Chapter III

Existing Conditions in the Affected Environment

3.1 Introduction

3.1.1 Setting

Located at the western edge of the Great Plains, the Rio Grande is one of the longest rivers in the United States (U.S.) and the 24th longest in the world. It runs 1,960 miles (3,154 kilometers [km]) from its headwaters in the San Juan Mountains of southern Colorado to its terminus in the Gulf of Mexico. This Water Operations Review (Review) and Environmental Impact Statement (EIS) considers a planning area that includes the entire upper Rio Grande basin and a project area that includes the river corridors along the Rio Grande and its major tributaries from its headwaters in Colorado downstream to Fort Quitman, Texas. The affected environment is described for either the planning area or the project area, as appropriate for each resource. In this EIS, the river is discussed in terms of the following sections, reaches, and facilities shown on Map 1-1.

- **Northern Section—Rio Grande from Alamosa, Colorado, to the confluence with Rio Chama (Reaches 1 through 4 of Map 1-1)**. Water operations of the Closed Basin Project and flood control operations at Platoro Reservoir may affect this section, but no changes in operations were identified at these facilities. Flood flows in these reaches are unregulated, for the most part, except for the regulation of the Rio Conejos by Platoro Reservoir during high snowmelt runoff periods.
- **Rio Chama Section—Rio Chama to the Rio Grande confluence downstream to Cochiti Dam (Reaches 5 through 9)**. Water operations at the dams on the Rio Chama (Heron and Abiquiu) affect this section. The flood pools at Abiquiu Reservoir and Cochiti Lake are included and are affected by flood control operations at the dams. Flood control operations of Abiquiu and Cochiti were considered in coordination with other facilities. This section is also affected by facilities and projects outside the scope of this Review and EIS (El Vado Dam and the San Juan-Chama [SJC] Project).
- **Central Section—Cochiti Dam to the Rio Puerco confluence (Reaches 10 through 13)**. Water operations at Cochiti and Abiquiu Dams affect this section. This section may also be affected by facilities and projects outside the scope of this Review and EIS, or facilities where no changes in operation were identified (El Vado Dam, Galisteo Dam, Jemez Canyon Dam, and the SJC Project).
- **San Acacia Section—Rio Puerco confluence to Elephant Butte Dam (Reach 14)**. Water operations at Cochiti and Abiquiu Dams and the Low Flow Conveyance Channel (LFCC) affect this section. The flood pool of Elephant Butte Reservoir is also included in this section.
- **Southern Section—Elephant Butte Dam to Fort Quitman, Texas (Reaches 15 through 17)**. Flood control operations at Elephant Butte Dam and Caballo Dam and Reservoir affect this section. No changes in flood control operations at Elephant Butte Dam and Caballo Dam and Reservoir were identified and is a function of the U.S. Section of the International Boundary and Water Commission (USIBWC) action on the Canalization Project. Other operations and facilities outside the scope of this Review and EIS may also affect this section.

3.1.2 Resources Considered

This chapter describes the resources in the existing environment that could be impacted by the Action Alternatives and the No Action Alternative. Because action alternatives only consider water operations changes at facilities in the Rio Chama, Central, and San Acacia Sections, the descriptions of the affected environment address the reaches in those sections in the most detail. The resources presented are based on a valuation of the relative importance and potential impact on the resource, as expressed by the joint lead agencies (JLA), cooperating agencies, stakeholders, and the public. Resources not affected or only minimally affected by changes identified during this Review and EIS include noise levels, air quality, hazardous materials, and seismicity. These resources are discussed only briefly at the end of this chapter. Potential measures to mitigate any impacts of changes in water operations on fish, wildlife, and other resources with statutory requirements for considering mitigation are described in Chapter 4.

3.2 Existing Hydrology and Geomorphology

The physical characteristics of natural rivers are strongly controlled by the magnitude, duration and timing of the natural, unconstrained flows that pass through them (Schumm 1977). The natural flows are in turn controlled by the climatic, geologic, and physical characteristics of the contributing watershed (Lee et al. 2004). These natural physical characteristics can be significantly altered by human activities that change infiltration and runoff patterns; that store and release water in ways that alter the natural runoff cycle and change the sediment supply; and that constrain the river to protect adjacent property from flooding and erosion. The existing form of the Rio Grande results from a combination of all of these factors. More detailed information on hydrology can be found in Appendix I and on geomorphology in Appendix H.

3.2.1 Hydrology

Natural flows in the Rio Grande system are derived from two primary sources: (1) snowmelt originating predominately from the upstream, higher elevation portions of the watershed and (2) summer thunderstorms that tend to be more localized and concentrated at lower elevations. During the past century, nearly 60 percent of the natural runoff volume in the Rio Grande at Otowi Bridge, as indicated by the Otowi Index Supply, occurred during April, May and June (**Figure 3-1**).

In the Rio Chama, about 80 percent of the natural annual flow volume occurs during April, May, and June, based on recorded flows between 1955 and 2001 at the near La Puenta gage. In contrast, runoff from lower elevation tributaries tends to occur during the monsoon season in the late summer and early fall. Nearly 80 percent of the recorded annual flow volume at the Rio Puerco near Bernardo gage occurs between July 1 and October 31, with nearly 40 percent occurring during August alone. The locations of the gages, diversions, and structures discussed in this section are shown on **Map 3-1**.

Under natural, unconstrained river conditions, the annual flow volume varies significantly from year to year, depending on climatic conditions (Waltemeyer 1987). Annual variations in the timing and volume of streamflow in the Upper Rio Grande are strongly influenced by the El Niño-southern oscillation (ENSO) through its modulation of the seasonal cycles of temperature and precipitation and their effects on snow accumulation and melting (Lee et al. 2004). The ENSO cycles can be several years to decades long and can result in extended drought or wet periods. An extended period of below average precipitation occurred from the early 1940s through the mid 1970s and above average precipitation from 1981 through the mid 1990s (National Oceanic and Atmospheric Administration [NOAA] 2002). The analysis used to develop the representative 40-year synthetic flow sequence for input to the Upper Rio Grande Water Operations Model (URGWOM) shows similar periods in the Palmer Drought Severity Index (Appendix I).

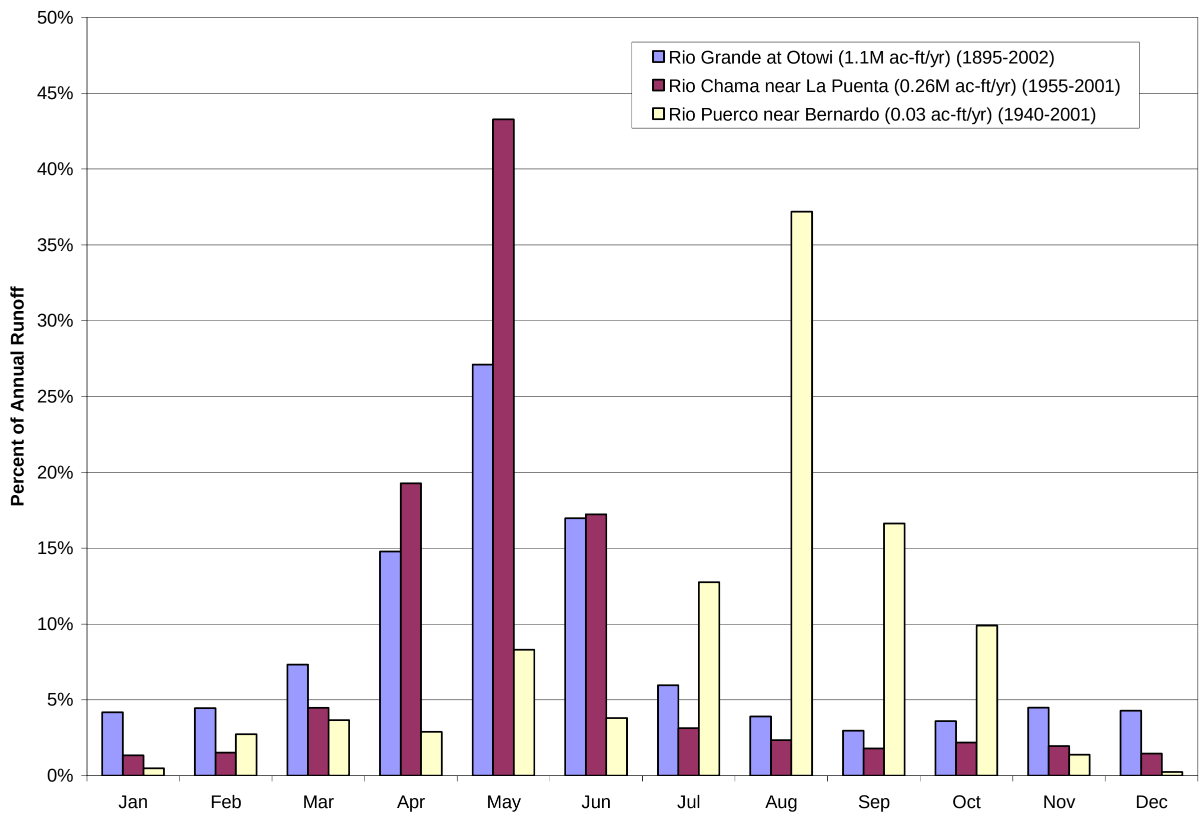
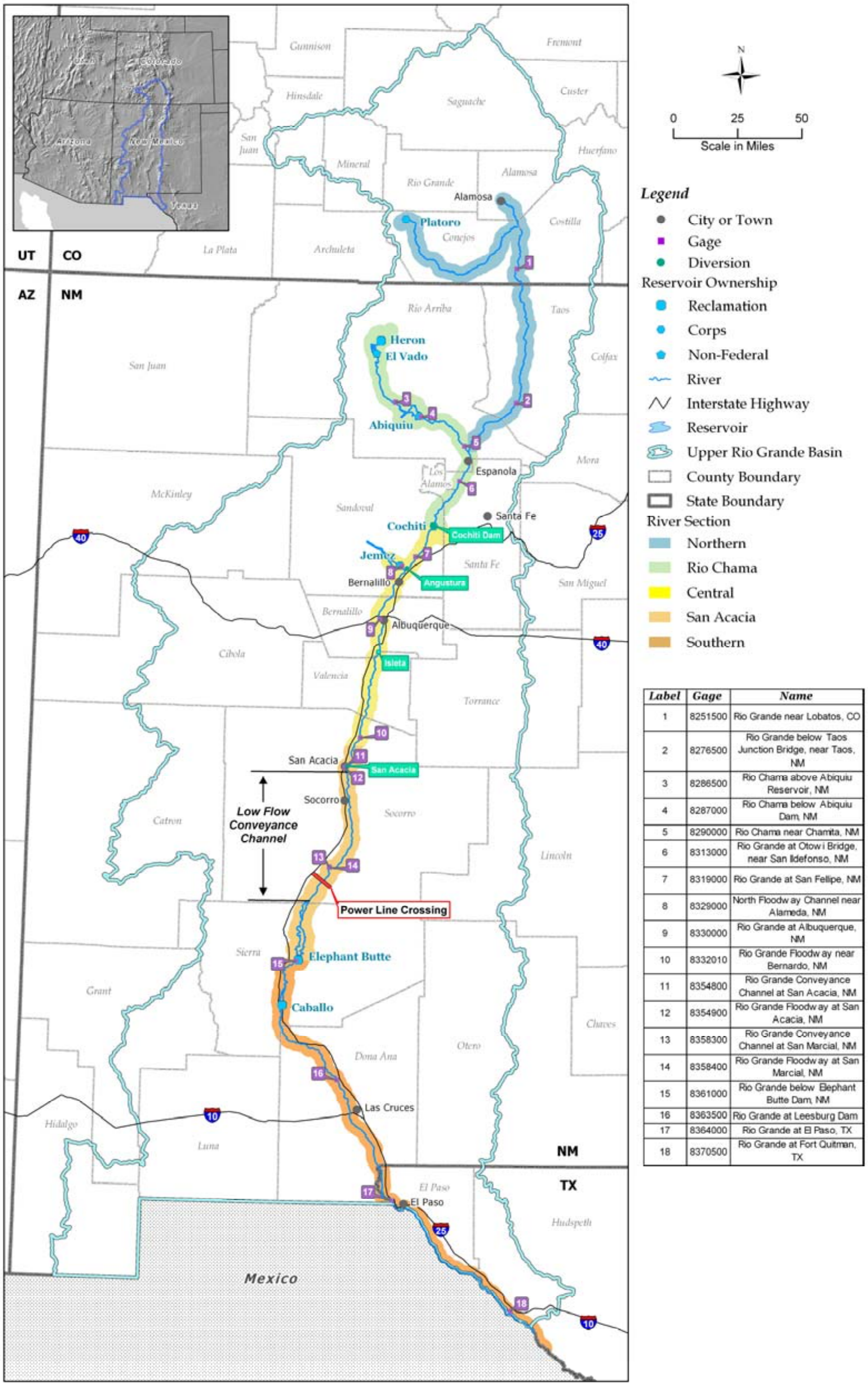


Figure 3-1. Average Monthly Distribution of Native Runoff of the Rio Grande at Otowi, Rio Chama Near La Puenta, and Rio Puerco Near Bernardo Gages (Over History Of Gage)

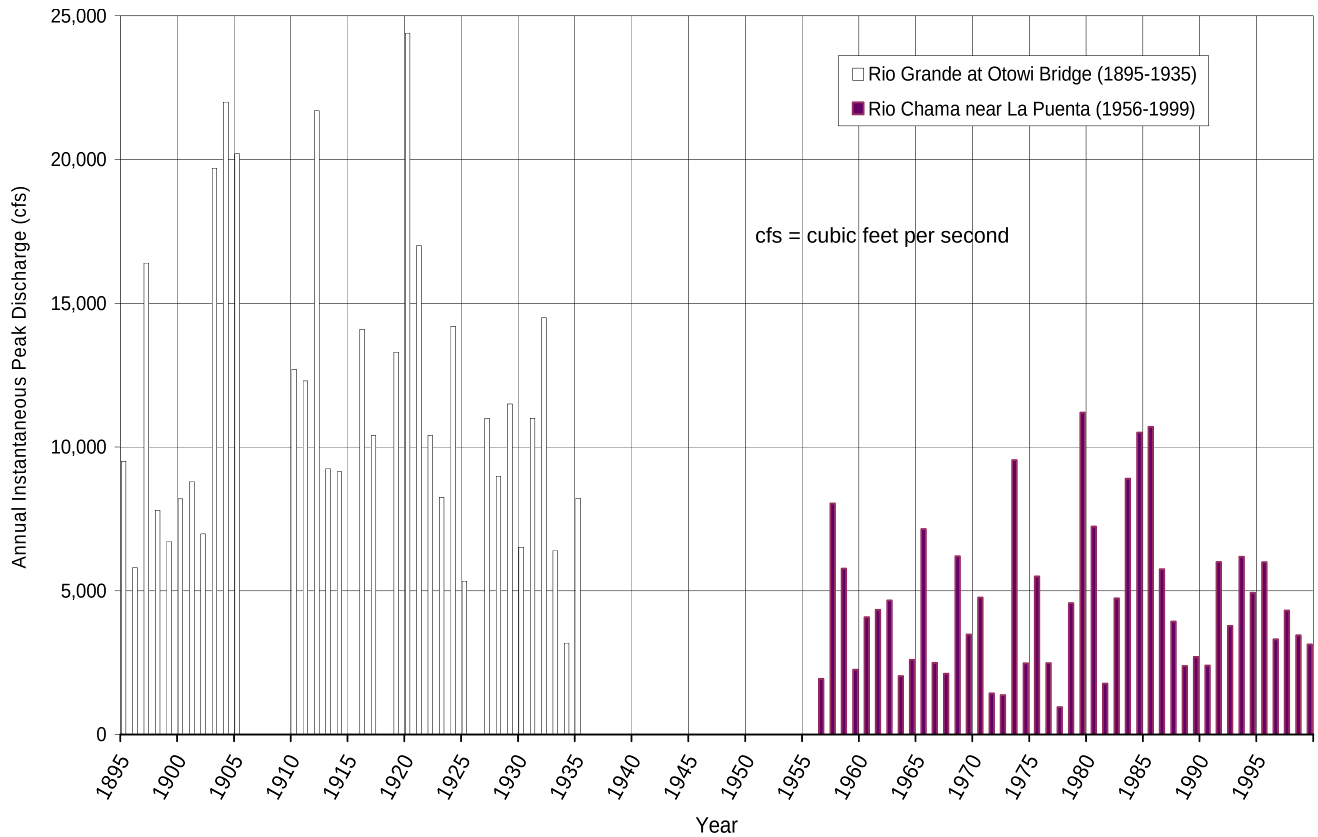
The annual flood regime varies significantly from year to year due to natural variability in climate and precipitation. During the period prior to completion of El Vado Dam in 1935, the approximate annual native flood peaks at the Otowi gage averaged about 11,600 cubic feet per second (cfs), but varied from about 24,400 cfs in 1920 to 3,200 cfs in 1934 (**Figure 3-2**). Annual native flood peaks at the Rio Chama near La Puenta gage averaged about 4,600 cfs during the period of record, but varied from about 960 cfs in 1977 to 11,200 cfs in 1979.

