boating trips become intermingled with very high levels of general boating and recreation use in the Quartermaster Area.

Several helicopter operations transport people into the Grand Canyon and connect with motorized pontoon boats that give 20-minute tours of the immediate area. These same helicopters serve a dual service in flying out boaters who have traveled from Diamond Creek on commercial motor day trips.

Camping also occurs in the Grand Canyon National Park on undeveloped beaches along the river. The important variable is the number and quality of high-water versus low-water campsites.

The Hualapai Indian Reservation offers camping, fishing, hiking, and big game hunting. A Tribal enterprise operates a river rafting company that offers rafting trips on the section of river from Diamond Creek to Quartermaster Canyon.

Boating Facilities. There are few boating facilities in the Grand Canyon National Park, except for major launch facilities that include Lees Ferry, Phantom Ranch, Whitmore, Diamond Creek, and the Quartermaster Area. Brief descriptions of each facility are provided below.

Lees Ferry. Lees Ferry, the primary put-in at the start of a Grand Canyon river trip, has a large ramp, parking, a camping area, and an information kiosk where pre-trip logistics and information sessions are conducted.

Phantom Ranch. Phantom Ranch is a collection of cabins, a small store, an NPS ranger station, and campground. River trips are prohibited from camping at Phantom Ranch, but it is a popular exchange location.

Whitmore. The Whitmore exchange point consists of a helicopter landing pad on Hualapai Indian Reservation and a boat tie-up and camping area. The Whitmore area is used by commercial trips as an exchange point for passengers to begin or end their river trip; nearly all of those passengers arrive at or depart from the area via a helicopter flight.

Diamond Creek. The Diamond Creek take-out and launch is operated by both the NPS and the Hualapai Indian Tribe. The tribe charges fees to use Diamond Creek. The Hualapai River Runners (HRR) manage take-out and launch operations in addition to conducting guided whitewater trips that put-in at Diamond Creek, and floating trips that put-in at Quartermaster Canyon. All of these trips take out at Pearce Ferry. There is a gravel ramp area and a limited parking lot.

Quartermaster Area. There are 15 helipads, 2 docks, and other facilities in the Quartermaster Area. While all of the pads offer access for look-and-leave flights, a few pads are also used to transport HRR and pontoon trip passengers out of the canyon.

Camping. Sandbars form the camping beaches are used by river runners. Camping is possible in only a limited number of locations along the Colorado River between Glen Canyon Dam and Lake Mead because most of the shoreline is unsuitable. At a given time, however, campable area depends on the local stage (height) of the river, which is determined by the magnitude of releases and local topography.

There are three general categories for camp sizes: small (one to 12 people); medium (13 to 24 people); and large (25 or more people), that are further divided into high-water and low-water camps (Kearsley and Warren 1993). High-water camps are available at flows above 15,000 cfs, generally on terraces. Low-water camps are available only at flows below 15,000 cfs. Thirty-seven favorable sites that become available at discharges of 15,000 cfs or less were identified by Kearsley and Warren (1993). Table 3.12-4 lists the number of small, medium, and large camps, as well as the number of high- and low-water camps.

Table 3.12-4
Number of Camping Beaches by Camp Size for High- and Low-Water Camps

High- and Low-Water Camping Beaches	Small (1 to 12 people)	Medium (13 to 24 people)	Large (25 to 36 people)	Total
Camping beaches at high water (15,000 cfs or greater)	47	102	90	239
Additional camping beaches available at low water only (15,000 cfs or less)	27	10	*	37

*Source: Kearsley and Warren 1992, 1993; * not measured.*

3.12.1.3 Lake Mead and Hoover Dam

LMNRA contains 1.5 million acres and encompasses the 110-mile-long Lake Mead, 67-mile-long Lake Mohave, the surrounding desert, and the isolated Shivwits Plateau in Arizona.

The Virgin River flows into upper Lake Mead from the north. Recreational activities such as camping, boating, fishing, and hiking occur on upper Lake Mead. The Overton Wildlife Management Area provides opportunities for wildlife viewing and photography, waterfowl and upland game bird hunting, hiking, and fishing. The Overton Wildlife Management Area has an average of 5,300 annual visitor use days (Nevada Department of Wildlife 2006).

LMNRA extends along the lower Colorado River from the western border of Grand Canyon National Park (with the dividing line at the Grand Wash Cliff, RM 276.5) to Davis Dam. Primary recreational activities on the Lake Mead by percentage of users include cruising/sailing 41.4 percent, personal watercraft usage 17.5 percent, waterskiing

16.9 percent, fishing 14.2 percent, swimming 6.7 percent, and other 3.3 percent (NPS 2002). A number of campgrounds and picnic areas provide additional recreational opportunities and include Boulder Beach, Calville Bay, Echo Beach, Las Vegas Bay, and Temple Bar. The LMNRA has approximately six million visitor use days per year (NPS 2001).

Table 3.12-5 summarizes recreational visits to LMNRA for the last six years.

Table 3.12-5
Lake Mead National Recreation Area Recreational Visitors

Year	Recreational Visitors
2000	8,755,005
2001	8,465,547
2002	7,550,284
2003	7,915,581
2004	7,819,984
2005	7,692,438

Source: NPS 2006c.

Table 3.12-6 summarizes the total number of visits to LMNRA by visitor segment for 2003, the most recent year for which data are available.

Table 3.12-6
Lake Mead National Recreation Area Visits by Visitor Segment for 2003

	Local Day Trips	Non-Local Day Trips	Hotel	Camp	Total
Number of Recreational Visits	2,374,674	2,374,674	791,558	2,374,674	7,915,581
Percent Segment Shares in Recreational Visits	30	30	10	30	100
Party Days[1]	719,598	719,598	263,853	668,482	2,415,452

Source: NPS 2006d.

1 Party days equal the number of days each visitor party spends in the local region. Party days are estimated by converting recreational visits using estimates of the average party size, length of stay in the area, and number of park entries per trip (re-entry rate).

Boating Facilities. The LMNRA is considered one of the premier water-based recreation areas in the nation. Most visitors are involved in water-based recreational activities, primarily between May and September. These recreational activities are supported by marina and launch ramp facilities developed along the Lake Mead shoreline. On average, the majority of boats are personal watercraft. There may be as many as 6,000 boats on Lake Mead and Lake Mohave during a peak recreation use weekend. The Boulder Beach developed area, which is one of the most heavily visited portions of the recreation area located near the urbanized area of Las Vegas and surrounding communities, includes special use areas for sailing, scuba, and personal watercraft use.

Water-based recreational facilities at Lake Mead are located at Boulder Beach, Las Vegas Bay, Callville Bay, Echo Bay, Overton Beach, and Temple Bar marinas and Hemenway, Government Wash, South Cove, and Pearce Ferry boat ramps. Pearce Ferry is used as a take-out by Colorado River boaters. Table 3.12-7 shows critical elevations, identified by the NPS for Lake Mead, below which marinas, boat docks, or boat launch ramps become inoperable. The Pearce Bay launch ramp, a take-out point for rafts and whitewater boats, is closed at elevation 1,175 feet msl. This results in rafts and other whitewater boats having to continue downstream to South Cove, an additional 16 miles.

Table 3.12-7
Critical Elevations and Surface Area for Lake Mead by Recreational Facility

Lake Elevation (feet msl)	Impact and Facility
1,225	
1,175	Pearce Bay Launch Ramp closed
1,150	Las Vegas Bay and Government Wash Public Launch Ramps closed
1,125	Overton Beach Marina, Callville Ramp and South Cove Ramp closed
1,112	Lake Mead Marina – Relocation of "C Dock" to Hemenway
1,110	Overton Public Launch Ramps closed
1,100	Lake Mead Marina Must Relocate Out of Protected Harbor
1,080	Lake Mead Marina public launch ramp closed; Hemenway public launch ramp closed; Temple Bar Public Launch Ramp closed
1,050	Echo Bay Public Launch Ramp closed

Source: Henderson 2006

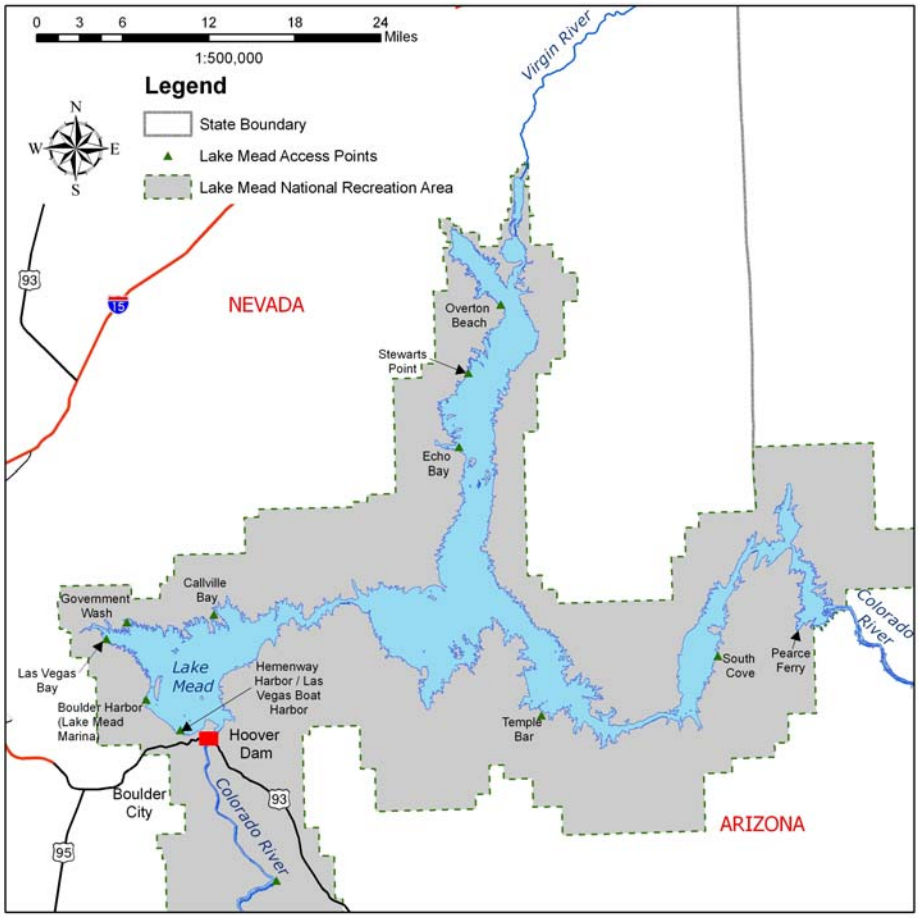
Shoreline public use facilities on Lake Mead are shown on Figure 3.12-2 and described on the following pages.