The lower elevation tributaries contribute a relatively small percentage of the annual runoff volume to the Rio Grande. Peak flows from the larger tributaries can equal or exceed the annual snowmelt peak flows in the mainstem, and typically carry high sediment loads that can have a significant effect on the behavior of the river (MEI 2002). For example, annual runoff at the Rio Puerco near Bernardo gage, where the flows are relatively unaffected by upstream augmentation or diversion, were less than 3 percent of the average native flow in the Rio Grande at Otowi during the same period. However, many of the floods in the Rio Puerco were of the same order of magnitude as those in the mainstem Rio Grande. Annual peak flows in the Rio Puerco averaged almost three times greater between 1940 and 1972 than they were during the subsequent four decades. Molnar and Ramirez (2001) attributed the decrease in annual peak flows to changes in precipitation patterns and channel conveyance characteristics in the Rio Puerco watershed, despite a statistically significant increase in annual precipitation over the past 50 years. The increase in precipitation occurred primarily during the autumn and spring, rather than the summer monsoon season. As a result, the average annual runoff did not change significantly because the decrease in monsoon-season runoff was balanced by an increase in long-term runoff.



Label	Gage	Name
1	8251500	Rio Grande near Lobatos, CO
2	8276500	Rio Grande below Taos Junction Bridge, near Taos, NM
3	8286500	Rio Chama above Abiquiu Reservoir, NM
4	8287000	Rio Chama below Abiquiu Dam, NM
5	8290000	Rio Chama near Chamita, NM
6	8313000	Rio Grande at Otowi Bridge, near San Ildefonso, NM
7	8319000	Rio Grande at San Fellipe, NM
8	8329000	North Floodway Channel near Alameda, NM
9	8330000	Rio Grande at Albuquerque, NM
10	8332010	Rio Grande Floodway near Bernardo, NM
11	8354800	Rio Grande Conveyance Channel at San Acacia, NM
12	8354900	Rio Grande Floodway at San Acacia, NM
13	8358300	Rio Grande Conveyance Channel at San Marcial, NM
14	8358400	Rio Grande Floodway at San Marcial, NM
15	8361000	Rio Grande below Elephant Butte Dam, NM
16	8363500	Rio Grande at Leesburg Dam
17	8364000	Rio Grande at El Paso, TX
18	8370500	Rio Grande at Fort Quitman, TX

Map 3-1. Major Gages, Diversions, and Structures Along the Rio Grande

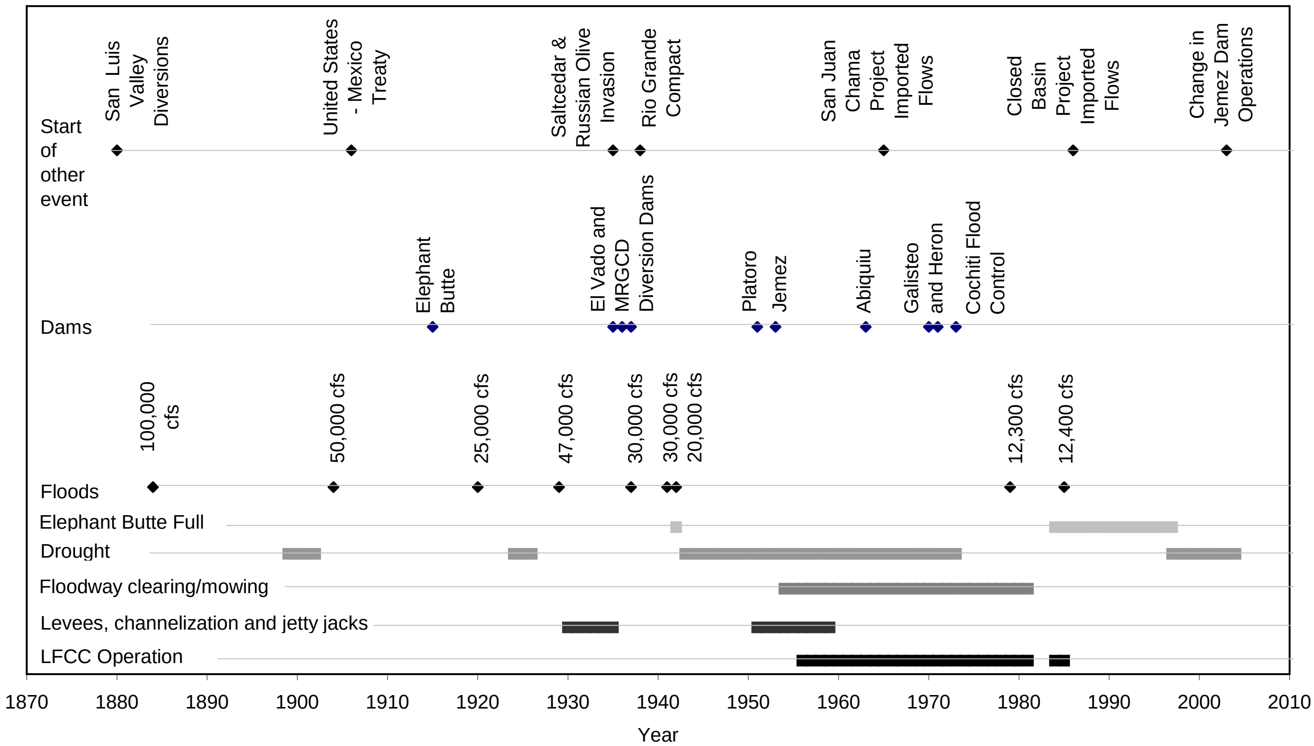


Note: Gaps within the period of record indicate that no gage data are available.

Figure 3-2. Recorded Annual Peak Flows During the Period Prior to Significant Flow Regulation (1895-1935) of the Rio Grande at Otowi Gage and at the Rio Chama Near La Puenta Gage

Human activities affecting flows in the Rio Grande system have been documented back to the arrival of Spanish settlers in the late 16th century (Wozniak 1997). Human activities are described in more detail in the Cultural Resources section of this chapter and in Appendix N. Significant changes in the Rio Grande occurred during the past century in response to a combination of human-induced factors (**Figure 3-3**). These alterations to the environment equate to significant changes in land use through time and space. Construction of reservoirs, changes to and expansion of historic irrigation conveyance systems, upland drainage networks, and bank stabilization have all served to modify the flow regime of the Rio Grande and associated groundwater recharge dynamics (Reclamation 1997; Scurlock 1998; Wozniak 1997). Many of these alterations have resulted in the general tendency for extending runoff hydrographs, reducing peak-flow runoff events, limiting dry-channel vegetative colonization (*i.e.*, new channel formation), and limiting lateral channel migration; resulting in a persistent and additive transition away from a more natural avulsive disturbance regime. These characteristics now dominate the nature and behavior of the Rio Grande.

Reservoirs along the Rio Chama and Rio Grande are operated by several agencies serving a variety of purposes, including flood control, sediment detention, and storage of native and imported water. Based on the available flow records, the average annual flow volume was higher during the past four decades than it was during the earlier periods due to a combination of higher than average precipitation during parts of the period and imported flows from the SJC Project.



Notes: cfs = cubic feet per second; LFCC = Low Flow Conveyance Channel; MRGCD = Middle Rio Grande Conservancy District

Figure 3-3. Timeline of Human Activities Since 1880 That Have Affected the Rio Grande

The eight major dams listed in Figure 3-3 affect flows in the river by storing and releasing water in a manner that generally decreases the flood peaks and alters the timing of the annual hydrograph, but they do not necessarily cause significant changes in the annual flow volume. The SJC Project, which imports flows into the basin, began operating in late 1971, thereby increasing flow in the system downstream from Heron Reservoir. The volume of imported San-Juan Chama water passing the Otowi gage has averaged about 54,000 acre-feet per year (AFY) since SJC Project inception (RGCC 2003).

The hydrologic characteristics of each reach have been characterized primarily based on flow records collected during the past century. These records provide a means of quantifying the most significant changes that occurred as a result of upstream flow regulation and storage, imported flows, cycles of drought and above average precipitation, and changes in land use. The following natural and human-caused hydrologic characteristics are particularly important to the existing geomorphology of each reach:

- Flows during the spring snowmelt season in April, May, and June typically make up more than half of the total annual runoff in the system. On an average annual basis, the total runoff volume was higher during the past four decades than it was in the earlier recorded period due to a combination of imported flows and higher than average precipitation during portions of that period.
- Flows associated with frequently occurring floods in the 1.5- to 10-year range are generally believed to have the most significant influence on channel form (Wolman and Gerson 1978). The morphologic characteristics of rivers in arid environments such as the Rio Grande are also strongly affected by larger, less frequent floods that create a disturbance regime that effectively “resets the clock” by altering the characteristics that develop during the intervening lower flow periods (Graf 1988). In spite of the increase in total runoff, both the average annual maximum mean daily flow (AAMMDF) (which is used to represent the mean annual flood peak) and the

infrequent, large magnitude peak discharges have decreased in all reaches downstream from Cochiti Dam, presumably due to the presence of upstream dams.

The river and adjacent environs respond to cycles of drought and above average precipitation that occur over periods of several years through a variety of mechanisms, including increases in riparian vegetation, channel narrowing during drought periods, and channel widening through bank erosion and migration during wet periods. Generally, these processes vary widely over both time and space and represent a fundamental organizing force throughout the river system. Over the passage of time, different flow regimes (both high and low) have shaped the riparian plant community by means of deposition and scour; however, widespread and large-scale human alterations in the last century have muted this pattern and disrupted the natural disturbance regime (Crawford 1993; Reclamation 1997; Scurlock 1998; Wozniak 1995). The estimated native flows at Otowi gage over 60 years are shown on **Figure 3-4**. Channel widening is limited on the Rio Chama and Rio Grande by installed bank stabilization structures and by vegetation that becomes established within the channel margins (Reclamation 2004a).

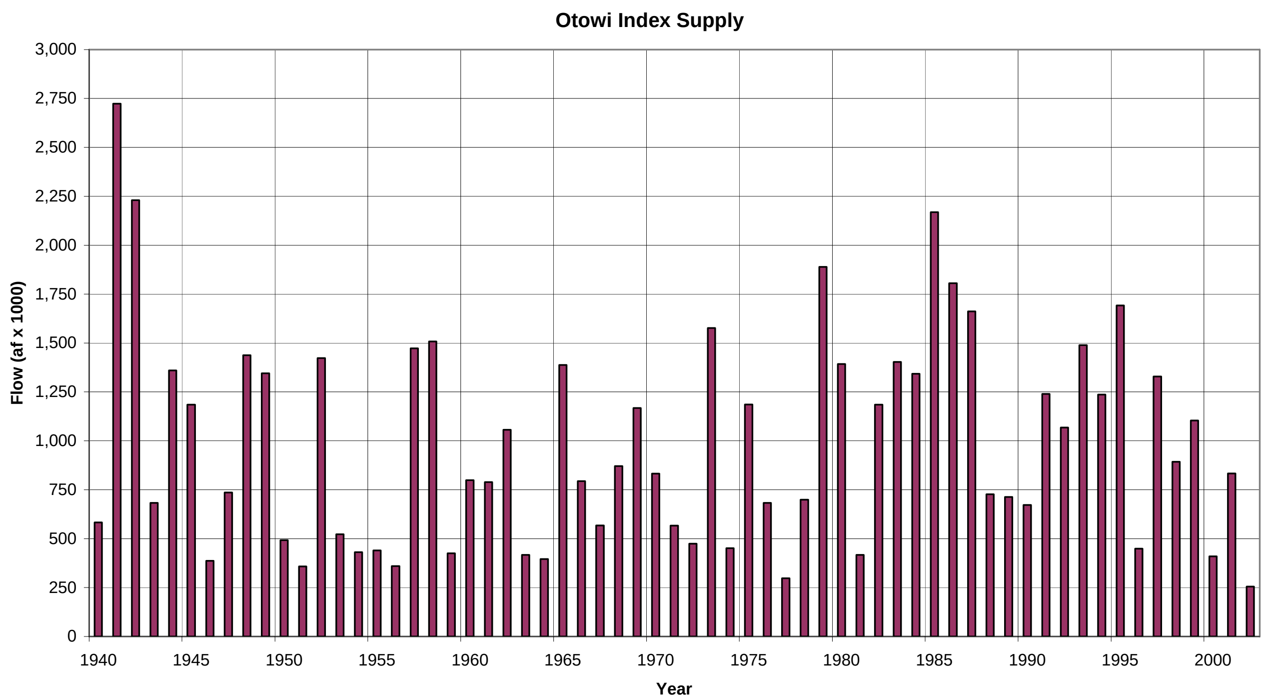


Figure 3-4. Historic Native Flows at Otowi Gage

To illustrate these flow changes, gages along the system were selected for comparison (**Figure 3-5)**. The two gages at San Acacia were combined into a single record to represent flows in the Rio Grande channel at that location before and after construction of the LFCC that began operation in late 1958.

Estimated native flows of the Rio Grande at Otowi Bridge and of the Rio Chama near Chamita gages both averaged about 20 percent higher during the period from 1972 to 2001 than during the earlier period of comparison between 1943 and 1971. This indicates that a significant part of the difference in flows throughout the system between the two periods is related to climatic conditions, in addition to the effects of the imported flows.

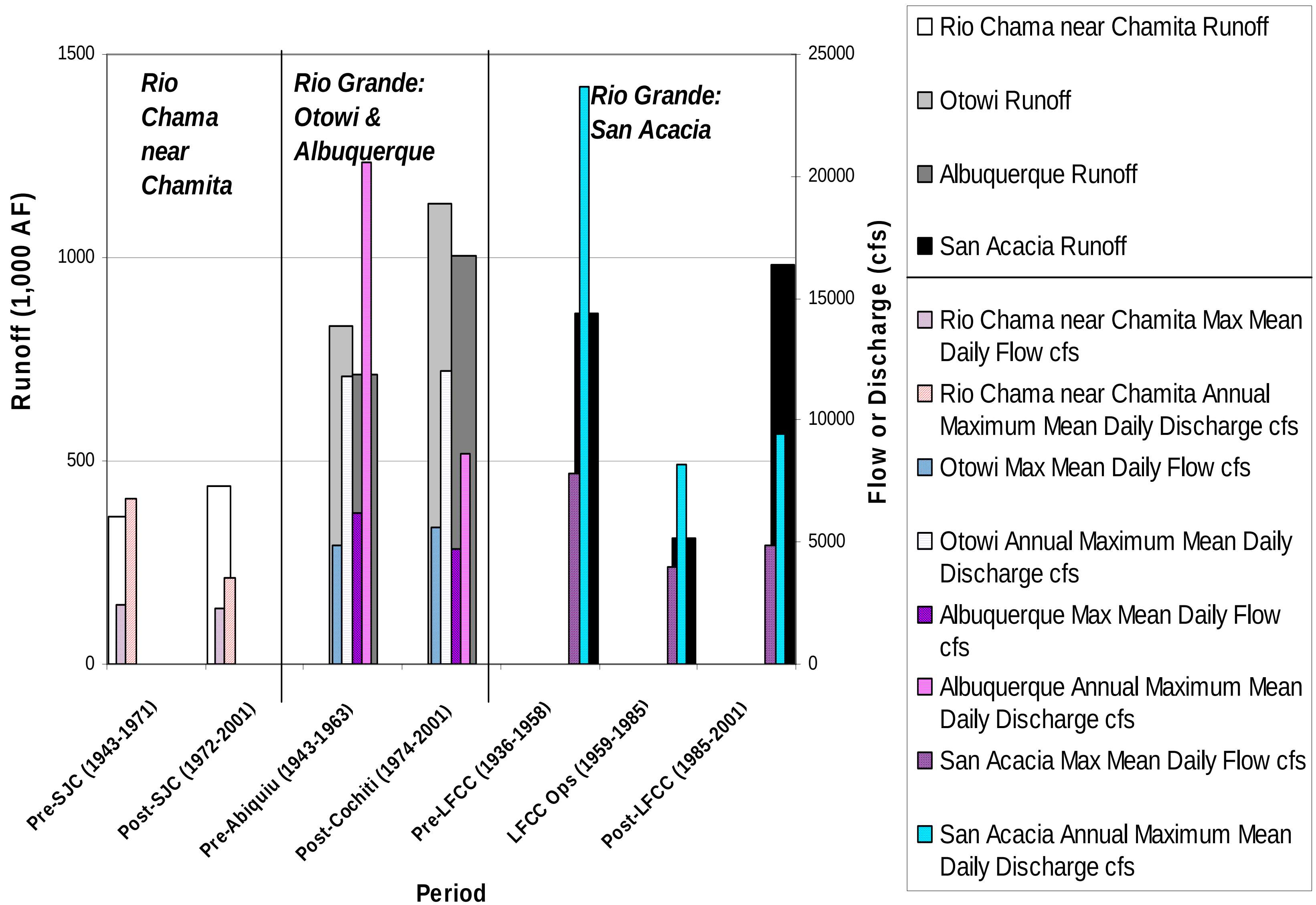


Figure 3-5. Runoff and Mean Daily Discharge from Selected Gages print in color

Flows at the San Acacia gage have been primarily affected by operations of the LFCC that diverted an average of about 193,000 AFY between 1959 and 1985. In early 1985, diversions into the LFCC were discontinued, and essentially all of the upstream flows have passed into the downstream river channel since that time. Although the annual flow volume increased between the pre- and post-LFCC operations periods, the annual maximum flows decreased significantly in the portions of the sections downstream from Cochiti Dam. The decrease in annual maximum flow is believed to be related to operation of Cochiti Dam and other upstream dams.

Comparison of annual flood flows at San Acacia is confounded by operation of the LFCC between 1958 and 1984 and changes in Rio Puerco flows discussed previously. Compared to the 23-year period of record from 1936 to 1958 (prior to completion of the LFCC), the average annual maximum mean daily flow decreased during the period of LFCC operation (1959 through 1984). It then increased in 1985 after diversions to the LFCC were discontinued, though not to its original pre-LFCC levels. The maximum daily flow reflects this same trend.

The URGWOM Planning Model was developed to simulate the Rio Grande river system and its reservoirs. A 40-year planning horizon was chosen and a 40-year sequence of synthetic inflow hydrographs (see Figure 2-1) and initial reservoir storage volumes were developed to assist in evaluating the effects of the No Action Alternative and identified Action Alternatives. The pool of data available to support the modeling was restricted to the 25-year period from 1975 to 1999, which was wetter than the long-term average. A 40-year sequence of years was, therefore, derived from the available data using statistical sampling techniques, the Palmer Drought Severity Index, and the Otowi Index Supply to create a synthetic inflow hydrograph that would be representative of broader climatic conditions over the past 300 years (Appendix I). The resulting flow sequence has 5 average flow years followed by sequential blocks with flows representative of 7 drought years, 15 average years, 8 wet years, and 5 average years. The average annual flow volume at the Otowi gage for the 40-year synthetic sequence is about 934,000 acre-feet (AF), which is about 18 percent less than the average Otowi Index Supply between 1975 and 1999 of about 1.15 million AF.

In summary, the flood regime has decreased as a result of upstream control and regulation. The net effect of the hydrologic changes is a less dynamic river because the energy that drives channel change is primarily associated with the flood regime.

3.2.2 Geomorphology

The geomorphic characteristics of rivers represent the integration of physical factors present within the basin and drainage network. The existing reach-specific characteristics of the Rio Grande and Rio Chama vary significantly due to a range of natural and human-caused factors whose effects have varied temporally and spatially. These factors can be broadly grouped into three categories:

- Hydrology, which encompasses precipitation and the range, duration, and magnitude of flows (as provided in Section 3.2.1);
- Sediment supply and transport, which encompasses the characteristics of the upstream and tributary sediment supply, and the bed-material characteristics along the reach, and directly affects the vertical and lateral stability of the river including the planform; and
- Local controls that include bedrock outcrop, older terraces, and other erosion-resistant material, as well as structures and channelization.

Each of these three categories includes a natural component governing the overall characteristics of any reach and a human component that has altered those natural characteristics to varying degrees. In a general sense, the channel size and planform characteristics have developed in response to the magnitude and duration of the flows and the sediment supply to each reach over the long term, including the period prior to significant human influence. These general characteristics of each specific reach are modified by local factors, including geology, tributary sediment supply, and local climate, particularly as it affects riparian vegetation, which results in significant variability about the general trend, even in the absence of human activity. Although there is evidence of human activity that could have affected the morphology of the river dating back at least several centuries, the current morphology of the rivers is more strongly influenced by human activities that have occurred in the past century, including changes affecting hydrology and sediment supply, construction of river training and flood protection works, and installation of irrigation diversion structures (Williams and Wolman 1984; Graf 1994). Geomorphic characteristics of reaches in the Rio Chama, Central, and San Acacia Sections are summarized in **Table 3-1**.

Table 3-1. Summary of Geomorphic Characteristics of the Rio Grande Reaches

River Section	Reach	Description	Reach Length (miles)	Typical Median (D_{50}) Bed Material Size (mm)[1,2,3]	Average Gradient (ft/mi)[1,2,3]	Active Channel Width (feet)[1,2,3]	Approximate Post-Cochiti Dam 2-year Flood Peak (cfs)[3]
Rio Chama	7	Abiquiu Dam to confluence with Rio Grande	32	30–75	14	75-120	1,800
	8	Rio Grande/Rio Chama Confluence to Otowi Gage	14	20–50	9	370	6,160
	9	Otowi Gage to Cochiti Dam	—	—	—	—	6,160
Central	10	Cochiti Dam to Bernalillo (NM 44 Bridge)	27	10–20	5	320	4,640
	11	Jemez Canyon Dam to Rio Grande Confluence	—	—	31	—	664
	12	Bernalillo to Isleta Diversion Dam	34	<1–3	5	420	5,610
	13	Isleta Diversion Dam to Rio Puerco confluence	42	<1–2	4	510	5,710
San Acacia	14	Rio Puerco confluence to Elephant Butte Reservoir	66	<1	4	455	4,590

Notes: [1] Corps 1996a,b
[2] Reclamation 2001
[3] Appendix H
cfs = cubic feet per second
ft/mi = feet per mile
mm = millimeters

The current channel morphology is also affected by changes in distribution of annual precipitation over periods of a few to several years. Streamflow trends (Waltemeyer 1987) parallel the long-term precipitation/drought trends discussed in Section 3.2.1. The rivers responded to these trends through a range of adjustments. Changes in channel width of the Rio Grande parallel these trends (Massong et al.

2002; Reclamation 2004a), but causality is confounded by the extensive channelization and flow regulation that occurred during the same time period.

3.2.3 Sediment Supply and Transport

Historically, the Central and San Acacia Sections had one of the highest sediment loads of any river in the world, with measured sediment concentrations as high as 200,000 parts per million (ppm) (Baird 1998). The suspended sediment concentrations in the San Acacia and San Marcial floodways include sediment delivered by the Rio Salado and Rio Puerco. During the past half-century, sediment concentrations have fallen significantly, primarily as a result of reduced sediment supply due to upstream dam construction. Analyses of the available data (MEI 2002) show significant decreases in suspended sediment concentrations throughout the Rio Grande (**Figure 3-6**).

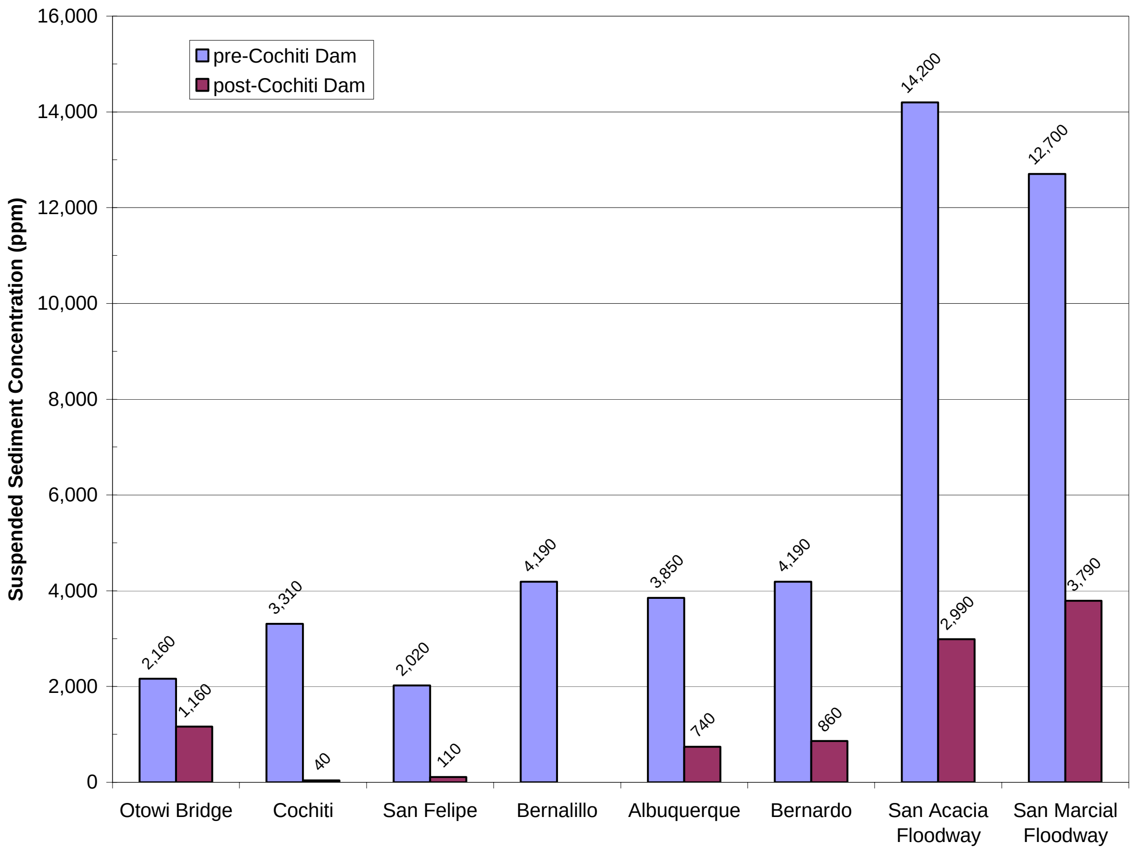


Figure 3-6. Average Annual Suspended Sediment Concentrations in the Middle of the Project Area during the Pre- and Post-Cochiti Dam Period (Appendix H)

Although the dams have undoubtedly affected downstream sediment loads, other factors are also involved, including changes in land use that decrease overland erosion rates; increases riparian vegetation and bank stabilization that decrease lateral erosion; and a general decrease in erosive energy associated with reductions in the magnitude of flood flows. Existing bed-material characteristics are the result of the combined effects of local geology, base flows, tributary sediment supply, hydrologic impacts of reservoir operations, dam-related reductions in downstream sediment supply, channel morphology, and hydraulics.

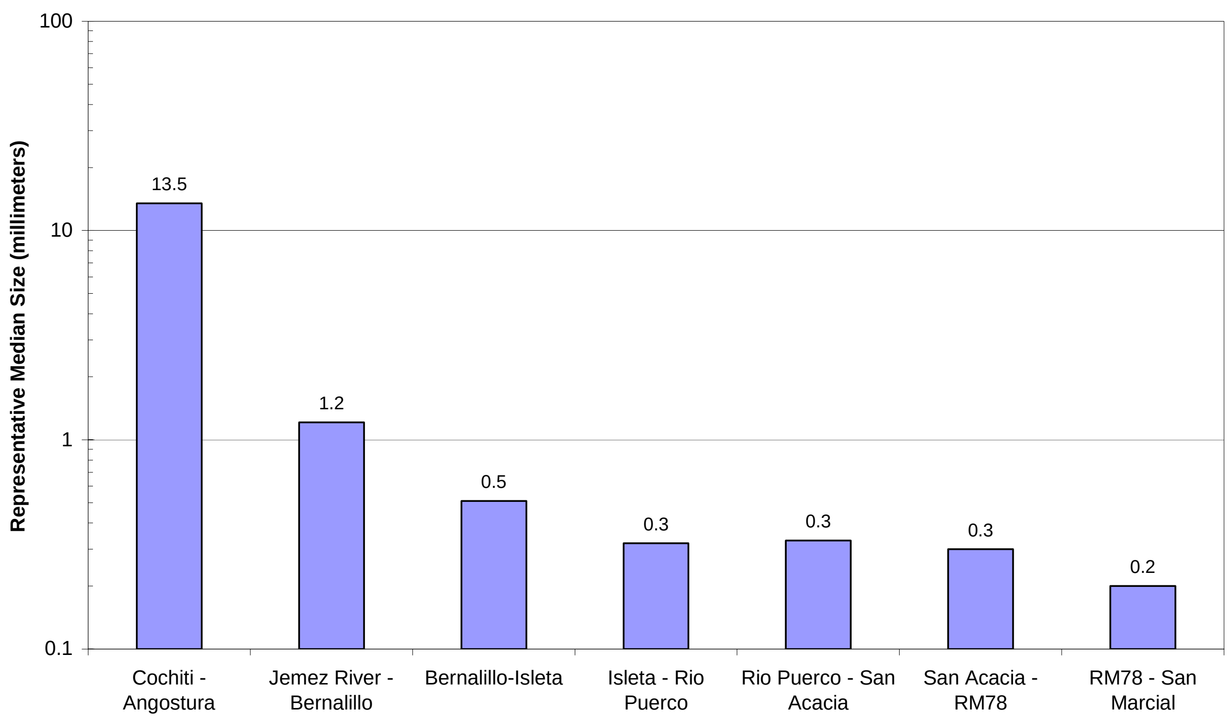
Rio Chama Section

The Rio Chama downstream from Abiquiu Dam (Reach 7) is primarily a single-thread, gravel-bed channel, in which the dominant bed-material grain size is 30–75-millimeters (mm) with increasing amounts of sand in the downstream direction (Corps 1996b). The sediment supply at the upstream end of this reach was effectively eliminated by Abiquiu Dam, which has probably caused the coarsening of the bed material compared to pre-Abiquiu Dam conditions. The portion of the sediment supply derived from bank erosion has also likely decreased over time due to the presence of significant bank protection along this reach. Bank protection slows formation of in-channel habitat.

The bed of the Rio Grande between the confluence with the Rio Chama and the head of Cochiti Lake (Reaches 8 and 9) is also composed predominantly of gravel with median grain sizes of 20–50-mm range. Based on suspended sediment data collected at the Otowi gage, the sediment supply to this reach also appears to have decreased over time (Appendix H).

Central Section

The bed material between Cochiti Dam and Elephant Butte Reservoir (along reaches 10, 12–14) generally becomes increasingly fine-textured in the downstream direction (**Figure 3-7**). However, between Cochiti Lake and Bernalillo (Reach 10), there has been a significant coarsening trend since the completion of Cochiti Dam in 1973 (Lagasse 1994; MEI 2002). Both the coarsening and degradation trends in this reach are typical of the expected response downstream of Cochiti Dam. Downstream from Bernalillo, bed material in the Rio Grande transitions to primarily sand, with typical median grain sizes decreasing from coarse sand between Bernalillo and Isleta Diversion Dam (Reach 12) to medium sand between Isleta and the confluence with the Rio Puerco (Reaches 12 and 13) (MEI 2002).



Based on post-1990 data collected between May 1 and August 31.
Source: MEI 2002

Figure 3-7. Representative Median (D50) Surface Bed-Material Size for Reaches of the Rio Grande Downstream from Cochiti Dam

San Acacia Section

Downstream from the Rio Puerco, the predominant bed-material size is in the fine to medium sand range; however, substantial gravel is also present locally, particularly near the mouth of the Rio Salado and at confluences with the numerous eastside tributaries. The bed material has also coarsened somewhat since the early 1970s in the reach downstream from the San Acacia Diversion Dam, although the median bed-material size remains in the medium sand range throughout most of the reach. Bed-material sizes in other portions of the reach between Isleta Diversion Dam and the head of Elephant Butte Reservoir, as represented by data collected at Bernardo and San Marcial, has remained relatively constant during the post-Cochiti Dam period. Integration of bed-material transport relationships over the post-Cochiti dam average annual hydrograph shows that annual bed material load increases in a downstream direction.