Pearce Ferry. Pearce Ferry includes a primitive public launch ramp used by Grand Canyon raft tour companies as their take-out. The ramp is located in a cove off of the river and operable when Lake Mead is at an elevation above 1,175 feet msl. Below that elevation, the cove becomes isolated from the river by a large sand bar separating the cove and graded ramp from the main flow of the Colorado River (NPS 2006e).

When Pearce Ferry is inaccessible due to low flows, boaters must continue downstream to South Cove, an additional 16 miles. This costs river runners fuel (for motorized craft), time (one to two more hours on the river), and possible safety problems (due to fatigue).

South Cove. The facilities at South Cove provide access to one of the best sand beach areas. There is one courtesy dock, public launch ramp, picnic facilities, and unpaved parking (Henderson 2000). The public launch ramp is constructed of asphalt and concrete and extends to an elevation of 1,125 feet msl. Other public facilities include a picnic area and restrooms. In addition, there is an airstrip approximately four miles from the facilities at South Cove (Henderson 2000).

Figure 3.12-2
Lake Mead Shorline Access Points



Temple Bar. Temple Bar Marina includes a public launch ramp, boat, houseboat, and personal watercraft rentals, slip rentals, and fuel. Other facilities and services include a restaurant/lounge, motel, cabin rentals, trailer village, recreational vehicle sites, dry boat storage, store, shower/laundry, boat/motor repairs, and auto/boat gas.

Overton Beach. The facilities at Overton Beach Marina include two public launch ramps. The marina is closed at elevation 1,125 feet msl and the public launch ramps are closed at 1,110 feet msl.

Additional available facilities and services at the Overton Beach Marina include covered rental slips, boat and personal watercraft rentals, small boat repair, fuel dock, and snack bar. Land based facilities include a store, shower/laundry, recreational vehicle campground, a trailer village, and dry boat storage.

Stewart's Point. Stewart's Point has an unpaved launch ramp (River Lakes Host 2006). The shoreline at Stewart's Point is a popular summertime weekend destination. The area is also a vacation cabin site area. The 2003 Lake Management Plan approved the future construction of a public boat launch at this location.

Echo Bay. The Echo Bay Marina includes boat, houseboat, and personal watercraft rentals, slip rentals, and fuel. Other facilities and services include a restaurant, motel, trailer village, recreational vehicle sites, dry boat storage, store, shower/laundry, boat/motor repairs, and auto/boat gas.

Callville Bay. The Callville Bay Marina includes rental slips; boat, houseboat, and personal watercraft rentals; and fuel. Other facilities and services include boat and motor repair, a trailer village, recreational vehicle sites, cafe/lounge, shower/laundry, auto/boat gas, dry boat storage, and a general store.

Government Wash. The facilities at Government Wash include one courtesy dock, public launch ramp, and a parking area. These facilities are closed at elevation 1,150 feet msl.

Las Vegas Bay. The facilities at Las Vegas Bay Marina include two public launch ramps, dry boat storage, and fuel service and maintenance area. The public launch ramps close at elevation 1,150 feet msl.

Las Vegas Boat Harbor. The facilities at Las Vegas Boat Harbor Marina are located next to Hemenway Harbor, and include rental slips, boat and personal watercraft rentals, floating gas dock, boat/motor repairs, store, and restaurant.

Boulder Harbor. The facilities at Boulder Harbor include two public launch ramps at Boulder Beach.

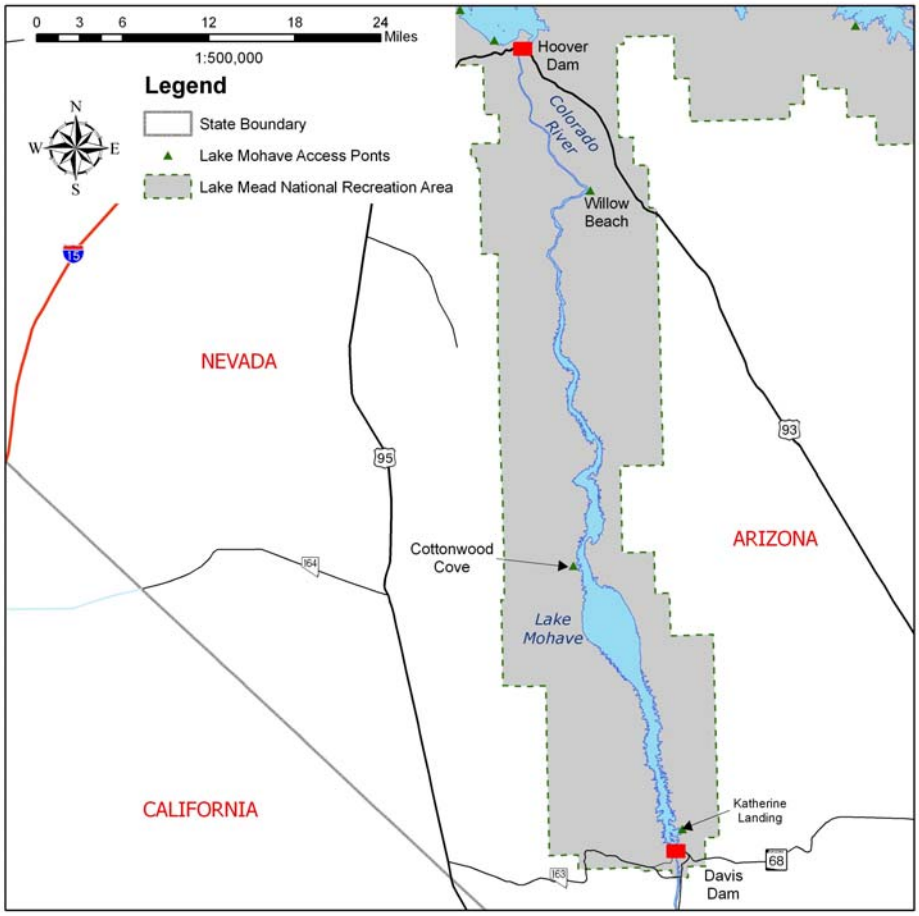
Hemenway Harbor. The facilities at Hemenway Harbor include one courtesy dock, public launch ramp, campgrounds, and a parking area. It also serves as the departure point for Lake Mead Cruises that provides sightseeing tour boat service to and from Hoover Dam, breakfast and dinner cruises, and charter boat service.

3.12.1.4 Hoover Dam to Davis Dam

Lake Mohave provides a multitude of recreational opportunities. Activities include boating, canoeing on northern parts of the lake, camping, exploring, fishing, photography, picnicking, swimming, parasailing, two locations for cliff diving, and water skiing. There are also hundreds of beaches that can only be accessed by boat.

The main shoreline access points for Lake Mohave are Katherine Landing, Cottonwood Cove, and Willow Beach (Figure 3.12-3). Facilities for public use and boat launching are located at Katherine's Landing in Arizona near Davis Dam, and at Cottonwood Cove, east of Searchlight, Nevada. Boats and jet skis can be rented at both locations. Public campgrounds are available at both locations where concessionaires provide trailer parks, restaurants, lodging, docking facilities, boat and fishing tackle equipment, and fishing licenses. Facilities for public use and boat launching are also located at Willow Beach, 31 miles upstream on the Arizona shore.

Figure 3.12-3
Lake Mohave Shoreline Access Points



3.12.1.5 Davis Dam to Parker Dam

Recreational Areas. The Davis Dam to Parker Dam reach includes several recreational areas along the Colorado River including Laughlin, Bullhead City, Davis Camp, Needles, Havasu NWR, Lake Havasu State Park, and Bill Williams River NWR. Relevant recreational areas are briefly described in the following sections.

Davis Camp. Located near Bullhead City, Davis Camp, a campground and day use area, has boat launching facilities, picnic areas, numerous campsites, and recreational vehicle hookups. Davis Camp offers many river-oriented recreational opportunities, including fishing and water sports.