3.2.4 Local Controls and the Integrated Effects on Morphology

A variety of natural and constructed controls affect the morphology and dynamics of the Rio Chama and Rio Grande in the project area. These controls include:

- The bedrock canyon that limits lateral movement in the most upstream portion of the Rio Chama below Abiquiu Dam (Reach 7) and in the Whiterock Canyon section of the Rio Grande (Reach 9);
- Relatively coarse-grained tributary fans that control the river location, width, and gradient at several locations along the Rio Chama and Rio Grande, such as those at Rio Ojo Caliente on the Rio Chama and Arroyo Tonque on the Rio Grande;
- The Belen-Socorro uplift that affects the profile of the Rio Grande in Reaches 13 and 14;
- The presence of erosion-resistant terraces and local bedrock outcrops that limit lateral migration, such as at the Coronado State Monument upstream of Bernalillo (Map 3-1);
- The presence of dams that affect the hydrology and sediment supply for downstream reaches;
- The cycles of drought and above-average precipitation that occur over periods of several years;
- The presence of irrigation diversion structures that provide local base lever controls, interrupt the sediment flux in the river, and divert flows from the river; and
- Riverside drains intercept hundreds of cfs as groundwater between the river and drain system.

The Central and San Acacia Sections of the Rio Grande have been affected by human intervention since at least the 1800s, when water used for irrigation in Colorado’s San Luis Basin reduced the natural flows in the river by 40 to 60 percent (Natural Resources Commission 1938). By 1880, approximately 125,000 acres of land were under cultivation in the valley of the Central and San Acacia Sections, which led to increased water diversion from the river and removal of riparian vegetation (Crawford et al. 1993). Widespread drought, often punctuated by devastating floods, waterlogging, salinization, alkali poisoning of arable lands, and the breakup of many community-based land grants, caused the total area of irrigated lands to sharply decline in these sections to about 45,000 acres by the mid-1920s (Wozniak 1995). The decrease in irrigated lands resulted in a proportional reduction in the amount of water removed from the river for irrigation.

The earliest detailed information available on the geomorphic characteristics of the river was the 1917–1918 survey. However, by the time this survey was conducted, the hydrology and sedimentology of the reach had changed considerably (Berry and Lewis 1997; Scurlock 1998), and there is uncertainty as to whether the form of the river at that time was in equilibrium.

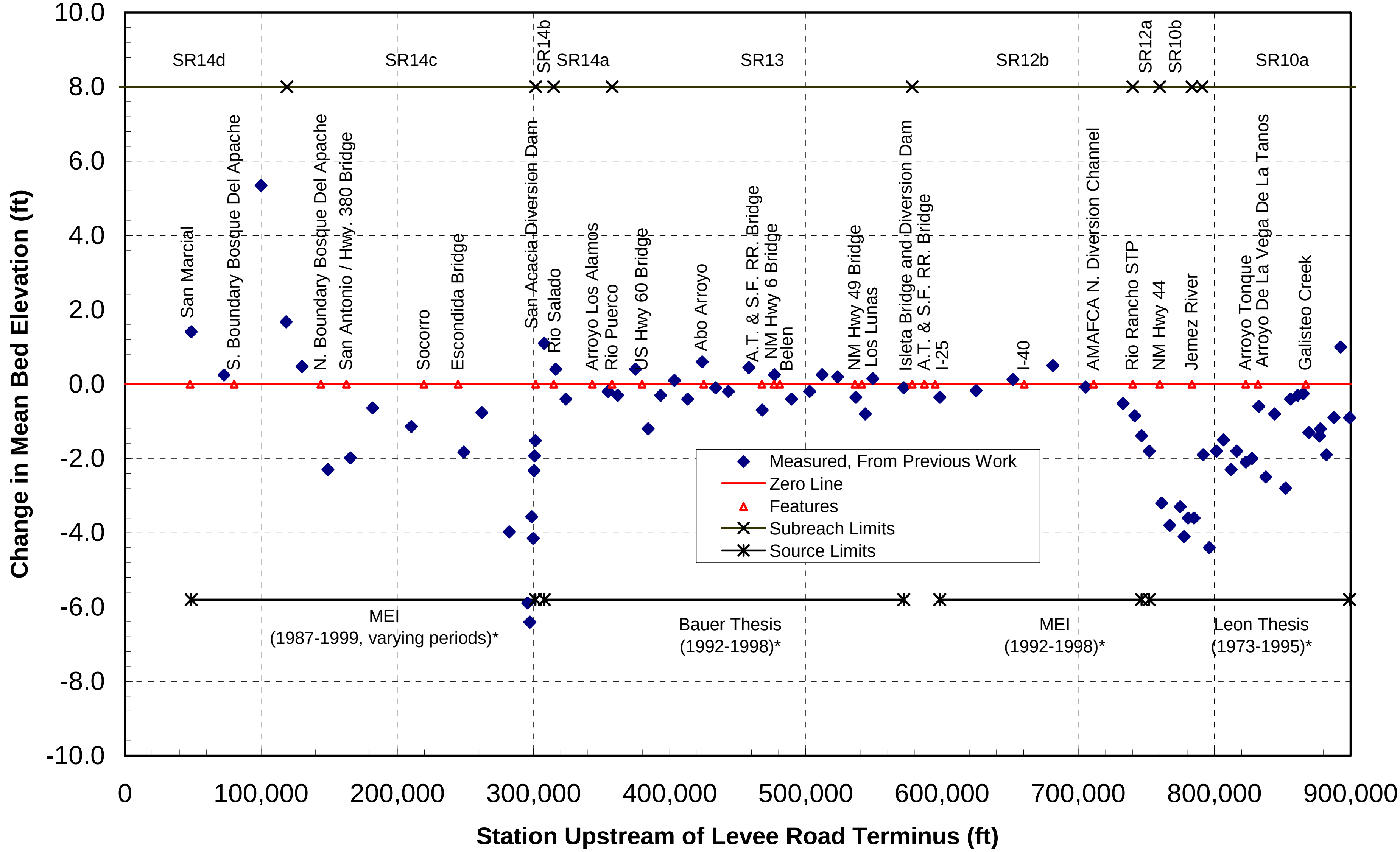
Channel width data developed from the 1917–1918 survey shows a general trend of increasing channel width in the downstream direction to near the southern boundary of the Bosque del Apache National Wildlife Refuge (NWR). A much narrower channel was observed downstream of Bosque del Apache

NWR (MEI 2002; Reclamation 2004a). Extensive channelization of the river occurred during the early and middle parts of the 20th century, and by the early 1960s, a considerable portion of the river had been narrowed and stabilized with jack fields (see Appendix G for authorizations). Although some reaches are continuing to narrow as a result of reductions in peak flows due to drought, upstream flow regulation, channel degradation, and increased amounts of riparian vegetation, average changes in channel width after 1972 are much smaller than the changes observed between 1918 and 1972 (MEI 2002; Reclamation 2004a).

During the recent drought period, a significant amount of vegetation has established on low-elevation bars and floodplain surfaces, further decreasing channel widths and width variability. During previous drought periods, this vegetation has typically been mechanically removed to improve flood conveyance along the reach (Berry and Lewis 1997). The response of the river to future high flows, including the potential for removal of recently established riparian vegetation by the river, is not known.

Since at least the mid-1970s, the Rio Grande has downcut by varying amounts throughout most of the reach between Cochiti Dam (subreach 10a) and the Bosque del Apache NWR (**Figure 3-8**), which is the approximate beginning of deposition that continues downstream to the head of Elephant Butte Reservoir (approximately the lower end of subreach 14d). Refer to Appendix H, Sediment Continuity Analysis, for the background data. Surveyed cross-sections for the period 1992–1998 indicate that the degradation trend has slowed or stopped in the portions of the reach from about Bernalillo downstream to at least San Acacia (subreaches 12a to 14c). The water surface at the Albuquerque gage located at the Central Avenue Bridge lowered by about 2.5 feet between the late 1970s and the late 1980s in response to the low to intermediate ranges of flows.

In response to the combined effects of both natural and human factors, the Rio Chama below Abiquiu Dam and the Rio Grande downstream of Cochiti Dam are less dynamic rivers than they had been historically. The present channel widths are considerably less than they had been historically and, where channel downcutting has occurred, the channels are deeper. Immediately below the dams, bed materials have coarsened. However, bed materials along most of the reaches are composed of sands, with reaches of gravel that affect channel morphology. Changes in hydrology and channel morphology have reduced the frequency of overbank flows in most of the reaches, except where aggradation is occurring downstream of the Bosque del Apache NWR.



Notes: SR = subreach; *Most Recent Period of Data used to Compute Elevation Change; **Using average annual change in bed elevation multiplied by number of years used in measured data.

Figure 3-8. Computed Annual Aggradation/Degradation Volumes for Each Subreach under Existing Conditions (without bed-material Supply from the Jemez River)

3.3 Existing Biological Conditions

3.3.1 Aquatic Habitats

Dams and diversions have altered flow regimes in most river reaches and have reduced sediment load to the river channel. Collectively, these efforts have resulted in a river that is considerably different from how it had been historically (Dudley and Platania 1997). Although these anthropogenic alterations have resulted in improved flood control and modification of river flows for the benefit of humans, the effects on the aquatic system have not been positive. Alterations to aquatic habitat have resulted in changes in species composition and numbers of fish from those historically found in the river (Appendix L). A description of these structures and their effects, as well as other information on the aquatic system, are included in Appendix L.

The major dams and irrigation diversions are physical barriers to natural channel flow in the Rio Grande, barriers that limit movement of fish and drifting insects. Habitat fragmentation in riverine systems is of concern because some fishes rely on river connectivity for survival and reproduction. Areas of poor water quality may further fragment a river, if these areas become unsuitable for fish or invertebrates.

Habitat availability is the main factor in the success or decline of a species (Carlson and Muth 1989). Other driving factors include population genetics, genetic variability, food availability, and predation or competition by native or non-native species. Important habitat elements for survival and reproduction typically include temperature, substrate type, seasonal flow variations, and adequate water quality.

In rivers, the aquatic food base is composed of various algae, aquatic plants, and aquatic invertebrates. Physical features like water velocity, substrate, temperature, and sediment inputs affect these food sources. Impoundments and diversions affect the structure of the aquatic food base (Thorp and Covich 1991).

In reservoirs, the aquatic food base consists of small plants and animals known as phyto- and zooplankton. These important ecosystem components may be affected by water temperature, water quality, and water residence time within a reservoir (Wetzel 1975).

Riverine Habitat and Fish Community

Each reach and its fish community are described in the following sections. The Rio Grande silvery minnow (RGSM) is the only endangered riverine fish within the project area and is addressed in more detail in Section 3.3.3—Threatened, Endangered, and Special Status Species. Appendix L (Biological Resources) lists the reaches and identifies fish species known to occur, including life history information. **Table 3-2** summarizes riverine fish distribution throughout the project area.

Northern Section

Fish species in the Rio Conejos include brown, brook, rainbow, and Rio Grande cutthroat trout. The Conejos River is managed as a put-and-take fishery and stocked with hatchery fish in late spring. Brown and rainbow trout are stocked by the New Mexico Department of Game and Fish (NMDGF) at several places on the Rio Grande west of Taos from the John Dunn Bridge south to the Taos Junction Bridge off State Road 96. Naturally reproducing cutbows (rainbow trout and cutthroat trout hybrids) occupy the Rio Grande Gorge, as do northern pike (MWH 2001). Native and non-native fish species occurring in the Northern Section are summarized in Table 3-2 (MWH 2001).

Rio Chama Section

The fish community of the Rio Chama, the largest tributary of the Rio Grande, may be contrasted from pre- and post-impoundment periods. Prior to the construction of Abiquiu Dam in 1963, the fish community consisted primarily of native main stem minnows including the RGSM, Rio Grande bluntnose shiner, Rio Grande chub, and Rio Grande sucker which reached the northern limit of their ranges in the Rio Chama near Abiquiu (Bestgen and Platania 1990). Since construction of Abiquiu Dam, the community has shifted towards more headwater type fauna (Platania 1996). Introduced brown trout are self-sustaining in the system, and rainbow trout occur but are generally not self-sustaining. Some fishes stocked into Abiquiu Reservoir occasionally escape into the lower reaches of the Rio Chama. Some native minnows, which persisted following dam construction, are generally considered headwater species adapted to cool waters with relatively high velocities. Native and non-native fish species occurring in the Rio Chama Section are summarized in Table 3-2.

Aquatic habitat in the Rio Chama was temporarily altered by short-term construction at Abiquiu Dam affecting sediment load and water quality during the late 1980s and into the 1990s (Corps 2001b). River habitat downstream of Abiquiu Dam represents an altered ecosystem, which includes alteration of the natural hydrologic pattern in terms of flow and temperature, and reduction of suspended sediment. These changes have modified the distribution and abundance of aquatic habitats available to native fish (Dudley and Platania 2001).

Central Section

In a study conducted by Reclamation (PEC 2001), 26 fish species, representing nine families, were collected along the Central Section from 1995 to 1999. Native and non-native fish species occurring in the Central Section are summarized in Table 3-2.

The lower Rio Jemez reach extends from Jemez Canyon Dam to the confluence of the Jemez River with the Rio Grande. The most common species in this reach were common carp, red shiner, fathead minnow, white sucker, and western mosquito fish (Hoagstrom 2000). The study found the RGSM was the tenth most abundant species in the lower Rio Jemez, representing 1.2 percent of all fish collected. The flathead chub has also been found in the Rio Jemez below Jemez Canyon Dam (Dudley and Platania 2000).

Table 3-2. Riverine Fish Distribution in Project Area

Common Name	SECTION					
	Northern	Rio Chama	Central	San Acacia	LFCC	Southern
Native Minnows						
Red shiner	Present	Present	Present	Present	Present	Present
Rio Grande chub	Present	Present	Present	—	Present	—
Rio Grande silvery minnow	—	—	Present	Present	—	—
Golden shiner	—	—	—	—	—	Present
Fathead minnow	Present	Present	Present	Present	Present	Present
Bullhead minnow	—	—	—	—	—	Present
Flathead chub	-Present	Present	Present	Present	Present	—
Longnose dace	Present	Present	Present	Present	Present	Present
Other Native Species						
Gizzard shad	—	—	Present	Present	Present	Present
Threadfin shad	—	—	—	—	—	Present
Mosquitofish	—	Present	Present	Present	Present	Present
Smallmouth buffalo	—	—	Present	Present	—	Present
Bluegill	—	—	Present	Present	Present	Present
River carpsucker	—	Present	Present	Present	Present	Present
Rio Grande sucker	Present	Present	—	—	—	—
Flathead catfish	—	—	Present	Present	—	Present
Longnose gar	—	—	—	—	—	Present
Rio Grande Cutthroat trout	—	—	—	—	—	—
Non-native Species						
Longfin dace	—	—	—	—	—	Present
Black bullhead	—	Present	Present	Present	Present	Present
Yellow bullhead	—	—	Present	Present	Present	Present
Fantail goldfish	—	—	—	—	—	Present
White sucker	Present	Present	Present	Present	Present	—
Common carp	Present	Present	Present	Present	Present	Present
Northern pike	Present	—	—	—	—	—
Plains killifish	—	—	—	—	—	Present
Channel catfish	—	Present	Present	Present	Present	Present

Common Name	SECTION					
	Northern	Rio Chama	Central	San Acacia	LFCC	Southern
Green sunfish	—	Present	Present	Present	Present	Present
Longear sunfish	—	—	Present	Present	Present	Present
Rainwater killifish	—	—	—	—	—	Present
Smallmouth bass	Present	Present	—	Present	—	Present
Spotted bass	—	—	—	—	—	Present
Largemouth bass	—	Present	Present	Present	Present	Present
White bass	—	—	Present	Present	—	Present
Striped bass	—	—	—	Present	—	—
Rainbow trout	Stocked	Stocked	Stocked	Present	Present	Present
Yellow perch	—	Present	Present	Present	Present	Present
Sailfin molly	—	—	—	—	—	Present
White crappie	—	—	Present	Present	—	Present
Black crappie	—	Present	Present	—	—	Present
Brown trout	Stocked	Stocked	Present	—	—	Present
Brook trout	Present	—	—	—	—	—
Grey redhorse	—	—	—	—	—	Present
Walleye	—	—	—	Present	—	Present

Notes:
Stocked = Species is stocked to maintain population size; Present = Self-sustaining population.
— means not present.
LFCC = Low Flow Conveyance Channel
Data summaries from references cited under each section in text.

San Acacia Section

The San Acacia Section contains two parallel channels—the mainstem channel and the LFCC. This section of the Rio Grande contains the greatest abundance of RGSM remaining in the wild. Native and non-native fish species occurring in the San Acacia Section are summarized in Table 3-2.

The mainstem channel is 300 to 600 feet wide and generally less than 3 feet deep. It is a braided, meandering river with a sand substrate that carries a high silt load and has an average velocity of less than 3 feet per second. No major tributaries enter the Rio Grande between the San Acacia diversion dam and the Elephant Butte delta (Dudley and Platania 2000). Habitat characteristics include runs, flats, shorelines, and islands. Debris piles provide low velocity habitat for many fish species including the RGSM. Riverine habitat in this stretch is considered to be more representative of natural conditions than habitats elsewhere in the project area, despite the parallel channel configuration in this section. Numerous factors influence the composition of fish species, including stream channelization, altered river discharge patterns, instream barriers to fish movement, competition from non-native species, water quality degradation, and channel drying (Reclamation 2000a).

The LFCC was constructed to reduce depletion losses for water destined for storage in Elephant Butte Reservoir by diverting water from the Rio Grande into a narrower, deeper, more hydraulically efficient channel (Reclamation 2000a). The LFCC runs parallel to the western side of the Rio Grande from the San

Acacia Diversion Dam to the delta of Elephant Butte Reservoir and is capable of maintaining a flow of 2,000 cfs. When operational water is diverted to the LFCC at San Acacia, but the downstream portion of the LFCC is currently nonfunctional due to high flow destruction in 1988 and sedimentation. The LFCC acts as the principal drain, capturing groundwater seepage and return flow from the Middle Rio Grande Conservancy District (MRGCD) (Reclamation 2000a). Average drainage flow through the LFCC has been between 200 to 300 cfs near San Marcial (Reclamation 2000a).

Southern Section

Six native fish species occur from Elephant Butte Dam to Caballo Reservoir, including gizzard shad, red shiner, river carp sucker, mosquito fish, fathead minnow, and smallmouth buffalo; 22 non-native or uncertain status fish species also occur in this section (Propst et al. 1987).

From Caballo Dam to El Paso, 22 species of fish have been recorded, eight of which are native to the system (FWS 2003a). Native and non-native fish species occurring in the Southern Section are summarized in Table 3-2.

Reservoir Habitat and Fish Community

Each reservoir and its fish community are described in the following sections. Appendix L lists the reservoirs and identifies known fish species, including life history information. **Table 3-3** summarizes reservoir fish distribution throughout the project area.

Platoro Reservoir

The Colorado Division of Wildlife stocks Platoro Reservoir with kokanee salmon, brown trout, and rainbow trout. White suckers are also present in relatively high abundance (Alves 2002).

Heron Reservoir

Heron Reservoir supports a cold-water fishery managed by NMDGF. Sport fish species include rainbow trout, lake trout, and Kokanee salmon. The U.S. Fish and Wildlife Service (FWS) stocks 400,000 rainbow trout in the reservoir in April and another 200,000 trout in August of each year and does not expect natural reproduction to sustain the rainbow trout population. The NMDGF stocks Kokanee salmon in the reservoir, with approximately 475,000 fish stocked each year in January (Ortiz 2001).

El Vado Reservoir

El Vado Reservoir supports a cold-water fishery with several warm-water species. NMDGF annually stocks 220,000 rainbow trout, 100,000 Kokanee salmon in April and 100,000 rainbow trout in October. Rainbow trout in El Vado Reservoir constitute a put-grow-and-take fishery; natural reproduction is not expected to sustain populations (Ortiz 2001).

Table 3-3. Distribution of Fish Species in Reservoirs of the Project Area

Common Name	Platoro	Heron	El Vado	Abiquiu	Cochiti	Elephant Butte	Caballo
Black bullhead	—	—	—	Present	Present	Present	Present
Black crappie	—	—	—	Present	Present	Present	Present
Blue catfish	—	—	—	—	—	Present	Present
Bluegill	—	—	Present	Present	Present	Present	Present
Brown trout	Stocked*	Present	Present	Present	Present	—	—
Bullhead minnow	—	—	—	—	—	Present	—
Channel catfish	—	Present	Present	Present	Present	Present	Present
Common carp	—	Present	Present	Present	Present	Present	Present
Rio Grande cutthroat trout	—	—	—	—	—	—	—
Fathead minnow	—	Present	Present	Present	Present	Present	Present
Flathead catfish	—	—	—	—	—	Present	Present
Flathead chub	—	—	—	Present	Present	—	—
Gizzard shad	—	—	—	—	—	Present	Present
Goldfish	—	Present	Present	Present	Present	Present	—
Green sunfish	—	Present	Present	Present	Present	Present	Present
Kokanee salmon	Stocked*	Stocked*	Stocked*	Stocked*	—	—	—
Lake trout	Present	Present	Present	Present	—	—	—
Largemouth bass	—	—	—	Present	Present	Present	Present
Mosquitofish	—	Present	Present	Present	Present	Present	Present
Northern pike	—	—	—	—	Present	Present	—
Rainbow trout	Stocked*	Stocked*	Stocked*	Stocked*	—	—	—
Red shiner	—	Present	Present	Present	Present	Present	Present
Rio Grande chub	—	Present	Present	Present	Present	—	—
River carpsucker	—	—	—	Present	Present	Present	Present
Smallmouth bass	—	—	Present	Present	Present	Present	Present
Smallmouth buffalo	—	—	—	—	—	Present	Present
Striped bass	—	—	—	—	—	Stocked*	Present
Threadfin shad	—	—	—	—	—	Present	Present
Walleye	—	—	—	Present	Stocked*	Present	Present
White bass	—	—	—	—	Present	Present	Present
White crappie	—	—	Present	Present	Present	Present	Present
White sucker	Present	Present	Present	Present	Present	—	—
Yellow perch	—	—	—	Present	Present	Present	—

Notes:
No sustainable reproduction*
Stocked = Species is stocked to maintain population size; Present = self-sustaining population.
— means not present.
Data summaries from references cited under each section in text.

Abiquiu Reservoir

Abiquiu Reservoir supports a cold-water fishery and a warm-water fishery. Most fish populations other than rainbow trout and walleye in the reservoir are sustained by natural reproduction. Rainbow trout are stocked by the NMDGF in April, October, and November, with 100,000, 290,000, and 100,000 fish stocked, respectively. Approximately 200,000 Kokanee salmon are stocked in April. Walleye are occasionally stocked by the NMDGF in April with approximately 1,000,000 fish (Ortiz 2001).

Cochiti Lake

Cochiti Lake is primarily a warm-water fishery with a limited cold-water fishery. Cold-water fish species include rainbow trout and brown trout. Approximately one million walleye are stocked in April by the NMDGF (Ortiz 2001).

Jemez Canyon Reservoir

Jemez Canyon Reservoir is operated as a dry reservoir specifically for flood control purposes; there is no permanent water in the reservoir and therefore it does not support a sustained fishery. Prior to the change in operations, the species known to occur included largemouth bass, white bass, channel catfish, common carp, green sunfish, white crappie, white sucker, gizzard shad, and small numbers of brown and rainbow trout (Corps 2000).

Elephant Butte Reservoir

Elephant Butte Reservoir is primarily a warm-water fishery with a limited cold-water fishery. NMDGF stocks 300,000 striped bass in the reservoir in early June or July, and the FWS stocks 10,000 fish in June of each year (Ortiz 2001).

Caballo Reservoir

Fish species include striped bass, white bass, white crappie, largemouth bass, walleye, and channel catfish.

3.3.2 Riparian and Wetland Habitats

Riparian areas include the soils, vegetation, and associated wildlife that border waterways, including open sand bars along the main channel. Riparian vegetation comprises much of the upper Rio Grande basin riparian zone and exhibits a diversity of plants and structural types. Forest composition is varied and may include both native tree species and non-native species in different combinations.

Upper Rio Grande Basin Riparian Vegetation Communities

Hydrologic Factors Affecting Riparian Ecosystems

Water operations at the various facilities on the Rio Grande affect the surface and groundwater available to the riparian ecosystem. Periodic overbank flooding is necessary to the health of established native plant communities and literally "…creates the distribution of different communities and age classes" (Scurlock 1998). Regulated flood flows may prevent the overbank floods necessary to scour away existing vegetation and make new seedbeds for cottonwoods and other native trees (Scurlock 1998). Riparian areas that seldom receive overbank flooding show a definite lack of both structural and species diversity. Canopy trees tend to be mature, same-aged stands that are not regenerating. The understory becomes littered with deadfall, a fuel load that inhibits growth of desirable grasses, forbs, and other understory species (**Figure 3-9a**). Restricted flow regimes changed the nature of riparian areas in the Rio Grande, adversely affecting cottonwood and other native plants. Many areas of the Rio Grande floodplain, both inside and outside the levees, contain relic stands of mature cottonwood and willow that have not flooded for several decades. Riparian vegetation that is not regularly flooded is more vulnerable to encroachment by non-native saltcedar and is extremely vulnerable to fire because of the accumulation of debris that occurs with reduced peak flow events (Ellis et al. 1996). The timing, duration, and magnitude of peak flows are critical to habitat creation and maintenance. Peak flow variability contributes to the diversity of vegetation and wildlife. Seasonally flooded riparian zones exhibit both structural and species diversity in the canopy and understory. Banks are scoured and reshaped, forming depressions that support vital wetland areas and associated species (**Figure 3-9b**).

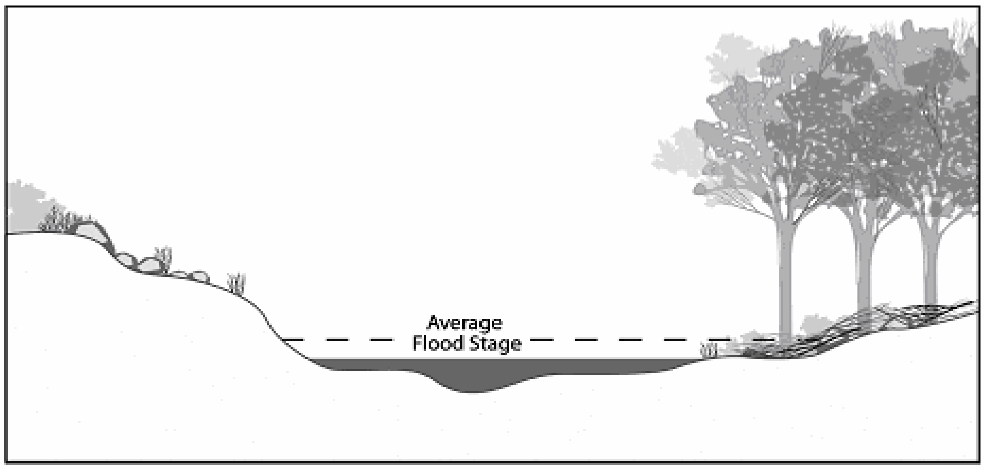


Figure 3-9a. Vegetation Response to No Overbank Flooding

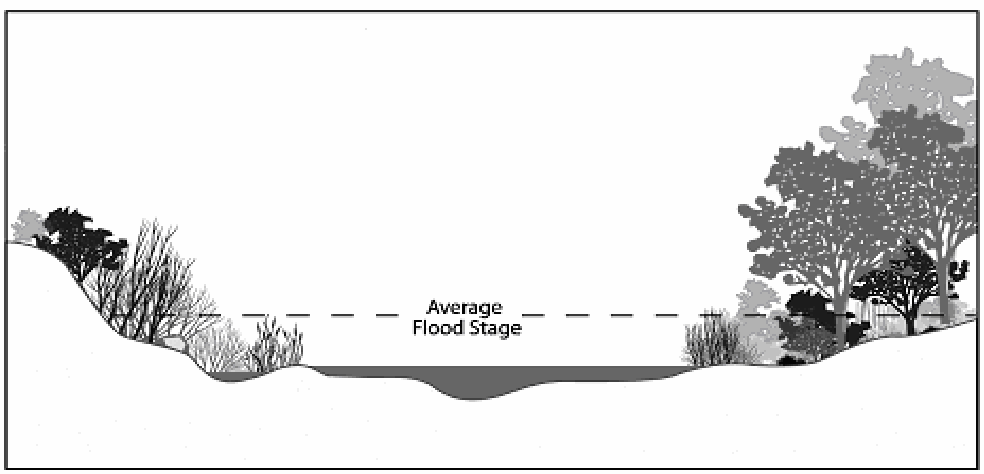


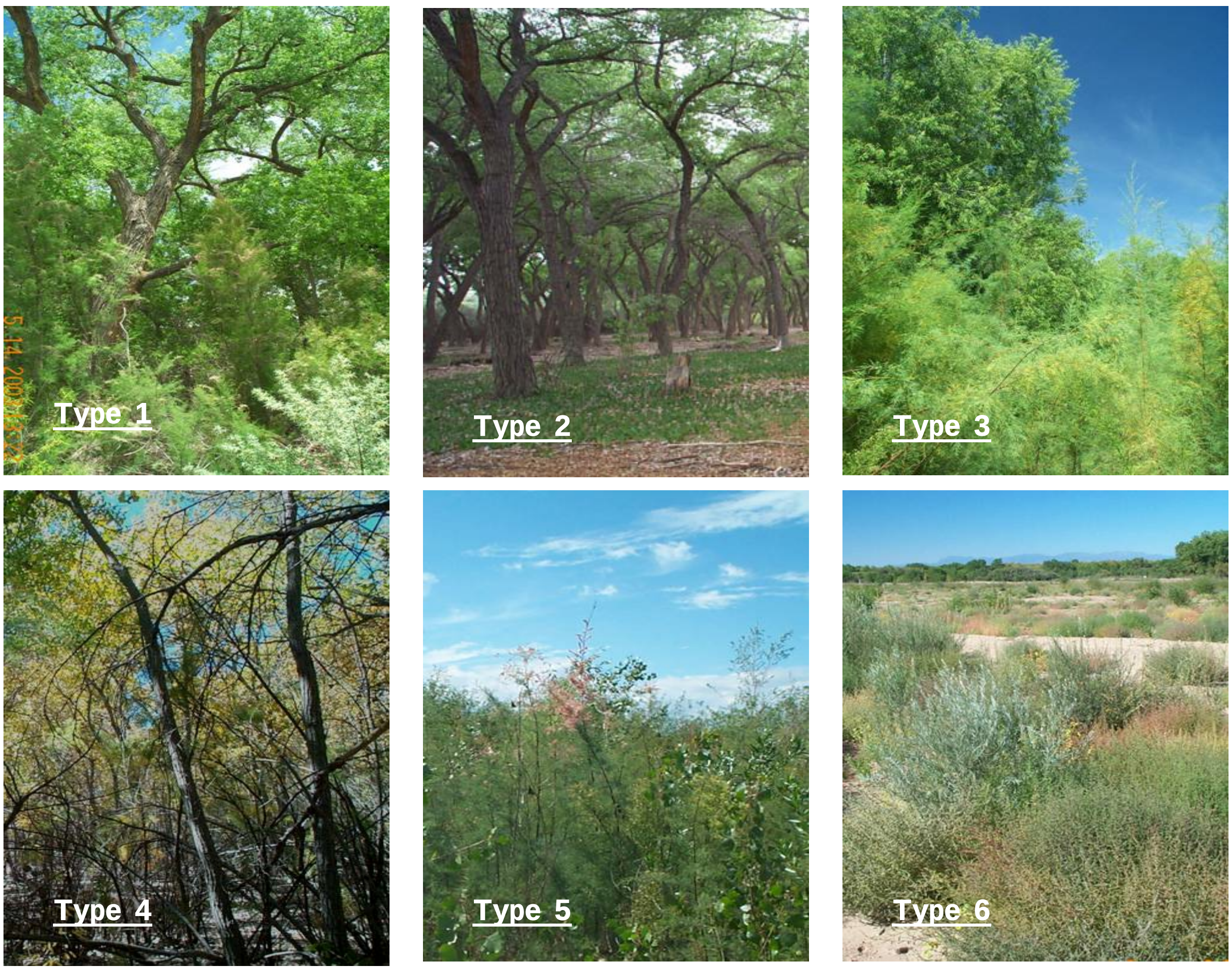
Figure 3-9b. Vegetation Response to Seasonal Overbank Flooding

Figure 3-9. Vegetation Response with and without Flooding in Riparian Zone

Riparian Vegetation Types

Cottonwood riparian forests provide the greatest structural and species diversity along the Rio Grande. The most common forests—called the "bosque"—include forests dominated by cottonwood or Goodding's willow. A bosque contains a variety of understory species such as willow, seepwillow, and New Mexico olive, with some non-native species such as Russian olive and saltcedar. One of the most prevalent species in certain reaches, saltcedar can exclude all other woody vegetation. Although saltcedar stands provide some habitat for wildlife, they inhibit valuable native vegetation and thus are less valuable than a mixed native forest. Open sand bars typically have sparse growths of young cottonwood, coyote willow, and saltcedar as well as perennial grasses, sedges, and forbs.