Havasu National Wildlife Refuge. The Havasu NWR, managed by the FWS, covers 30 river miles (300 miles of shoreline) from Lake Havasu City, Arizona to Needles, California, and includes one of the last remaining natural stretches of the lower Colorado River, which flows through the 20-mile-long Topock Gorge (FWS 2002f). Typical activities include canoeing, fishing, boating through the scenic Topock Gorge, and hiking in the Havasu Wilderness Area. Each year, thousands of visitors explore the 4,000–acre Topock Marsh, which offers excellent canoeing, fishing, and water-bird watching. Other activities offered by the Havasu NWR include camping and hunting.

Lake Havasu State Park. Lake Havasu, formed by Parker Dam, contains a number of coves and inlets, and it is a popular spot for fishing. The waters of Lake Havasu also are used for canoeing, house boating, jet-skiing, kayaking, sailing, and speed-boating, swimming, and water-skiing. Camping and hiking also occur along the more than 400 miles of the lake's shoreline. Additional visitor opportunities include viewing the London Bridge. Lake Havasu is a popular spring break and family vacation destination.

Lake Havasu is the premier attraction area within the Davis Dam to Parker Dam reach. Visitation for Arizona's Lake Havasu and Cattail Cove State Parks is listed in Table 3.12-8.

Table 3.12-8
Visitation at Arizona's Lake Havasu and Cattail Cove State Parks

State Park	Visitation (1995-1996)	Visitation (2000-2001)	Percent Change
Lake Havasu	371,700	345,590	-7.0
Cattail Cove	96,459	106,939	10.9
Totals	468,159	451,983	-3.4

Source: Northern Arizona University 2002

Bill Williams River National Wildlife Refuge. The Bill Williams River NWR, managed by the FWS, is located along the Bill Williams River near its confluence outlet into Lake Havasu. The refuge offers a variety of recreational opportunities, including hiking and bird watching (as well as other wildlife viewing), with opportunities to view Yuma clapper rails and southwestern willow flycatchers, among other species. Hunting is permitted for dove, cottontail, quail, and desert bighorn sheep. Other activities include boating and fishing.

Boating Facilities. The Davis Dam to Parker Dam reach includes shoreline public use facilities at Laughlin, Nevada; Bullhead City, Arizona; Davis Camp, near Bullhead City; Needles, California; Havasu NWR, covering 30 river miles (300 miles of shoreline) from Lake Havasu City, Arizona to Needles, California; Lake Havasu State Park, Arizona; and Bill Williams River NWR, Arizona. Recreational activities within this reach include canoeing, fishing, houseboating, jet-skiing, kayaking, sailing, speed-boating, swimming, and water-skiing.

3.12.1.6 Parker Dam to Cibola Gage

Recreational Areas. The Parker Dam to Cibola Gage reach includes several recreational areas including Parker Strip Recreation Area, Palo Verde Diversion Dam, Blythe, and Cibola NWR. Relevant recreational areas are briefly described in the following sections.

Parker Strip Recreation Area. The Parker Strip Recreation Area includes an 11-mile road along the Colorado River. Recreational activities include boating, camping, fishing, hiking, rock hounding, swimming, and wildlife viewing.

Palo Verde Diversion Dam. There are approximately 95 miles of navigable waters between the Imperial Dam below Yuma and the Palo Verde Diversion Dam above Blythe. Activities include canoeing, fishing, hunting, power boating, and other water sports.

Cibola National Wildlife Refuge. The Cibola NWR, including Cibola Lake, managed by the FWS is located about 15 miles south of Blythe. The largest concentration of Canada geese and sandhill cranes on the lower Colorado River winter at the refuge. Visitors to the refuge engage in canoeing, fishing, hiking hunting, photography, and wildlife observation.

Boating Facilities. The Parker Dam to Cibola Gage reach includes shoreline public use facilities at Parker Strip Recreation Area, Arizona; Palo Verde Diversion Dam, Arizona; Blythe, California; and Cibola NWR, Arizona. Typical water activities within this reach include canoeing, power boating, fishing, swimming, and other water sports.

3.12.1.7 Cibola Gage to Imperial Dam

Recreational Areas. The Cibola Gage to Imperial Dam reach includes a few recreational areas including Picacho State Recreation Area (SRA), Imperial NWR, and Martinez Lake. Each recreational area is briefly described in the following sections.

Picacho State Recreation Area. Picacho SRA is a popular area for camping, desert exploring, river running, and sport fishing. It receives approximately 60,000 visitors annually (Picacho State Recreation Area 2006). The area has a group boat-in area, three individual boat-in camp areas, and large group camping areas. Bird watching and small game hunting for doves, ducks, and quail are among other recreational opportunities.

Imperial National Wildlife Refuge. Recreational opportunities at the Imperial NWR include canoeing, fishing, and hunting. The refuge is valued by boaters for its remote scenery.

Martinez Lake. Martinez Lake, which adjoins the Imperial NWR, encompasses 300 to 500 acres and it is an attraction catering to anglers, birdwatchers, boaters, fishers, hunters, nature lovers, rock hounds, sightseers, and water skiers. Martinez Lake has a large variety of birds year around that can be viewed from boats on the Colorado River as well as the many side lakes along the river.

Boating Facilities. Cibola Gage to Imperial Dam reach includes shoreline public use facilities at Picacho SRA, California; Imperial NWR, Arizona; and Martinez Lake, Arizona. Picacho SRA has a group boat-in area and three individual boat-in camp areas. Typical water activities within this reach include river running, boating, canoeing, water-skiing, and sport fishing.

3.12.1.8 Imperial Dam to NIB

Recreational Areas. The Imperial Dam to the NIB reach includes a few recreational areas along the Colorado River, including Betty's Kitchen and Mittry Lake Wildlife Area. Each recreational area is briefly described in the following sections.

Betty's Kitchen. Betty's Kitchen, a 10-acre wildlife interpretive area, provides bird watching and fishing opportunities.

Mittry Lake Wildlife Area. Mittry Lake, within the Mittry Lake Wildlife Area, covers approximately 600 acres and it is an ideal location for small game hunting and sportfishing. There is a three-lane boat launch ramp for motorized boating on the lake. The area is also popular for birdwatching and nature study.

Boating Facilities. The Imperial Dam to the NIB reach includes shoreline public use facilities such as a public fishing pier (National Recreation Trails Program 2006) at Betty's Kitchen, Arizona and a three-lane boat launch ramp for motorized boating and fishing jetties Mittry Lake Wildlife Area, Arizona (AZBLM 2006). Typical water activities within this reach include boating, swimming, and sport fishing.

3.12.1.9 NIB to SIB

The NIB to the SIB reach includes shoreline public use facilities in the City of Yuma, Arizona. Located on the edge of the historic floodplain to the east of the Colorado River, typical water activities within this reach include boating, swimming, and sport fishing.

3.12.2 Reservoir Boating

Reservoir boating is affected by fluctuating reservoir elevations, specifically causing changes in exposure to boating navigation hazards and changes in safe boating capacities. Hazards such as exposed rocks may become more evident and changes in navigation patterns may be necessary as reservoir elevations decline. At low pool elevations, special buoys or markers may be placed within reservoirs to warn boaters of navigational hazards. In addition, signs may be placed in areas that are deemed unsuitable for navigation.

3.12.2.1 Lake Powell

Safe Boating Navigation. In 1986, the GCNRA developed an "Aids to Navigation Plan" for Lake Powell that identified boating safety issues on the reservoir and low pool elevations that could affect boating (NPS 1986). The navigation system uses regulatory buoys and other marking devices to warn boat operators of hazardous conditions associated with subsurface obstructions or changes in subsurface conditions that could be hazardous for safe passage. Placement of many of these marking devices is dependent on the lake elevation.

At pool elevations below 3,680 feet msl, there are several places that remain passable, although buoys are placed for safe navigation. At elevations 3,626 feet msl and 3,620 feet msl, there are two areas on the reservoir that are closed to commercial tour boats and recreational boats, respectively, because of hazardous obstructions to navigation. One of these areas is around Castle Rock (elevation 3,620 feet msl), just east of the Wahweap Marina, and the other is around Gregory Butte, which is about midway to Dangling Rope Marina from Wahweap (Figure 3.12-1). At elevation 3,626 feet msl commercial tour boats leaving the Wahweap Marina heading up reservoir (east) must detour 8.5 miles around the southern end of Antelope Island. At elevation 3,626 feet msl, commercial tour boats must detour 4.5 miles around Padre and Gregory Buttes (NPS 1986). The added mileage and increased travel time makes the more popular half-day trips of the area infeasible for commercial tour boat operators. In addition, the added mileage may influence recreational boaters to remain in the area of Wahweap Bay, which can result in congestion (Henderson 2000).

In addition to buoys marking obstructions, the Aids to Navigation Plan also established a marked travel corridor to guide boat travel on Lake Powell. This primary travel corridor is the main channel of the Colorado River and it is marked with buoys along the entire length of the reservoir. Except for the reservoir mouth, there are no known pool elevations at which boat passage along this main travel corridor becomes restricted and affects boating.

Near Hite a delta has formed that can affect river boaters coming into Lake Powell at low-pool elevations. River boaters from the Colorado River row or motor through Lake Powell to a location where a boat transports them 20 to 25 miles (depending on the pick-up location) to the Hite Marina. At low elevations, the river boaters must travel further downstream to reach a location accessible to the transport company's boat.

Although this results in more miles to the takeout, there is usually enough current in the river to carry the boats. At lower elevations, additional rapids are exposed in Cataract Canyon (Hyde 2000), benefiting river runners; however, lower Lake Powell elevations result in the possibility of additional navigational hazards due to restricted channel widths and subsurface conditions.