Riparian vegetation of the Rio Grande was studied using six structural classes of riparian wetland vegetation described by Hink and Ohmart (1984). This classification scheme is described in the Bosque Management Plan (Crawford et al. 1993) and a modified approach is used in this EIS (**Figure 3-10**). Beginning with the lowest biomass category, Type 6 is very young vegetation that may be short (5 feet or under) or sparse. Type 5 classification occurs when plant heights reach 5 to 15 feet, creating young stands with dense shrubby vegetation. The remaining four structural classes constitute further variations in height and density of both canopy and understory species. Type 4 is represented by intermediate-aged trees (20–40 feet), with little or no shrubby vegetation in the understory. Type 3 is represented by intermediate-aged trees with dense, shrubby understory vegetation. Type 2 is represented by mature and mid-aged trees (over 40 feet) with little or no shrubby vegetation in the understory. Type 1 is represented by mature and mid-aged trees with a dense understory of shrubby, mixed-height vegetation.



Type 1: Mature and mid-aged trees with shrubby vegetation at all heights.
Type 2: Mature and mid-aged trees with little or no shrubby vegetation.
Type 3: Intermediate-aged trees with dense, shrubby vegetation.
Type 4: Intermediate-aged trees with little or no shrubby vegetation.
Type 5: Young stands with dense, shrubby vegetation.
Type 6: Very young, low, and/or sparse vegetation.

Figure 3-10. Characteristics of Riparian Forest Vegetation Based on Hink and Ohmart 1984 Classification System

A vegetation survey was undertaken between 2002 and 2004, jointly funded by the Endangered Species Act (ESA) Collaborative Program, New Mexico Interstate Stream Commission (NMISC), and the Corps. The survey used field studies and interpretation of color infrared aerial photography taken in August 2002 to map riparian vegetation between Abiquiu Dam and Elephant Butte Reservoir. Over 50,000 acres were mapped using these methods, of which 30,665 acres were assigned to one of the vegetation categories. The detailed results of the vegetation mapping are included in Appendix L.

To evaluate habitat value, this EIS correlates the mapped Hink and Ohmart vegetation types with the "Resource Types" categorized by the FWS. The FWS developed Resource Community Type designations to assist in making consistent and effective recommendations for the protection and conservation of valuable fish and wildlife resources. Additional detail on the relationship between Hink and Ohmart structural types and FWS Resource Category types can be found in Appendix L, Biological Resources Technical Report.

- *FWS Resource Category Type 1:* Habitat is of high value for evaluation of species and is unique and irreplaceable on a national basis or in the ecoregion. Within the Rio Grande project area, this type represents marshes and other high-value wetlands.
- *FWS Resource Category Type 2:* Habitat is of high quality for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion. On the Rio Grande, Type 2 is found in riparian vegetation dominated by native species in the overstory or understory or both, and most wetlands all fall within this category.
- *FWS Resource Category Type 3:* Habitat is of high to medium value for evaluation species. On the Rio Grande, Type 3 is found in riparian vegetation dominated by mixtures of native and non-native species. The mitigation goal is, "no net loss of habitat value while minimizing loss of in-kind habitat value." Riparian vegetation dominated by mixtures of native and non-native species is considered to be FWS Type 3 vegetation.
- *FWS Resource Category Type 4:* Habitat is of medium to low value for evaluation species. Within the Rio Grande project area, Type 4 is exhibited by monotypic exotic vegetation, sparsely vegetated areas, and disturbed or bare land.

Hydrology strongly influences species composition in riparian systems. Changes in surface water hydrology may affect both structure and composition of riparian communities.

Marshes and emergent wetlands require the greatest hydrologic support, primarily from groundwater. Most marshes are indirectly dependent on surface flows in the river and nearby unlined drains and channels to keep groundwater levels at or near the ground surface elevation all year (Cowardin et al. 1979; Corps 1987a).

Willow-dominated communities require frequent surface saturation and shallow groundwater. These include low stature (H&O Type 5) coyote willow communities, intermediate height (H&O Type 3) communities with coyote willow or Gooding's willow in the understory, or mature (H&O Type 1) tree willow communities. These communities thrive on lengthy periods of saturation, 5- to 10-foot depth to groundwater, and low frequency and duration of droughts (Crawford et al. 1993; Stromberg and Patten 1991; Stromberg, Patten, and Richter 1991).

Cottonwood-dominated communities require spring overbank flooding every few years for natural seedling establishment and early success (Crawford et al. 1993). Cottonwood forests are tolerant of inundation during the growing season. Unlike willows, however, they do not survive year-round saturation (Kozlowski 2002). Once established, cottonwoods can maintain themselves through maturity in areas with infrequent surface inundation if they have reliable groundwater at 6 to 16 feet depth (Crawford et al. 1993; Graf and Andrew 1993; Stromberg and Patten 1991a). Most of the existing mature cottonwood gallery forests in the Central Section, both Hink and Ohmart Types 1 and 2, have not received overbank flooding in decades and are not regenerating as a result (Crawford et al. 1993).

Saltcedar generally reaches heights of 20 to 40 feet and does not form an overstory in structural Hink and Ohmart Types 1 or 2, although it may be present in the understory. Riparian forests dominated by saltcedar tend to be of Hink and Ohmart Types 3, 4 or 5, depending on age, and may become monotypic stands as shade and accumulating debris and salt prevent other species from establishing in the understory. Dense stands of saltcedar usually have deeper water tables (15 to 30 feet below the surface) than will support native cottonwoods (Horton 1977). Saltcedar communities are able to tolerate infrequent overbank flooding and longer periods of drought, as a result. Greater detail on riparian vegetation communities and hydrologic factors affecting them can be found in Appendix L.

Riparian Vegetation Communities in the Rio Grande Floodplain

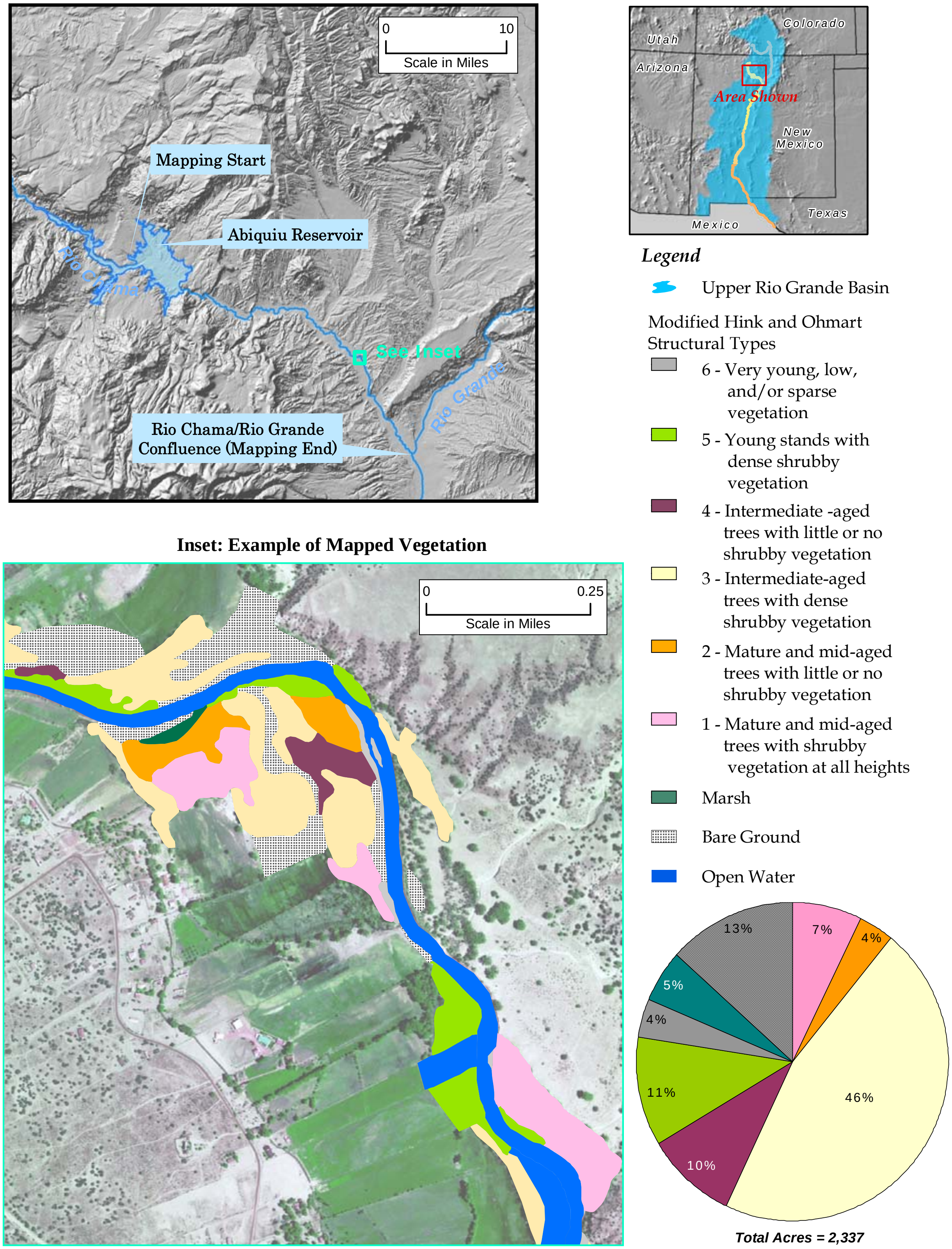
Northern Section

From the south boundary of Alamosa NWR in southern Colorado downstream to La Sauses, Colorado, the floodplain supports scattered stands of willow, narrowleaf cottonwood, and oxbow wetlands. In the Rio Grande gorge in northern New Mexico, riparian vegetation is limited to isolated stands that are restricted by the steep cliffs and deeply incised, narrow floodplain. Downstream of the gorge, the floodplain opens and species such as saltcedar, coyote willow, and box elder, with a few small isolated stands of cottonwood, are present in New Mexico. Cottonwoods become more common near Embudo and cottonwood bosque is well developed near Velarde. The Northern Section is not influenced by operations at any of the facilities under consideration for change in this EIS. Therefore, detailed vegetation mapping was not conducted for the Northern Section.

Rio Chama Section

The Rio Chama Section is characterized by a steep gradient and steep canyon walls, with a narrow floodplain in most areas. The riparian areas between Abiquiu Dam and the confluence of the Rio Chama and Rio Grande were mapped in 2002–2003 (Appendix L). The unmapped upper portion of the Rio Chama, from Heron Reservoir to the delta of Abiquiu Reservoir, has a narrow riparian zone with patchy stands of willow and saltcedar. The occasional intermediate-to-mature cottonwood canopy has an understory of Russian olive and New Mexico olive.

Areas upstream of the pool of Abiquiu Reservoir are considered unlikely to be affected by changes in water operations. Only the portions of the Rio Chama Section downstream from Abiquiu Dam were mapped to classify vegetation, primarily through photo-interpretation. The majority (2,337 acres) of the vegetation mapped in this section (3,073 acres) is within Reach 7 that extends from Abiquiu Dam to the confluence with the Rio Grande. Approximately 14 percent of the mapped riparian vegetation is composed of mature and mid-aged cottonwood forest, while over half of the mapped vegetation consists of intermediate and young stands of native trees with dense shrubby understory vegetation (Hink and Ohmart Types 3, 4, and 5). These riparian forest areas are interspersed with about 20 percent openings vegetated with grasses, forbs, and 13 percent composed of brushy vegetation between 5 and 15 feet tall. Native species comprise almost 22 percent of the riparian vegetation of the Rio Chama Section, with areas dominated by non-native species like Russian olive and saltcedar accounting for about 60 percent. Representative riparian vegetation mapped in this section is summarized on **Map 3-2.**



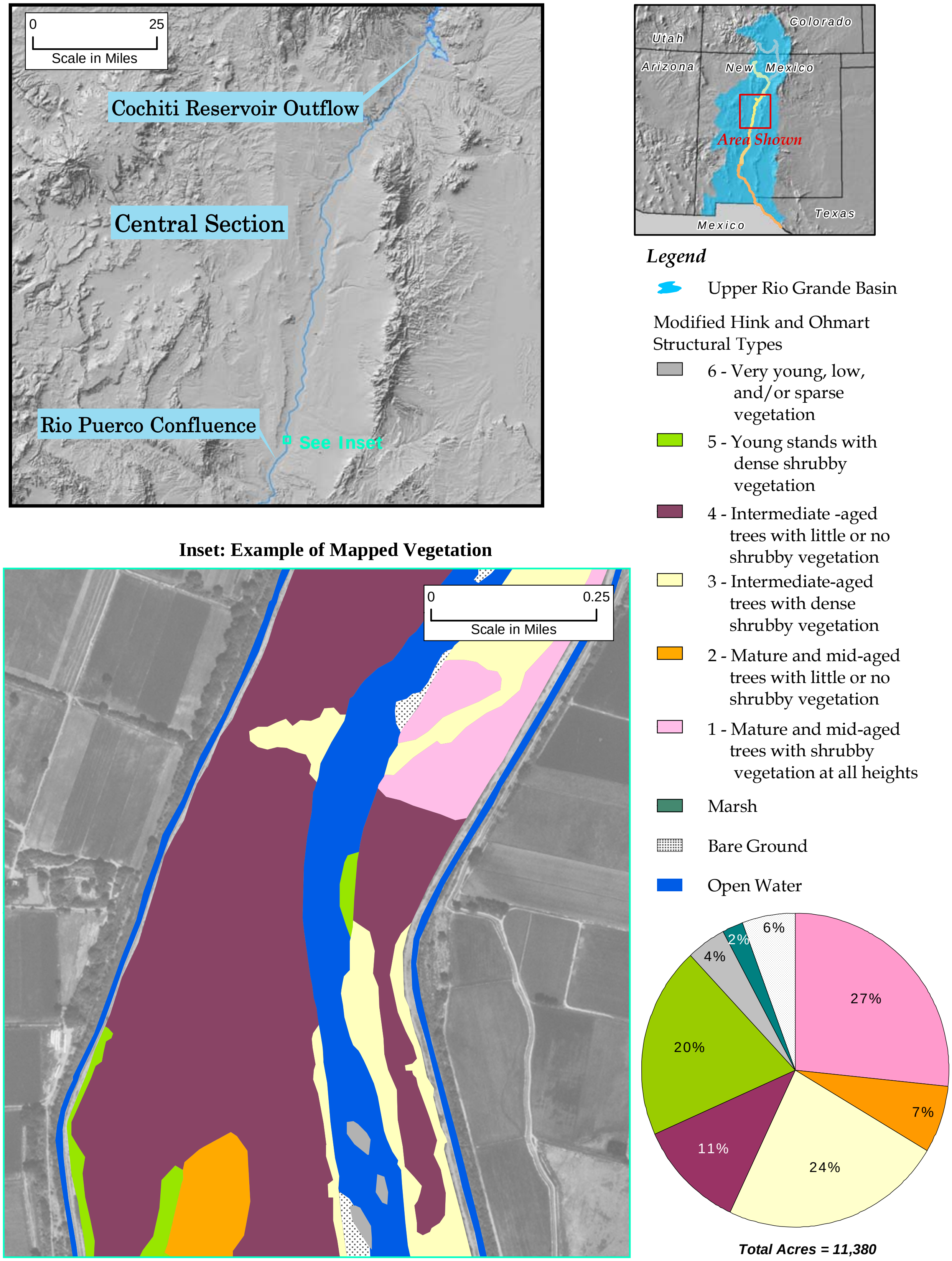
Map 3-2. A Sampling of Current Riparian Vegetation in Reach 7 of the Rio Chama Section