As shown in Table 3.12-9, watercraft use in the Glen Canyon NRA peaks in the months of June through August.

Table 3.12-9
Estimates of Watercraft Use in Glen Canyon National Recreation Area by Month in 2001

Month	Other Watercraft		Personal Watercraft		All Watercraft	
	Boat Days	Monthly Use (percentage)	Boat Days	Monthly Use (percentage)	Boat Days	Annual Use (percentage)
January	747	96	30	4	777	<1
February	1,059	97	33	3	1,092	<1
March	8,995	97	261	3	9,256	1
April	18,686	94	1,122	6	19,808	2
May	68,444	81	15,771	19	84,215	10
June	137,675	74	47,985	26	185,660	22
July	113,984	70	48,600	30	162,584	20
August	126,628	72	49,491	28	176,119	21
September	80,045	62	49,883	38	129,928	16
October	37,658	86	6,336	14	43,994	5
November	11,946	96	445	4	12,391	2
December	5,189	99	67	1	5,256	1
Total	611,056	74	220,023	26	831,079	100

Source: NPS 2003.

Safe Boating Capacity. Recreational boating is the most frequent type of boating activity on Lake Powell, with an estimated 1.5 million boaters per year. One of the most popular activities at Lake Powell is to take houseboats and motorboats for multiple day excursions to explore the reservoir.

At full-pool elevation for Lake Powell (3,700 feet msl), its operating surface area is 160,782 acres. Using nine surface acres per boat, Lake Powell's safe boating capacity at full-pool elevation is approximately 17,865 boats at one time. As pool elevation decreases, the surface area available for boats also decreases.

3.12.2.2 Lake Mead

Safe Boating Navigation. Regulatory buoys and other marking devices are used on Lake Mead to warn boat operators of dangers, obstructions, and changes in subsurface conditions in the main channel or side channels.

The main channel of the Colorado River forms the primary travel corridor on Lake Mead and it is marked along its entire length with buoys for boating guidance. In addition, regulatory buoys are placed in areas where there may be a danger for safe passage.

Excursions from Lake Mead into the Grand Canyon are a popular activity. Boats entering the Grand Canyon usually launch at Pearce Ferry, South Cove, or Temple Bar (Figure 3.12-2). In addition to sightseeing being a popular activity, many boaters include overnight camping on these excursions.

The upper arms and inflow areas of Lake Mead may be difficult to navigate due to shifting subsurface sediments. In the main channel of the reservoir, the Grand Wash Cliffs area is the beginning of dangerous navigation conditions and no houseboats are allowed beyond this point (NPS 2005a).

Over the years, sediment has built up in the section of the reservoir between Grand Wash and Pearce Ferry. When Lake Mead elevations drop below 1,170 feet msl, the sediment is exposed as mud flats and there is no well-defined river channel. As a result, the area is too shallow for motor boats to navigate upstream and into the lower reaches of the Grand Canyon. With fluctuating flows, even smaller crafts may have a difficult time accessing the area because of the shifting channel (Reclamation 1995b). Based on this information, 1,170 feet msl is considered a threshold elevation for safe boating navigation for the upper end of Lake Mead.

While the area around Pearce Ferry is an issue for navigation at elevation 1,170 feet msl, the Pearce Bay launch ramp is inaccessible as a take-out for boaters at elevation 1,175 feet msl and boaters must paddle an additional 16 miles to South Cove (Henderson 2006).

Safe Boating Capacity. At full-pool elevation for Lake Mead, its operating surface area is 153,235 acres. Using the safe boating density of nine surface acres per boat, Lake Mead's safe boating capacity at full-pool elevation is approximately 17,000 boats. As pool elevation decreases, the safe boating capacity also decreases.

3.12.2.3 Lake Mohave and Lake Havasu

Because Lake Mohave and Lake Havasu will continue to be operated to meet monthly target elevations, reservoir boating safe navigation and capacity in these reaches will not be impacted by the proposed federal action.

3.12.3 River and Whitewater Boating

Whitewater boating is the key recreational activity in the Grand Canyon from Lees Ferry to the Diamond Creek or Pearce Ferry take-outs. Other reaches are not predominately whitewater localities and so they are not covered here.

3.12.3.1 Glen Canyon Dam to Lake Mead

Most Grand Canyon river trips begin at Lees Ferry and take-out at Diamond Creek or Pearce Ferry when Lake Mead elevations are higher than 1,175 feet msl, or at South Cove when Lake Mead elevations are below 1,175 feet msl (Figure 3.12-2). Boating is regulated by the NPS through its Colorado River Management Plan (NPS 2005b). The number of permits or boaters will not change as a result of this proposed federal action: the key issue is whether the visitor experience could change as a result of potential changes in Glen Canyon Dam releases. The total number of river users is approximately 22,800 per year. Use is expected to increase to 28,000 per year as indicated in the Grand

Canyon National Park Colorado River Management Plan. There are seasonal differences in the number of river users, with the winter season having the lowest daily and monthly uses.

Motorized boats travel up and down river from Glen Canyon Dam to Lees Ferry and in the upper end of Lake Mead. Limited camps in the latter area discourages overnight use.

3.12.3.2 Hoover Dam to SIB

Fluctuations in river flows between Hoover Dam and the SIB under each alternative are expected to be within the range of historic operations for the river and would not deviate from historic highs and lows. Between Hoover Dam and the SIB, river and whitewater boating are not expected to be adversely affected by the proposed federal action.

3.12.4 Sport Fishing

This discussion is based on the GCNRA Fish Management Plan (NPS 1996) for Lake Powell, and the Desert Lake View Newspaper, Fall/Winter 1999 for Lake Mead. In addition, creel information and angler fishing data have been obtained from state agencies in Utah, Arizona, and Nevada responsible for managing the fisheries resources at Lake Mead, Lake Powell, Lake Mohave, and on the Colorado River.

There are no specific reservoir elevation thresholds or river stages related to sport fishing identified from the literature reviewed. Catch rates for reservoir fishing are assumed to be directly related to reservoir habitat. Fishing satisfaction is assumed to be directly related to the general recreation issues of boating access to water via shoreline facilities, and boating navigation potential for hazards or reservoir detours due to low reservoir elevations. Catch rates are not expected to be affected by fluctuations in reservoir elevations.

3.12.4.1 Lake Powell and Glen Canyon Dam

Lake Powell supports a popular warm water sport fishery comprised mainly of striped and smallmouth bass. The striped bass depend on threadfin shad, a mid-water forage species, for a significant portion of their diet. The threadfin shad in Lake Powell are at the northernmost portion of their range and are sensitive to fluctuations of water temperature. Gizzard shad, which were inadvertently released recently and made their way to Lake Powell, may become an important striped bass forage fish. In addition to striped and smallmouth bass, Lake Powell supports largemouth bass, walleye, channel catfish, bluegill, and black crappie. There are two million angler hours per year in pursuit of sport fish. Due to the drought and declining visitation, angler use in 2003 was the lowest it has been since 1985 (Blommer et. al. 2004).

3.12.4.2 Glen Canyon Dam to Lake Mead

The rainbow trout in the 15.5-mile stretch below Glen Canyon Dam attract large numbers of local and international anglers. In 2003, angler use was approximately 14,000 user days. The fishery is managed as a “blue ribbon” rainbow trout fishery by the Arizona Game and Fish Department and Glen Canyon NRA. The intention of blue ribbon management is to provide a quality fishing opportunity where anglers can catch larger than average trout, at a relatively high catch rate, in a unique recreational setting. Most

fishing occurs from boats, but some anglers wade in the area around Lees Ferry. Downstream of this area the native fishery is emphasized.

3.12.4.3 Lake Mead and Hoover Dam

Lake Mead has an excellent warm water sport fishery comprised of largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie, and bluegill. Eighty-six percent of the catch consists of striped bass. Fishing is generally better in the fall months of September, October and November. Larger fish are caught by deep water trolling in spring from March through May.

3.12.4.4 Hoover Dam to Davis Dam

Lake Mohave's fishery is similar to Lake Mead's fishery. In Lake Mohave there are largemouth bass, striped bass, channel catfish, rainbow trout, bullhead catfish, sunfish, crappie, and bluegill. Largemouth and striped bass are in deep water in the winter and move into shallow water to spawn in the spring. Fishing is open year round, but the best fishing generally occurs in September, October and November. For deep water trolling, March through May is best.

3.12.4.5 Davis Dam to Parker Dam

Striped bass is the dominant sport fish in Lake Havasu. They can be caught throughout the year, but best fishing locations change with seasons and with water temperature. The largemouth bass population supports tournaments nearly every weekend from September through May. The smallmouth bass population has experienced an increase in numbers over the past couple of years adding a needed resource for tournament anglers. Channel catfish are abundant and average two to four pounds in size. Flathead catfish grow to large sizes in the lake. Only a limited number of anglers fish specifically for catfish. Black crappie numbers are limited due to over-harvesting and lack of habitat. The lake also contains some very large bluegill and redear sunfish, many are well over a pound (Lake Havasu Fishing 2006).

3.12.4.6 Parker Dam to SIB

Fishing in Cibola NWR is limited to certain times of the year. Cibola NWR is managed to protect wintering waterfowl that use the lake. The lake is closed to fishing from Labor Day to March 15. Sport fishing in the lake includes largemouth, smallmouth, and striped bass, channel and flathead catfish, crappie, sunfish, tilapia, and common carp (FWS 2006a).

The Imperial NWR is managed as a refuge and breeding area for migratory birds and other wildlife. Fishing is limited to an area on the Colorado River (FWS 2006b).

Fishing is allowed in the mainstream Colorado River any time of the year by boat. Fluctuations in flows between Parker Dam and the SIB under the alternatives are expected to be within the historic operating range of the Colorado River.

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3.13 Transportation

Transportation refers to the movement of people and vehicles on existing road networks and on ferries that cross the Colorado River. While there are other transportation services, only the ferry service has the potential to be impacted by the proposed federal action.

3.13.1 Ferry Service

Three ferry services transport people and vehicles across the Colorado River and its reservoirs. These services are:

- Lake Powell ferry service;
- Laughlin River Taxis; and
- Lake Havasu ferry service.

3.13.1.1 Lake Powell Ferry Service

The John Atlantic Burr Ferry on Lake Powell is located 95 miles upriver from Glen Canyon Dam and connects Bullfrog and Hall Crossing marinas on Lake Powell (Figure 3.13-1). The State of Utah operates this ferry service year round. This ferry saves approximately 130 miles of driving and the cost is $39.50 plus tax for a one-way trip. If Lake Powell elevation falls below 3,550 feet msl, the ferry becomes inoperable (Aramak 2006).

3.13.1.2 Laughlin River Taxis and Tour Boats

Privately owned river taxis and tour boats operate on the Colorado River approximately 2.5 miles downstream of Davis Dam in Laughlin, Nevada (California Department of Boating and Waterways 2006) (Figure 3.13-2). The river taxis provide transportation between the casinos located along the Colorado River in Laughlin. The tour boats offer services ranging from air-conditioned cabins, open-air top decks, wedding chapels, and full service bars. The operation of these river taxis and tour boats depends upon the Colorado River elevations that result from releases of water from Davis Dam. Many operations, especially the larger tour boats with paddle wheels, require releases of two units (approximately 9,200 cfs) from Davis Dam to operate. Although some of the river taxi operations that operate smaller boats can get by with 0.5 units (approximately 2,300 cfs), most prefer at least one unit (approximately 4,600 cfs) (Fitch pers. com.).

3.13.1.3 Lake Havasu Ferry Service

The Dreamcatcher ferry transports people and vehicles between Havasu Landing Casino on the Chemehuevi Indian Reservation, California and a point near the London Bridge in Lake Havasu City, Arizona (California Department of Boating and Waterways 2006) (Figure 3.13-3). This ferry carries approximately 400,000 people per year but does not carry vehicles (Arizona State Parks 2006). This ferry is used to shuttle people to the Havasu Landing Casino located on the Chemehuevi Indian Reservation. Lake Havasu will continue to be operated to meet monthly elevation targets and therefore, the proposed federal action will not affect the operation of the Lake Havasu ferry service.

Figure 3.13-1
John Atlantic Burr Ferry Route – Lake Powell

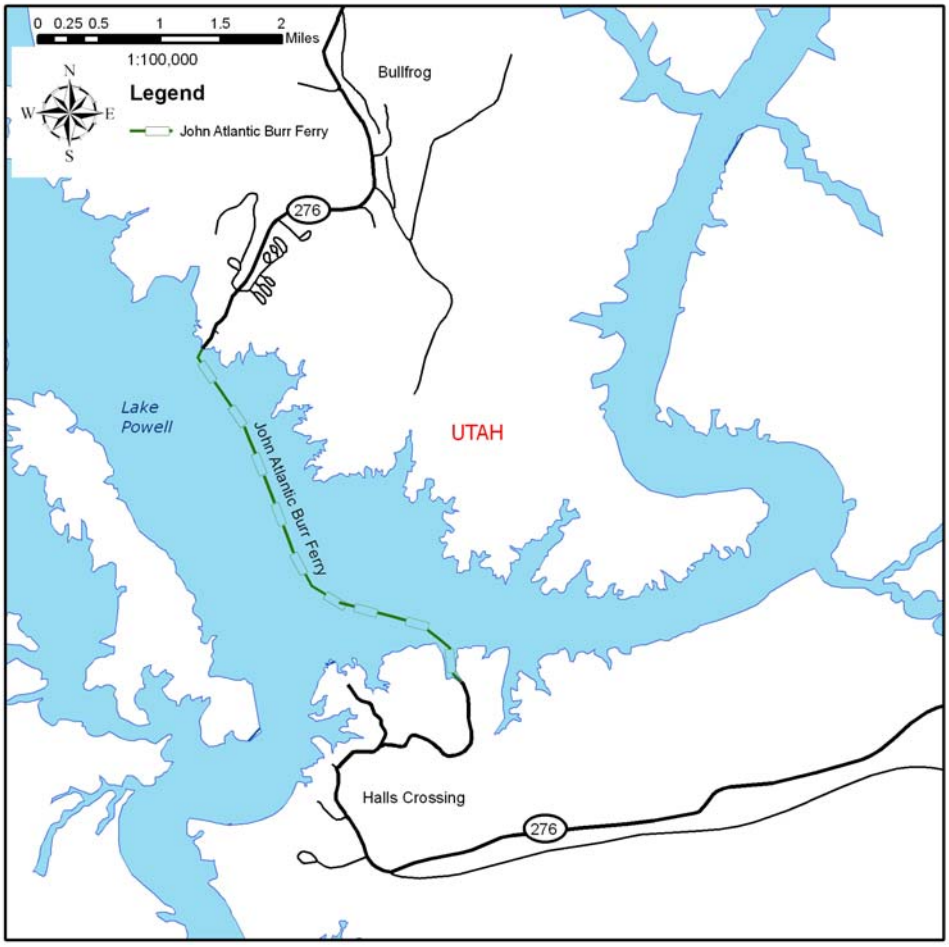

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Figure 3.13-2
Laughlin River Taxi and Tour Boat Crossing