Central Section

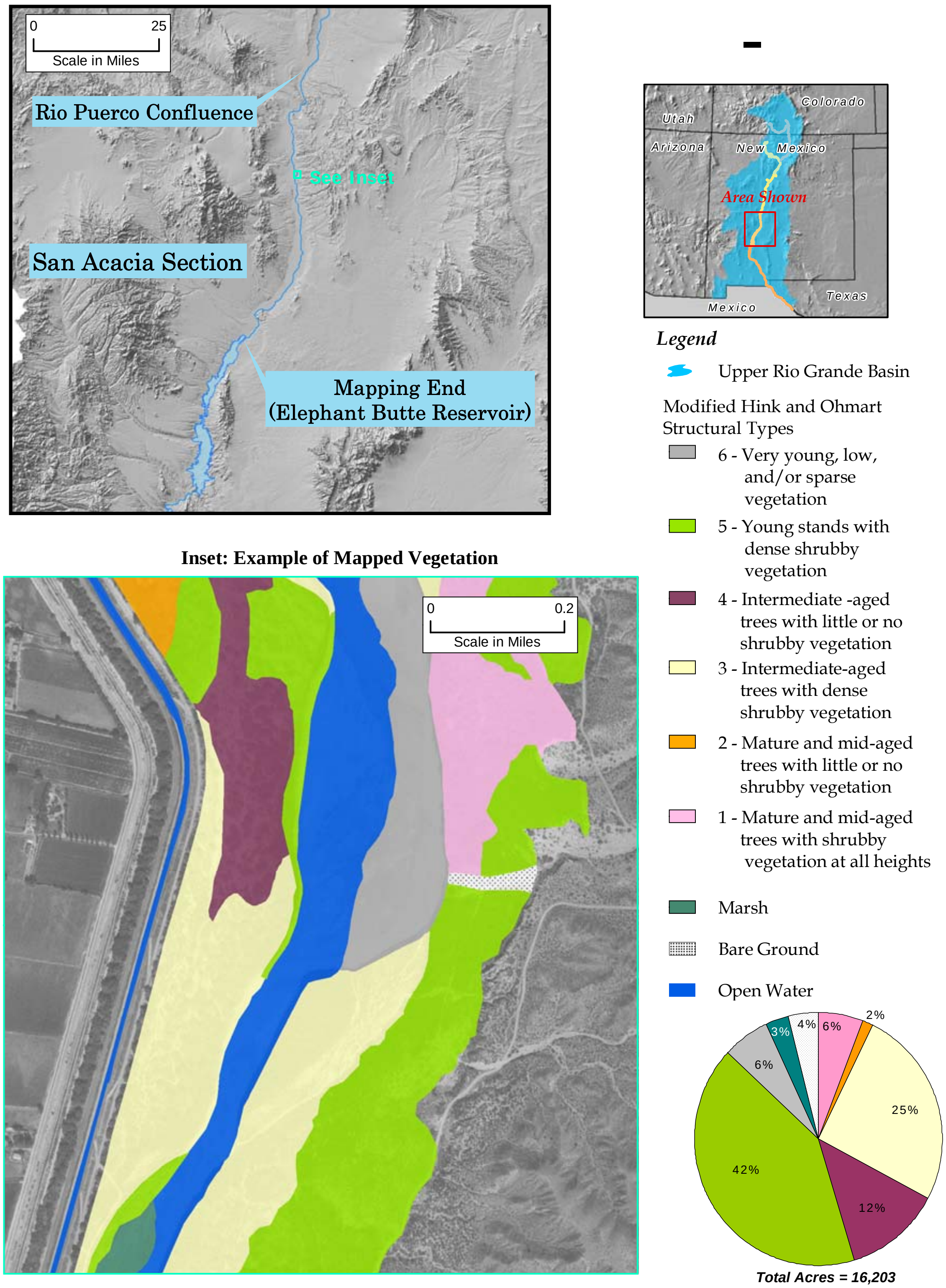
The Central Section contains the largest vegetative component of mature riparian forest in the study area. Of the 11,380 acres of vegetation mapped in the Central Section, 34 percent is composed of mature cottonwood gallery forest with a high canopy. Most of the bosque in the Central Section has a dense shrubby understory, although almost 7 percent of the riparian area is composed of cottonwood gallery forest with little or no understory vegetation. An additional 35 percent of the total vegetation consists of intermediate-sized riparian forests, often with dense understory and very high biomass. Young stands of trees, with or without shrubby undergrowth, make up 20 percent of the mapped vegetation, and approximately 10 percent consists of bare ground or sparse vegetative cover. An estimated 66 percent of the Central Section mapped vegetation is dominated by non-native species, primarily Russian olive, Siberian elm, and saltcedar, with approximately 28 percent native species, some with small amounts of invasive plants included but not dominant. Representative riparian vegetation mapped in this section is shown on **Map 3-3.**

San Acacia Section

The San Acacia Section contains 16,203 acres of riparian vegetation mapped within the levees, the largest area of riparian vegetation mapped in the project area. Only 7 percent of the riparian vegetation in the section is composed of mature or mid-aged cottonwood gallery forest, mostly in the area downstream from San Marcial. Over 80 percent of the riparian vegetation is composed of intermediate and young stands of woody vegetation, most with dense shrubby undergrowth categorized as Hink and Ohmart Types 3 and 5. The San Acacia Section contains the highest proportion of non-native vegetation in the three sections mapped. Approximately 80 percent is dominated by saltcedar and other non-native species, which have limited value as riparian habitat. Other communities are highly valuable as habitats, such as the 460 acres of marsh within the section. Representative riparian vegetation mapped in this section is summarized on **Map 3-4.**



Map 3-3. A Sampling of Current Riparian Vegetation in the Central Section



Map 3-4. A Sampling of Current Riparian Vegetation in the San Acacia Section

Southern Section

The Southern Section was not included in the 2002–2003 vegetation survey because potential operational changes are not likely to affect areas south of Elephant Butte Reservoir. Below Elephant Butte Reservoir, the channel is confined and flows are regulated, resulting in decreased vegetation density and diversity. Occasional patches of saltcedar and willow occur where seasonal tributaries enter the floodplain. Shoreline vegetation along Caballo Reservoir is primarily saltcedar shrubland with mesquite in some areas. The floodplain below Caballo Reservoir includes some riparian forest, riparian grassland, and riverbank shrub-scrub, but primarily saltcedar shrubland (Reclamation 2004b). Vegetation surrounding the American Dam is park-like with a few scattered cottonwoods and native grasses. The river corridor below American Dam is predominantly grassland except for a narrow band of saltcedar shrubland along the river shore (USIBWC 2004).

Vegetation Changes in the Central Section

The 1982 Hink and Ohmart vegetation surveys covered most of the Central Section, specifically from Bernalillo Bridge on Highway 550 to the Jarales Bridge, approximately 8 miles south of Belen (Hink and Ohmart 1984). That vegetation survey and mapping occurred seven years after initial operations at Cochiti Lake. The 2002-2003 survey conducted for the Water Operations Review and EIS covered the same geographic area and used similar methods. Data gathered by the two surveys allow a comparison of vegetation composition classes and structural types to identify changes over two decades.

The information, discussed in detail in Appendix L, is summarized by the changes in cover types shown in **Figure 3-11**.

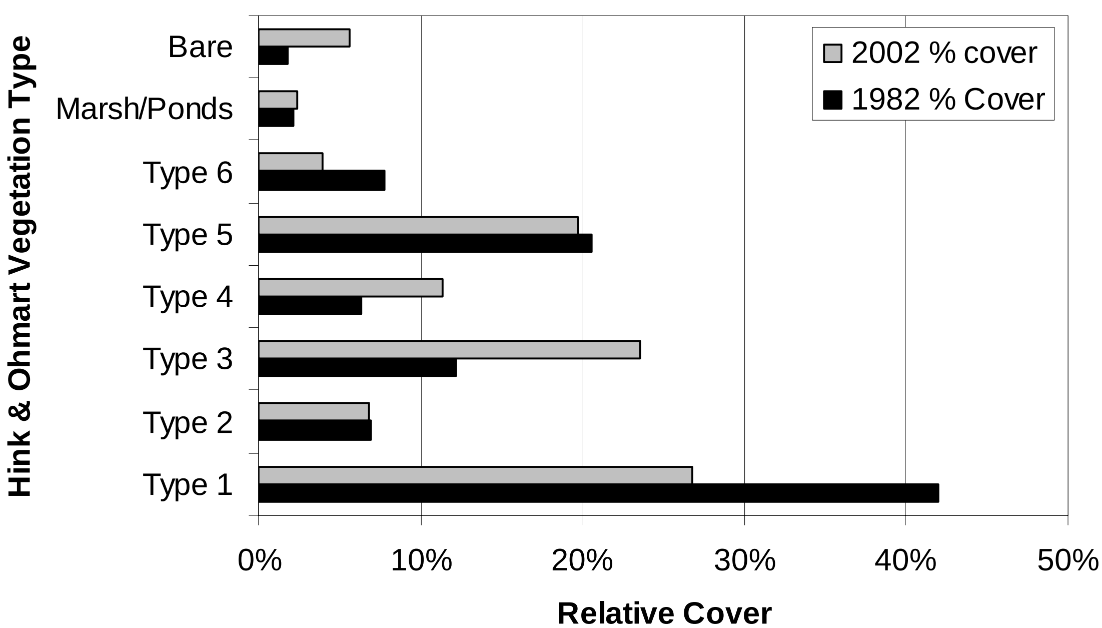


Figure 3-11. Changes in Cover Types (1982 and 2002)

Source: Hink and Ohmart 1984; Reclamation 2004 b, c

Statistical tests of significance were applied to evaluate the observed changes in relative cover of different vegetation types (Appendix L). The data indicate the following vegetation trends:

- The relative amounts of structural Types 1, 2, 5, and 6 declined by 36 percent, 2 percent, 4 percent, and 50 percent, respectively. Loss of native vegetation was particularly significant in each of these vegetation types.

- The relative amounts of structural Types 3 and 4 increased by 92 percent and 80 percent, respectively. Exotic and mixed exotic and native vegetation accounted for the increase observed in structural Type 3. Increases in native riparian vegetation occurred in Type 4, those dense intermediate height trees with little undergrowth that may provide important habitat for riparian songbirds.
- The relative amount of marshes/ponds increased slightly and bare ground/salt grass increased by just over 200 percent. Marshes and ponds support a wide variety of wildlife, but bare ground and salt grass areas do not.

Riparian Wildlife Resources

Wildlife Use of Riparian Zones within the Rio Grande Floodplain

Riparian ecosystems play a vital role in determining wildlife abundance and diversity in arid lands. The Rio Grande floodplain is significant to regional wildlife even though it is less than one percent of the land area of the upper Rio Grande basin (Finch et al. 1995). It also provides a valuable corridor for migratory birds and high-quality habitat for insects, amphibians, reptiles, birds, and mammals (Scurlock 1998).

From north to south in the project area, the riparian zones differ somewhat in wildlife abundance and in common species. There is a disproportionate amount of data available for the Central Section, and less published data available on wildlife use in the Rio Chama Section. Appendix J provides the available data on wildlife use in the different river sections.

Insect Use of the Rio Grande Floodplain

Terrestrial insects influence nutrient cycling and plant productivity and are prey species for both invertebrates and vertebrates (Ellis et al. 2001). A 1994–1997 study (Bess et al. 2002) found 80 species of spiders, beetles, isopods, and crickets on the floor of the bosque. Ellis et al. (2000) found 138 taxa from four sites and reported that a variety of ant species were also found in riparian ecosystems.

Amphibian and Reptile Use of the Rio Grande Floodplain

The distribution of several amphibian and reptile species is closely correlated to riparian vegetation communities. In their studies of wildlife use of Rio Grande riparian communities, Hink and Ohmart (1984) found amphibian and reptile capture rates were highest in areas of mixed cottonwood/coyote willow stands with sparse understory and small openings with little or no woody species (Type 2, 4, 6). Capture rates were lowest in sites with dense understories (Types 1, 3, 5), particularly in marshy, edge, and wooded areas.

Bird Use of the Rio Grande Floodplain

Birds are the most visible and, therefore, the most widely studied wildlife in the Rio Grande floodplain, which is utilized by over 60 percent of the bird species known to occur in New Mexico (Hink and Ohmart 1984). The most common breeding season species are mourning dove, black-chinned hummingbird, downy woodpecker, ash-throated flycatcher, white-breasted nuthatch, spotted towhee, black-headed grosbeak, and blue grosbeak. Common breeding raptors include great horned owl, western screech-owl, Cooper's hawk, and, in burned areas, American kestrel. Two federally listed threatened or endangered species, the bald eagle and the southwestern willow flycatcher, occur in the project area.

Generally, the abundance of breeding birds increases with the complexity and density of vegetation structure, which is thought to be related to the increased food, cover, or nest substrate it provides. Along the Rio Grande, the highest breeding densities typically were found in Type 1 and Type 5, regardless of whether vegetation is native or exotic (Hink and Ohmart 1984; Hoffman 1990; Thompson et al. 1994; Stahlecker and Cox 1996). Sparse understory bosque stands (Type 2) generally support fewer breeding birds, while Types 3 and 4 vary widely in breeding bird use.

The Rio Grande is a major migratory corridor for songbirds (Yong and Finch 2002), waterfowl, and shorebirds. Both the river channel and the drains adjacent to the bosque provide habitat for species such as mallards, wood ducks, great blue herons, snowy egrets, green herons, belted kingfishers, and black phoebes. Agricultural fields and grassy areas with little woody vegetation are important food sources for sparrows and other songbirds during migration and winter.

Mammal Use of the Rio Grande Floodplain

Hink and Ohmart (1984) found small mammal (anything smaller than a rat) capture rates were highest in sites where cottonwood and coyote willow were less than 40 feet tall and there was a relatively dense understory (Type 3). Capture rates were lowest in areas where trees were over 20 feet tall with limited understory vegetation (Type 4).

Large animals can significantly modify the structure and function of river corridors. Raccoons, domestic and feral dogs and cats were the most common large mammals identified. Also observed were porcupines, striped skunks, rock squirrels, pocket gophers, desert cottontails, coyotes, foxes, muskrat, beaver, and, to a lesser extent, bobcats. Mule deer were recorded from Cochiti Dam north, along the Rio Grande and Rio Chama. Domestic livestock are also common in riparian habitats, particularly on private and Pueblo lands. Many tree- and cave-dwelling bats were documented in the riparian areas of the Rio Grande. Populations around Elephant Butte Reservoir are associated with high insect populations. At least eight bat species, including pallid bat and Mexican free-tail bat, occur between San Acacia Diversion Dam and Elephant Butte Dam (Hink and Ohmart 1984).

Wetland Resources

Rio Grande Wetland Function and Types

Wetlands are defined as a transition zone between land and water, an area where the water table is at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). Water saturation determines the nature of soil development and the types of plants and animals living in these habitats. Wetlands exhibit wetter soils and support more plant and animal species than the riparian zone along which they occur. They stabilize streambanks and provide storage areas for floodwaters, thereby protecting downstream areas. Wetlands function as important biological filters to trap sediment and nutrient run-off from surface water and upland environments. In addition, wetlands provide areas of greater biological diversity than the surrounding riparian and upland habitats, and provide breeding sites and wintering areas for numerous wetland-dependent wildlife species. They also serve as migratory stop-over areas for waterfowl and shorebirds.

The naturally vegetated areas within the floodplain of the Rio Grande are primarily composed of forested, shrub/scrub, emergent, palustrine, and lacustrine wetlands, as defined by the FWS (Cowardin et al. 1979). Some pockets of vegetation within the project area may have become disconnected from the active channel over time so that they no longer fit wetland criteria, but nearly all vegetation is dependent on groundwater and surface water for part of the growing season. The baseline vegetation survey using the modified Hink and Ohmart classification system roughly correlates with the Cowardin system of wetland classification in that Hink and Ohmart Types 1, 2, 3, and 4 are forested wetland types, Type 5 is comparable to shrub scrub wetland types; Type 6 and marshes are generally emergent wetlands. Channels, lakes and ponds are largely un-vegetated wetlands. In addition, many areas with riparian vegetation communities described in Section 3.3.2.1 may qualify as jurisdictional wetlands as defined in the 1987 *Corps of Engineers Wetlands Delineation Manual*, if they possess the required characteristics of hydric soils, hydrophytic vegetation, and hydrology (Corps 1987a).

As a result of the large extent of different wetland types within the project area, selected wetland complexes are described in **Table 3-4** with locations shown in **Map-3-5**. These wetland complexes were selected because they may be affected by the proposed changes in water operations. All wetland vegetation in the project area may be affected by the duration of high surface water flows. Flows greater than the 75th percentile contribute to groundwater recharge and the stability of groundwater elevations and may be used as an indicator of inundation frequency of wetlands on islands and in the overbank areas. Low flows in the river channel (less than the 25th percentile) reduce the capability of the river flow to maintain minimum ground water levels in adjacent wetlands.