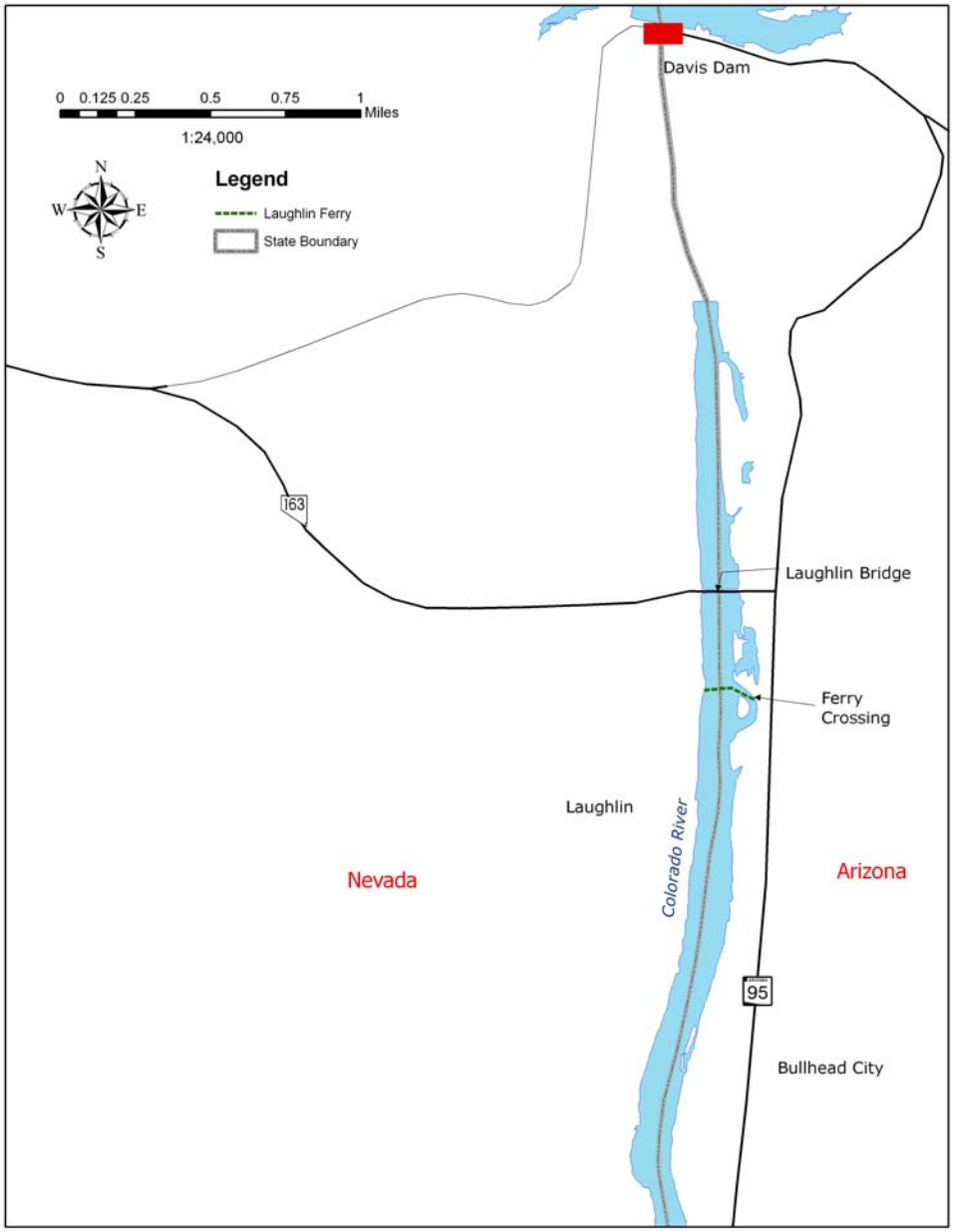

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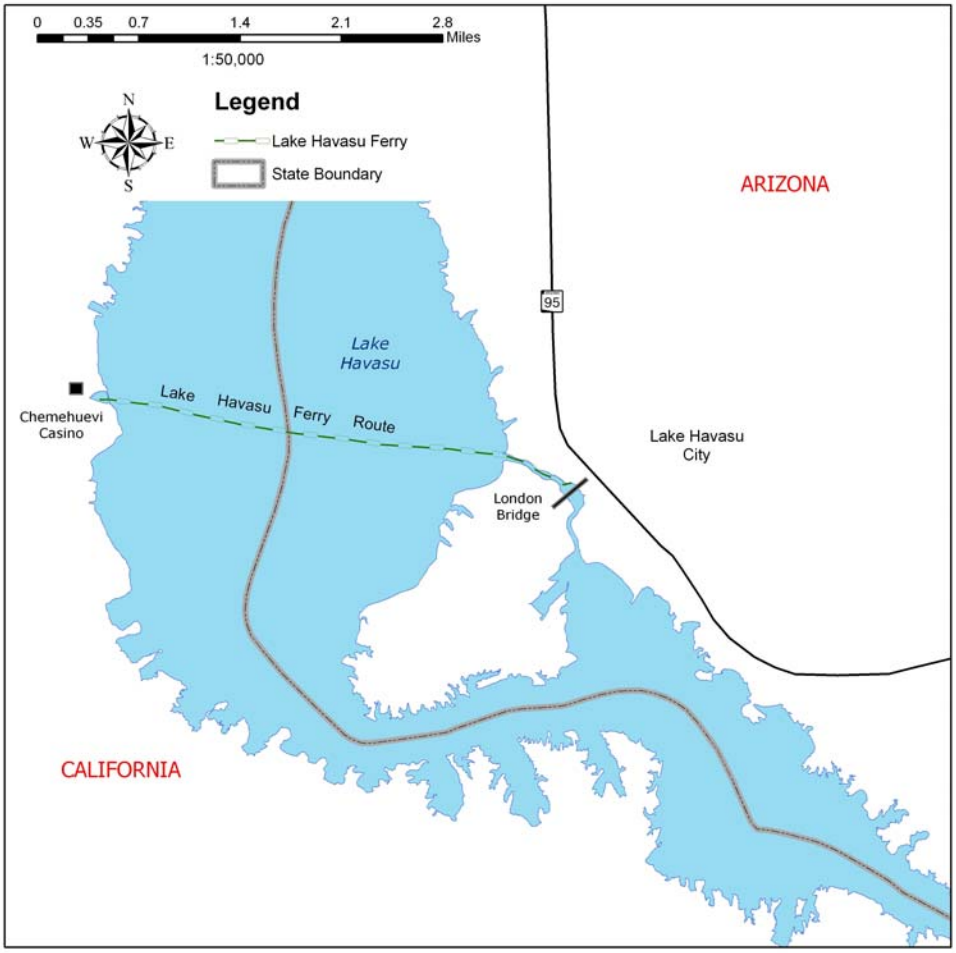
Figure 3.13-3
Lake Havasu Ferry Route



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3.14 Socioeconomics and Land Uses

This section provides an overview of socioeconomic and land use conditions within the states that could be affected by implementing the proposed federal action. The potentially affected socioeconomic and land use issues addressed include changes in:

- agricultural production and resulting changes in employment, income, and tax revenues;
- municipal and industrial uses and resulting changes in economic activity; and
- reservoir-related and river-related recreation activity and resulting changes in employment and income.

No long-term permanent changes in land uses are expected to be caused by the proposed federal action because only agricultural lands would be directly affected during a shortage and these lands would be fallowed and not permanently removed from production. In addition, the proposed federal action would not change apportionment or entitlements and changes in water deliveries would be temporary in nature. The proposed federal action will not result in any effects on prime or unique farmlands pursuant to the Farmlands Protection Policy Act of 1978. Any changes in land uses are likely to be short-term and the proposed federal action would not result in or encourage the conversion of agricultural lands to other uses.

Information regarding the value of agricultural production was limited to the counties falling within the CAP service area. Specific information regarding the value of agricultural production has not been included for Nevada or California. The value of agricultural production in Nevada is small relative to the sectors that drive the state and local economy. Agricultural production in California is not expected to be adversely affected because the potentially affected areas within California are almost all urbanized. Economic activity related to recreation is included in the information provided for Lake Powell, Lake Mead, and the Colorado River downstream of Lake Mead.

3.14.1 Study Area

The study area for the socioeconomics assessment was based on the states and counties in which a shortage may occur or in which changes in reservoir storage or river flow would result in a change in recreation opportunities or use. A county-level analysis was selected because information on employment and income is typically reported at the county level. The study area consists of counties in Utah, Arizona, Nevada, and California.

The Utah study area is comprised of Garfield, Kane, and San Juan counties. Although Utah will not experience shortages under any of the alternatives, changes in storage at Lake Powell could result in changes in recreation-related expenditures made in these counties.

The Arizona study area is comprised of Coconino, La Paz, Mohave, Pima, Pinal, Yavapai, Yuma, Maricopa, and Graham counties. These counties were selected because they are either located directly adjacent to Lake Powell, Lake Mead, or the Colorado River, or they are

counties in which shortages would likely occur. The counties in which measurable shortages could potentially occur, resulting in reduction in agricultural production or reduced municipal/industrial deliveries are Maricopa, Pinal, Pima, Mohave, La Paz, and Yuma.

The Nevada study area is comprised of Clark County. The study area was limited to Clark County because it is located adjacent to Lake Mead and encompasses the service area of the Southern Nevada Water Authority. Shortages in Nevada would be limited to the Southern Nevada Water Authority service area.

The California study area is comprised of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties. These counties were selected because they are either located directly adjacent to the lower Colorado River, or they are within the MWD service area.

3.14.2 Water Use

The potentially affected area within Arizona includes Coconino, La Paz, Mojave, Pima, Pinal, Yavapai, Yuma and Maricopa Counties. Maricopa, Pima, and Pinal Counties are served by the CAP, whereas Coconino, La Paz, Yavapai, Yuma, and Mojave Counties are adjacent to the Colorado River and/or Lake Mead.

3.14.2.1 Arizona

Agriculture. The total market value of agricultural production in Arizona was a little over $2.4 billion in 2002. The market value of agricultural production occurring within the Arizona study area accounted for nearly 90 percent of the statewide production value. In 2002, production values ranged from a low of approximately $16 million in Mohave County to a high of $802 million in Yuma County. (U.S. Department of Agriculture, National Agricultural Statistics Service 2002).

Agricultural lands receiving water for irrigation from the CAP are located generally within Pinal, Maricopa, and Pima Counties. A list of irrigation districts and Indian communities receiving water from the CAP is provided in Appendix H.

The three counties account for approximately 53 percent of statewide irrigated harvested cropland. These three counties also account for approximately 71 percent of Arizona's harvested cotton acreage, 18 percent of the State's vegetable crops and approximately 48 percent of irrigated wheat cultivation (USDA 2004). Table 3.14-1 provides a summary of lands in irrigated farms within these three counties.

Table 3.14-1
Central Arizona Irrigated Agricultural Land in 2002

Area	Total Land in Irrigated Farms (acres)	Total Land Area (acres)	Land in Irrigated Farms as a Percentage of Total Land in 3-County Area
CAP Counties	829,957	14,928,438	5.6
Western Arizona Counties	536,152	14,928,438	3.6

Source: USDA, National Agricultural Statistics Service 2004.

Agricultural resources in western Arizona are located in Mohave, La Paz, and Yuma Counties. Agricultural lands are located primarily along the Colorado River and in Yuma County along the Gila River Valley. A list of these districts is provided in Appendix H.

These three Western Arizona counties account for approximately 75 percent of the State's production of vegetable crops, 49 percent of irrigated wheat cultivation, and 38 percent of orchard lands (USDA 2004). Table 3.14-1 provides a summary of irrigated agricultural lands within these Western Arizona counties.

Municipal and Industrial Uses. Municipalities potentially affected by the proposed federal action include the cities of Phoenix, Tucson, Scottsdale, and numerous other Arizona towns and cities that rely on Colorado River water delivery through the CAP. Industrial land uses located in Arizona on the Colorado River include the major power facilities of Glen Canyon Dam and Navajo Generating Station in Coconino County and Parker Dam in La Paz County (and San Bernardino County, California).

Employment. Full and part time employment in Arizona totaled 3,047,543 jobs in 2004, an increase of approximately 477,000 jobs from 1994 levels. Employment in the private sector represented nearly 85 percent of total employment in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis 2006c). In 2004, employment in the arts, entertainment, and recreation sector totaled 59,022 jobs or approximately two percent of total employment in Arizona. Farm employment totaled 23,315 in 2004 and accounted for less than one percent of total employment in the state.

Full and part time employment in Coconino, La Paz, Mojave, Pima, Pinal, Maricopa, Yavapai, and Yuma Counties totaled 2,878,279 jobs in 2004, an increase of approximately 860,500 jobs from 1994. Total employment in the eight-county study area represents more than 94 percent of total employment in Arizona. Employment in the arts, entertainment, and recreation sector to the eight counties totaled 56,581 jobs or approximately two percent of total employment in the eight counties. Employment in the agricultural sector in Maricopa, Pima, and Pinal Counties totaled 12,295 jobs in 2004 and represented less than one percent of total employment for those three counties. (U.S. Department of Commerce, Bureau of Economic Analysis, 2006c).

Income. Total personal income in Arizona totaled just over $145.5 billion in 2004. This represents a substantial increase from the 1994 level of $81.5 billion. Statewide per capita income increased from approximately $19,000 in 1994 to approximately $29,000 in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis, 2006d).

In 2004, average per capita income ranged from a low of approximately $19,743 per year in La Paz County to a high of $31,757 per year in Maricopa County. The total personal income of the eight counties represents just over 94 percent of the state total (U.S. Department of Commerce, Bureau of Economic Analysis 2006d).

3.14.2.2 Nevada

The Nevada study area is comprised of Clark County, which is adjacent to the Colorado River.

Agriculture. Agricultural production in Clark County is very small compared to other farming areas in the study area. Table 3.14-2 provides a summary of agricultural land in this county. A small proportion of this land is used for cropland, most of which is irrigated. Cropland is used primarily for producing forage crops. Livestock and poultry are also produced in Clark County.

Table 3.14-2
Southern Nevada (Clark County) Agricultural Land in 2002

Total Land in Irrigated Farms (acres)	Total County Area (acres)	Land in Irrigated Farms as a Percentage of Total Land
65,206	5,062,614	1.3 percent

Source: USDA, National Agricultural Statistics Service 2002.

Municipal and Industrial Uses. Municipalities potentially affected by the proposed federal action include Boulder City, Henderson, Las Vegas, and North Las Vegas due to their reliance on Colorado River water supplied by SNWA. These municipalities support urban, commercial, and industrial land uses that could be potentially affected by the proposed federal action.

Employment. Full and part time employment in Nevada totaled 1,430,370 jobs in 2004, an increase of approximately 521,000 jobs from 1994 levels. Employment in the private sector represented nearly 89 percent of total employment in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis 2006e). In 2004, employment in the arts, entertainment, and recreation sector totaled 46,137 jobs or approximately three percent of total employment in the state. Employment in the accommodations and food service sector totaled 293,157 jobs and was the largest employment sector in Nevada. This is the largest employment sector in Nevada, accounting for approximately 24 percent of total employment.

Full and part time employment in Clark County totaled 998,000 jobs in 2004, an increase of approximately 422,000 jobs from 1994. Total employment in Clark County represents almost 70 percent of total employment in Nevada. Full- and part-time employment in the Clark County government sector was lower than the Nevada average (U.S. Department of Commerce, Bureau of Economic Analysis 2006e). In 2004, employment in the arts, entertainment, and recreation sector totaled 30,391 jobs or approximately three percent of total employment in the county. Similar to statewide totals, the accommodations and food service sector was the largest employment sector in the county, totaling 235,632 jobs in 2004.

Income. Total personal income in Nevada totaled just over $78 billion in 2004. This represents a substantial increase from the 1994 level of $43 billion. Statewide per capita income increased from approximately $23,800 in 1994 to approximately $33,800 in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis 2006f).

In 2004, per capita income in Clark County was $32,900, slightly lower than the state average. The total personal income of Clark County represents more than 69 percent of the state total (U.S. Department of Commerce, Bureau of Economic Analysis 2006f).

3.14.2.3 California

The California study area is comprised of Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties. These counties were identified because they are located within the service area of the MWD, which receives a portion of its water supply from the Colorado River. Although Ventura County is also in MWD's service area, it does not receive any water from the Colorado River and therefore it is not included in the study area.

Agriculture. Table 3.14-3 presents the amount of agricultural land present in each California county served by the IID, the CVWD, the MWD, and the San Diego County Water Authority (SDCWA), and the percentage of land in the counties that is in agricultural use. These counties include Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura. The categories included in Table 3.14-3 are used by the California Department of Conservation and are based on the Important Farmland maps for California. These maps are compiled from United States Department of Agriculture (USDA) Natural Resources Conservation Service soil surveys and current land use information.

Table 3.14-3
Southern California Agricultural Land in the Seven-County Study Area (2004)

Important Farmland in the Seven-County area[1] (acres)	Grazing Land in the Seven-County Area (acres)	Total Agricultural Land in the Seven-County Area[2] (acres)	Total Seven-County Area (acres)	Agricultural Land as a Percentage of Total Land in the Seven-County Area
1,443,109	1,601,689	3,044,798	27,334,413	11.1 percent

Source: California Department of Conservation (CDC) 2004 a-g.

Notes:

1. *Important Farmland includes Prime Farmland, Farmland of Statewide Importance, Unique Farmland and Farmland of Local Importance.*
2. *This category includes both Important Farmland and Grazing land.*
3. *Counties are Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura.*

Municipal and Industrial. Municipalities potentially affected by the proposed federal action include some 88 cities in Los Angeles County, 34 cities in Orange County, 24 cities in Riverside County, 31 cities in San Bernardino County, and 18 cities in San Diego County.

Employment. Full- and part-time employment in California totaled 20 million jobs in 2004, an increase of approximately 3.5 million jobs from 1994 levels. Employment in the private sector represented nearly 85 percent of total employment in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis 2006g).

Full- and part-time employment in the six county study area totaled 11 million jobs in 2004, representing 55 percent of total California employment. Full and part time employment in the government sector was higher than the California average (13 percent) in four counties (Imperial: 24 percent, Riverside: 14 percent, San Diego: 18 percent, and San Bernardino: 15 percent) and lower in two counties (Los Angeles: 11 percent, and Orange: eight percent) (U.S. Department of Commerce, Bureau of Economic Analysis, 2006g).

Income. Total personal income in California totaled just over $1.2 trillion in 2004. This represents a substantial increase of $497 billion from 1994. Statewide per capita income increased from approximately $23,000 in 1994 to approximately $35,000 in 2004 (U.S. Department of Commerce, Bureau of Economic Analysis, 2006h).

In 2004, total personal income ranged from a low of approximately $3.3 billion in Imperial County to a high of $329 billion in Los Angeles County. When combined, the total personal income of the six counties represents 44 percent of the state total. Per capita income ranged from a low of approximately $22,000 in Imperial County to a high of approximately $42,000 in Orange County (U.S. Department of Commerce, Bureau of Economic Analysis 2006h).

3.14.3 Recreation

Economic benefits result when visitors spend dollars locally on recreational activities. Those benefits include increased sales, income, and jobs. Direct economic benefits occur when businesses sell goods and services to park visitors. Indirect economic benefits result from the circulation of spending throughout the local economy (NPS 2005c).

This section describes the direct and indirect economic value of recreation occurring in the GCNRA and the LMNRA. The NPS maintains a database of recreational visits and the economic impacts of those visits. That information is summarized here for Lake Powell and Lake Mead. Lake Mohave is included within the LMNRA. Consequently, the visitor spending associated with Lake Mohave is included as part of the LMNRA discussion below. A discussion of recreation-related economic activity occurring on the Colorado River below Lake Powell and Lake Mead was not included because no change in recreation activities and resulting change in economic activity is expected under the proposed federal action.

3.14.3.1 Glen Canyon National Recreation Area

GCNRA hosted 1.88 million recreational visits in 2003. (Section 4.12 provides additional information on recreation use occurring within the GCNRA.) Table 3.14-4 summarizes the direct and indirect effects of visitor spending by sector. Direct recreation-related expenditures totaled $86.09 million in 2003 resulting in 2,119 jobs and $31.76 million in personal income. As direct spending circulates through the local economy, secondary or

indirect economic effects occur. This spending created an additional $14.11 million in personal income and 548 jobs.

Table 3.14-4
Glen Canyon National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003

Sectors	Sales (millions)	Personal Incomes (millions)	Jobs	Value Added (millions)
Direct Effects				
Motel, Hotel, B&B, and Cabins	$16.36	$5.34	356	$8.11
Campsites	$13.21	$4.31	288	$6.55
Restaurants & Bars	$20.65	$7.03	590	$9.80
Admissions & Fees	$13.11	$4.54	387	$7.42
Retail	$14.98	$7.64	410	$11.94
Others	$7.78	$2.31	88	$3.50
Total Direct Effects	$86.09	$31.17	2,119	$47.32
Total Indirect Effects	$38.80	$14.11	548	$24.36
Total Effects	$124.88	$45.28	2,667	$71.68

Source: National Park Service 2006b.

3.14.3.2 Lake Mead National Recreation Area

LMNRA (Lake Mead and Lake Mohave) hosted 7.92 million recreational visits in 2003. Tables 3.14-5 summarize the direct and indirect effects of visitor spending by sectors. Direct recreation-related expenditures totaled $176.82 million in 2003 resulting in 5,197 jobs and $63.15 million in personal income. This direct spending created an additional 856 jobs and $18.73 million in personal income.

Table 3.14-5
Lake Mead National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003

Sectors	Sales (millions)	Personal Incomes (millions)	Jobs	Value Added (millions)
Direct Effects				
Motel, Hotel, B&B, and Cabins	$27.08	$7.86	693	$11.95
Campsites	$18.59	$5.39	476	$8.20
Restaurants & Bars	$52.77	$16.62	1,648	$23.15
Admissions & Fees	$30.98	$10.65	912	$17.43
Retail	$35.57	$18.15	1,257	$28.34
Others	$11.82	$4.48	211	$6.51
Total Direct Effects	$176.82	$63.15	5,197	$95.58
Total Indirect Effects	$55.82	$18.73	856	$34.55
Total Effects	$232.64	$81.89	6,052	$130.12

Source: National Park Service 2006d.

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3.15 Environmental Justice

Environmental justice refers to the fair treatment and meaningful involvement of all people in the development, implementation and enforcement of environmental laws, regulations and policies.

- *Fair treatment* means that no group of people, including minority and low-income populations, should bear a disproportionate share of the adverse environmental impacts of government actions.

- *Meaningful involvement* means that people who would be adversely affected by the environmental impacts of government actions should have the opportunity to participate in decisions leading up to those actions and have their views considered.

Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that all federal agencies make achieving environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. Census data were used to identify the minority and low-income populations living in counties that could potentially be affected by the alternatives.

The affected area for environmental justice is comprised of 18 counties; three in Utah (Garfield, Kane, and San Juan), eight in Arizona (Coconino, La Paz, Maricopa, Mohave, Pima, Pinal, Yavapai, and Yuma), one county in Nevada (Clark), and six counties in California (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego). Ventura County in California is located within the MWD service area, but does not receive any water from the Colorado River, and therefore, it is not addressed in this section.

3.15.1 Minority, Low-Income Populations, and Indian Tribes

For purposes of this analysis, minority populations and low-income populations are defined following the CEQ's (1997) guidance as:

- *Minorities* – Persons of American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; Hispanic; or persons of two or more races (without double-counting persons of Hispanic or Latino origin who are also contained in the latter groups); and

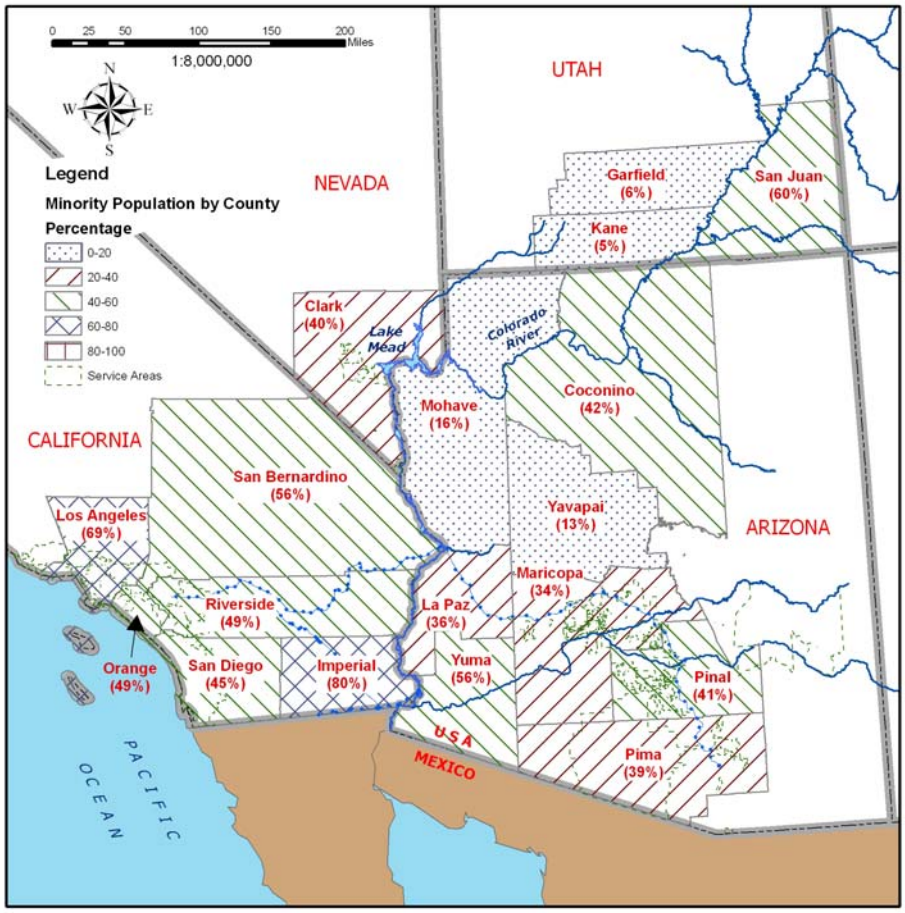
- *Low-income populations* – As reported in the 2000 census, persons living below the poverty level, which is $18,104 for a family of four in 1999 and varies depending on family size (U.S. Census Bureau 2000b).

Identification of minority and low-income populations was based on the 2000 Census of Population and Housing, which estimates each of the separate categories contained in these definitions. Minority populations were estimated using 2000 Census data that report Hispanic or Latino populations by race, and, separately, populations not Hispanic or Latino by race

(U.S. Census Bureau 2000a). Low-income populations were estimated using the 2000 Census data that report poverty status in 1999 by age (U.S. Census Bureau 2000b). The population for whom poverty status is determined is generally slightly less than the total population because the 2000 Census data excludes certain groups from consideration.

In 2000, population of the 18-county area was 24,691,833, of whom 13,225,335 (or 53.6 percent) were minorities. Minority populations are identified where minorities of the affected area [county] exceed fifty percent of the total population. Of the 18 counties, five have a minority percentage greater than 50 percent: Yuma County, Arizona; Imperial County, Los Angeles County, and San Bernardino County, California; and San Juan County, Utah; with Imperial County the highest at 79.8 percent. In the remaining 13 counties, the minorities comprise less than 50 percent of the population and so these counties are not considered environmental justice communities (Figure 3.15-1).

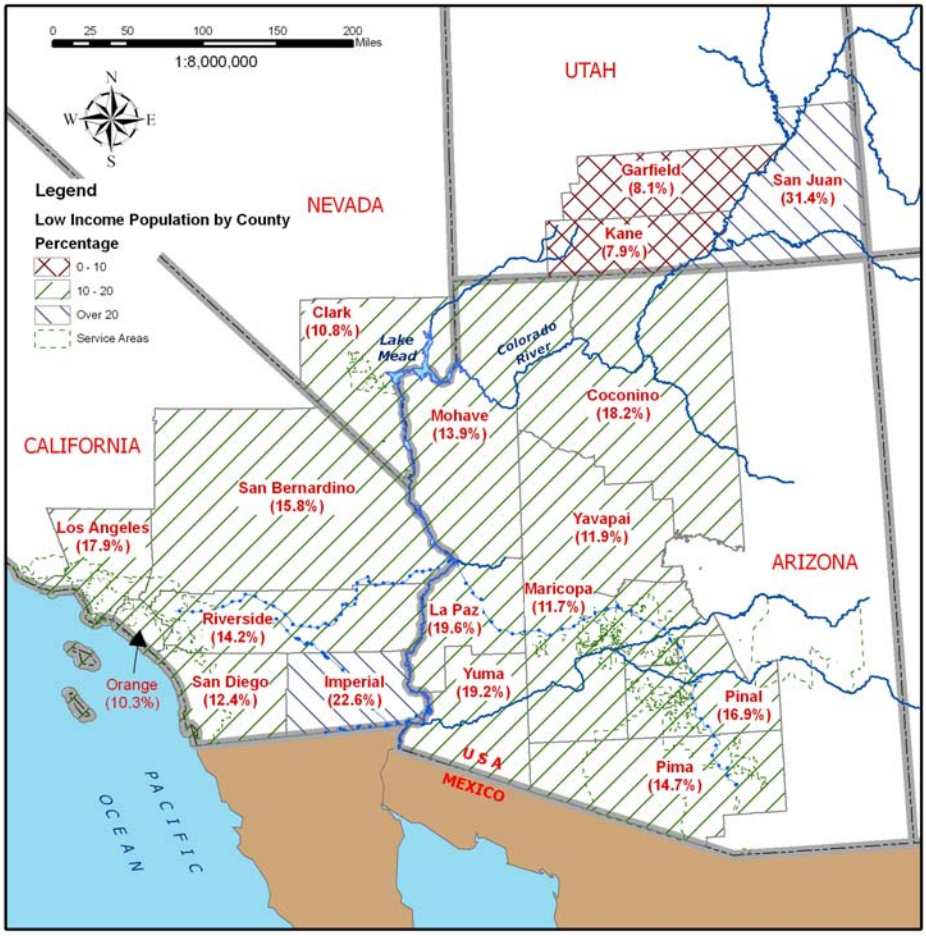
Figure 3.15-1
Minority Population by County



Indians are included within these census data. Following CEQ's 1997 guidance on environmental justice, as well as Exec. Order No. 13175 and the Presidential Memorandum on Government-to-Government Relations with Native American Tribal governments, Reclamation sought input from 42 federally-recognized tribes including those with reservations located within these counties and from tribes that might have interests in the proposed federal action. A description of the consultations undertaken for this project is included in Chapter 6 of this Draft EIS.

In 2000, some 3,559,939 persons (or 14.7 percent) in the study area were living below the poverty level. The percent poverty for the 18 counties is between 7.9 percent and 31.4 percent, with San Juan County, Utah having the highest percentage (Figure 3.15-2). For the environmental justice analysis, low income counties were defined as those above the average poverty percentage for the 18 counties (14.7 percent) in the study area (Figure 13.15-2). This added four counties in Arizona: Coconino, La Paz, Pinal, and Pima (the five minority counties were also low-income). Therefore, for purposes of this analysis, there are nine total environmental justice counties/communities.

Figure 3.15-2
Low Income Population by County



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