Table 3-4. Selected Wetland Complexes Along the Rio Grande, with Approximate Acreages of Wetland Types

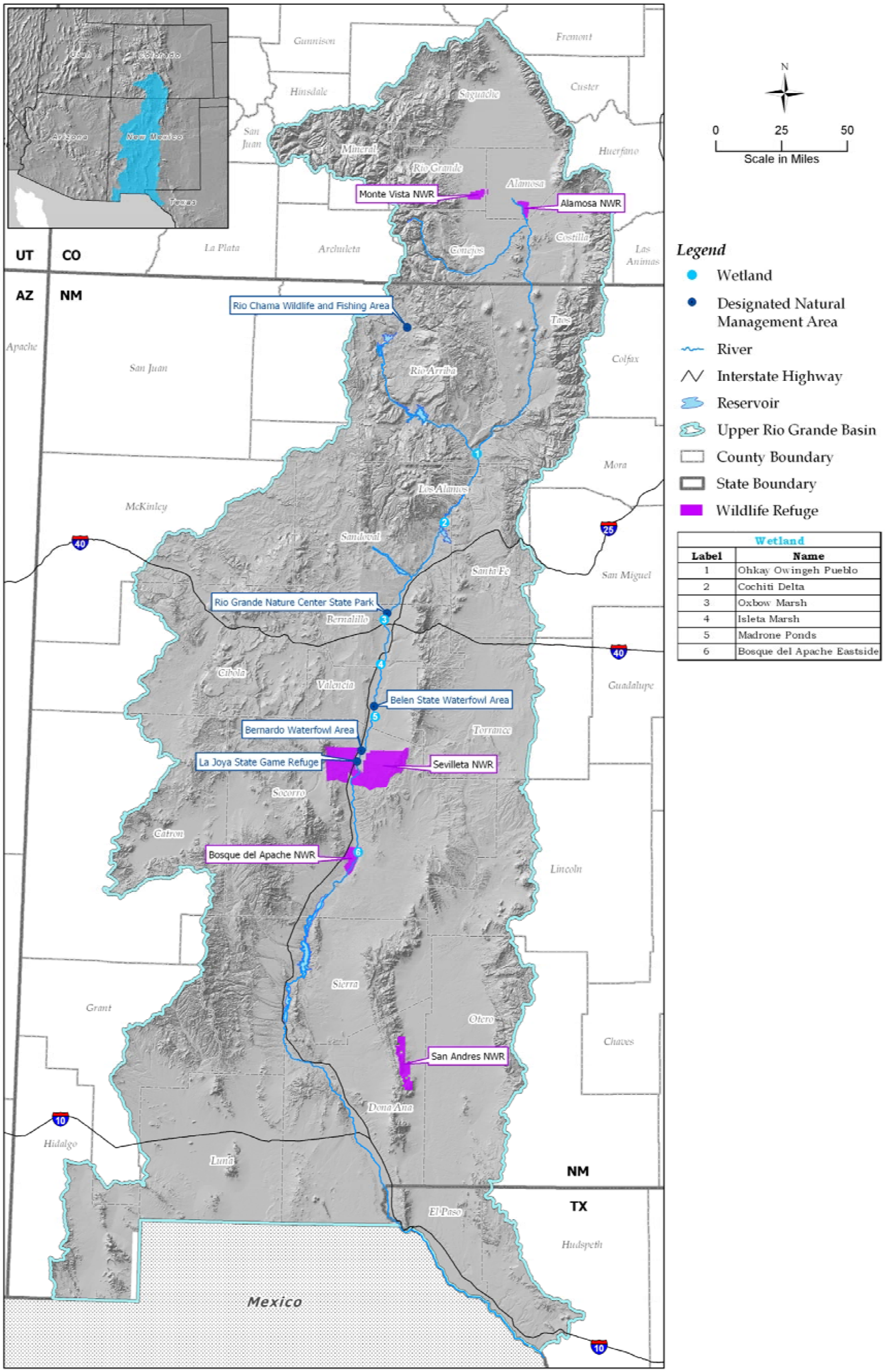
Wetland	Section	Open Water	Emergent Wetland	Shrub Wetland	Forested Wetland	Total
Ohkay OwingehPueblo	Northern	1	32	87	1	121
Cochiti Lake Delta	Rio Chama	245	24	159	—	428
San Antonio Oxbow	Central	7	36	20	2	65
Isleta Marsh	Central	12	225	126	35	398
Madrone Pond	Central	2	35	22	—	59
Bosque del Apache NWR (east bank)	San Acacia	15	141	317	12	485

Source: FWS 2003a

The water regime of these wetlands depends on proximity to the river channel and depth to groundwater. Most islands and point bars are periodically inundated by river flows and support meadow and shrub wetland communities, while side channels frequently support marsh vegetation. Surface water inundation also influences the development of backwater marshes and shrub wetlands, such as the delta of Cochiti Lake.

Most wetlands within the floodway developed in areas with a high groundwater table. Isolated wetlands, or those relatively far from the river, are typically only flooded during high snowmelt runoff, such as the natural wetlands along the east bank of the Rio Grande at Bosque del Apache NWR.

Abandoned channels or depressions deep enough to intersect the regional groundwater table often support the largest wetland complexes along the Rio Grande. River flows during the spring runoff period elevate the regional water table sufficiently to discharge into these wetlands. Those at Isleta Marsh and Madrone Pond are examples of large wetlands primarily influenced by groundwater discharge. Surface water during the spring runoff may also inundate portions of these wetlands, such as those bordering the channel at Ohkay Owingeh Pueblo. Surface water flow from arroyos may also support the wetland water regime, as at the San Antonio Oxbow (**Figure 3-12**).



Wetland	
Label	Name
1	Ohkay Owingeh Pueblo
2	Cochiti Delta
3	Oxbow Marsh
4	Isleta Marsh
5	Madrone Ponds
6	Bosque del Apache Eastside

Map 3-5. Selected Wetlands, Wildlife Refuges, and Designated Natural Management Areas

Figure 3-12. San Antonio Oxbow, Central Section

In addition to the relatively natural wetlands described here, very large and productive wetlands are maintained through intensive management at refuges and other areas outside the levees of the Rio Grande, including wetlands along the LFCC in the San Acacia Section.

Wildlife Refuges and Designated Natural Management Areas

National and State Wildlife Refuges and Designated Natural Management Areas were set aside with biological missions to protect and enhance biological conditions necessary to support numerous wildlife species. These areas in the Rio Grande floodplain, shown in **Table 3-5**, are dependent on surface and groundwater conditions supported by the water operations at facilities under consideration in this EIS. Map 3-5 shows the locations of these areas relative to the project area.

In addition to the lands set aside for wildlife protection and enhancement, there are some areas in which riparian restoration projects are established. These include the Santa Ana Pueblo Rio Grande Restoration Project, the Albuquerque Overbank Project, and the Los Lunas Riparian Project. These projects are described in Appendix L.

Table 3-5. National and State Wildlife Refuges and Designated Natural Management Areas in the Project Area

Name	Section	Size	Description
Alamosa National Wildlife Refuge	Northern	11,169 acres	Natural river bottom wetland, dissected by sloughs and oxbows of the river; wetland and wildlife habitat
Sevilleta National Wildlife Refuge	Central	229,700 acres	Habitats include bosque riparian forests and wetlands; supports four major ecological habitats; managed to maintain the natural processes of flood, fire, and succession that sustain this diverse ecosystem; vital to migrating birds and other wildlife
Bosque del Apache National Wildlife Refuge	San Acacia	57,191 acres	Waters of the Rio Grande have been diverted to create 7,000 acres of wetlands within total acreage of vital wildlife habitat
Rio Chama Wildlife and Fishing Area	Rio Chama	13,000 acres	On the Rio Chama, one of the state's larger and better trout streams (hatchery-stocked rainbow trout)
Rio Grande Nature Center State Park	Central	170 acres	Bosque located within the Central Flyway for migratory birds; wetlands and riparian wildlife habitat
Belen State Waterfowl Area	Central	230 acres	On Rio Grande bottomland; farmed to provide waterfowl feed and resting habitat
Bernardo Waterfowl Area	Central	1,573 acres	Includes 450 acres of crops cultivated to provide winter feed for migratory and upland birds; bird watching and hunting
La Joya State Game Refuge	Central	3,550 acres	Ponds, canals, and ditches in the Central Rio Grande Valley; wildlife and waterfowl protection; bird-watching and seasonal waterfowl hunting

Sources NMSP 2003; NMDGF 2003a,b

3.3.3 Threatened, Endangered, and Special Status Species

Federally Listed Species and Critical Habitat Designations

As shown in **Table 3-6**, of the federally listed species protected under the Endangered Species Act (ESA) of 1973 (16 United States Code [U.S.C.] 1531-1544, as amended), only five have the potential to occur within the planning area. Three of these species have habitat preferences and behaviors that may be affected by changes to water operations on the Rio Grande: Rio Grande silvery minnow, southwestern willow flycatcher, and bald eagle. Candidate species are not included because they are not afforded protection under the ESA.

Table 3-6. Summary Information on Federally Listed Species in the Project Area

Common Name	Federal Status	River Sections/ Reaches	Season and Habitat Preference
Rio Grande silvery minnow	Endangered	Central and San Acacia; Reaches 10–14	Stream margins, side channels, and off-channel pools where water velocities are low or reduced from main-channel velocities
Southwestern willow flycatcher	Endangered	ALL: Alamosa, Colorado to Ft. Quitman, Texas; Reaches 1–17	Breeding habitat consists of large stands of dense willow and cottonwood with seasonal adjacent surface water
Bald eagle	Threatened	ALL: Alamosa, Colorado to Ft. Quitman, Texas; Reaches 1–17	Wintering roosts in large trees near perennial water
Interior least tern	Endangered	San Acacia and Southern; Reaches 14–17	Occasional migrants have been observed at Bosque del Apache NWR
Brown pelican	Endangered	San Acacia and Southern; Reaches 14–17	A rare, non-breeding visitor to portions of the project area

Source: FWS 2005

The endangered interior least tern and brown pelican are occasional or rare migrants within the project area and therefore will not be addressed further. Federal candidate species relevant in the project area include, Gunnison's sage-grouse (*Centrocercus minimus*) and boreal toad (*Bufo boreas boreas*) listed in Colorado; the yellow-billed cuckoo (*Coccyzus americanus*) listed in Colorado, New Mexico, and Texas; and the black-tailed prairie dog (*Cynomys ludovicianus*) listed in New Mexico although it is considered extirpated from the state (NMDGF 2004a).

Rio Grande Silvery Minnow

The RGSM (*Hybognathus amarus*) was formerly one of the most widespread and abundant species in the Rio Grande basin of New Mexico, Texas, and Mexico (Bestgen and Platania 1991). At the time of its listing as endangered, the silvery minnow was restricted to the Central and San Acacia Sections, occurring only from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir, which is only 5 percent of its historic range (Platania 1991). FWS cited several factors responsible for declines in silvery minnow population including: drying of portions of the Rio Grande below Cochiti Dam; construction of mainstem dams; introduction of non-native competition/predator species; and degradation of water quality (FR 1993).

PHOTO: NMDGF

The RGSM was listed as federally endangered under the ESA in July 1994. The species is listed by the State of New Mexico as an endangered species, Group II (NMDGF 2004c). On February 19, 2003, the final rule designated critical habitat along the Rio Grande corridor from New Mexico Highway 22 Bridge (immediately downstream from Cochiti Dam) to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County, New Mexico, a distance of approximately 170 miles. This designation became effective March 31, 2003 (FR 2003). Constituent elements of critical habitat required to sustain the RGSM include stream morphology that supplies sufficient flowing water to provide food and cover needs for all life stages of the species; water quality to prevent water stagnation (elevated temperatures, decreased oxygen, etc.); and water quantity to prevent formation of isolated pools that restrict fish movement, foster increased predation by birds and aquatic predators, and congregate disease-causing pathogens (FWS 1999).

The RGSM is a moderately sized, stout minnow, reaching 3.5 inches in total length. It spawns in the late spring and early summer, coinciding with spring snowmelt flows (Sublette et al. 1990). Spawning also may be triggered by other flow events such as spring and summer thunderstorms. This species spawns by dispersing its eggs into the current that then drift downstream (Platania 1995). As egg development occurs during the drift, which may last as long as a week depending on temperature and flow conditions, the larvae seek quiet waters in eddys and channel margins. Considerable distance could be traversed by the drifting, developing eggs (Sublette et al. 1990; Bestgen and Platania 1991; Platania 1995; Platania and Altenbach 1998). Maturity for this species is reached toward the end of the first year. Most individuals of this species live one year, with only a very small percentage reaching age two. It appears that the adults die after spawning (Sublette et al. 1990; Bestgen and Platania 1991).

Because of upstream channel incision (habitat degradation) and downstream transport of RGSM eggs and larvae, a greater abundance of the species occurs in the San Acacia Section, as documented by fish sampling (Bestgen and Platania 1991; Platania 1993). Based on fish surveys in the late 1990s, over 95 percent of the collected RGSMs occurred downstream of San Acacia Diversion Dam (Dudley and Platania 1999; Smith and Jackson 2000). More recent monitoring surveys found that an increasing number of minnows are being captured above the San Acacia reach (Dudley et al. 2004).

Natural habitat for the RGSM includes stream margins, side channels, and off-channel pools where water velocities are lower than in the main channel. Areas with debris and algal-covered substrates are preferred. The sides of islands and debris piles often serve as good habitat (Sublette et al. 1990; Bestgen and Platania 1991).

Southwestern Willow Flycatcher

The southwestern willow flycatcher (*Empidonax traillii extimus*), or SWFL, is a riparian obligate and nests in riparian thickets associated with streams and other wetlands where dense growth of willow, buttonbush, box elder, Russian olive, saltcedar or other plants are present. Breeding territories occur in dense riparian vegetation, often within 50 meters of water, in stands that were created, or are maintained by, periodic overbank flooding. Along the Rio Grande, nests have been consistently found within 150 feet of surface water, typically river channels, sloughs, backwaters, and beaver ponds. The flycatcher is a late spring/summer breeder that nests in late May through July and fledges young from late June to early August (FR 1995a). The SWFL is federally listed as an endangered subspecies under the ESA.

PHOTO: NMDGF

Table 3-7 provides summary information on the number of known SWFL territories active since 2000 relative to Recovery Unit goals. The distribution of the species is not uniform in the planning area. Territories usually occur in clusters along the riparian corridor within approximately 10 miles of each other. Flycatchers return to these “sites” with great fidelity to establish territories and nests year after year. The size of each territory averages approximately 2.7 acres (FWS 2002a) and surface water hydrology has a strong influence on nest location.

Critical habitat designation for SWFL is effective as of November 18, 2005 (FR 2005) and followed a seven-month public comment period on the proposed rule that ended on May 31, 2005. New Mexico is one of five states included in the potential habitat designation. Lands identified as essential for the species fall within existing Recovery and Management Units.

The 2002–2003 vegetation survey quantified vegetation used by SWFL. Surveys for both vegetation and SWFL show that the species occupies territories and builds nests predominantly in Hink and Ohmart Types 3 and 4 and less frequently in Types 1 and 5 vegetation. No nests were identified in Type 2 vegetation. Native overstory with dense native understory vegetation was the predominant vegetation at nest locations, accounting for 78 percent of all nest locations and territories. A more recent study (Moore and Ahlers 2004) shows that there is a definite preference for willow-dominated habitats.

The structural composition and stem/twig density required by SWFL is developed and sustained by high frequency and duration of flooding. Breeding SWFLs exhibit a strong affinity for moist soils maintained by spring flooding and high groundwater levels in the overbank areas as well as for nearby availability of open water.

Active flycatcher territories are found in several locations in the planning area. Over 158 active territories were identified during intensive surveys in 2002 and 2003 (Moore and Ahlers 2003; Moore and Ahlers 2004; Stone 2003). The Rio Chama Section survey identified only one SWFL territory. Reach 7 contains 2,310 acres of mapped vegetation, of which 333 acres (14 percent) are suitable habitat for SWFL, and 137 acres (6 percent) of the total surveyed vegetation are located within 10 miles of the nearest active flycatcher territory.

The Central Section survey identified 21 active SWFL territories, primarily in Reach 13. The Central Section has 11,710 acres of riparian vegetation. Of that amount, 942 acres (8 percent) of suitable flycatcher habitat are within 10 miles of occupied territories and 1,468 acres (13 percent) are more than 10 miles from existing territories.

Known flycatcher territories in the San Acacia Section are concentrated in areas south of Bosque del Apache NWR, many of which are located within the delta upstream of Elephant Butte Reservoir. A total of 2,247 acres of suitable habitat, 8 percent of the total mapped vegetation, occur in this section. Of the suitable habitat, 1,374 acres (61 percent) occur within 10 miles of occupied territories. Surface water hydrology has a strong influence on nest location. Ninety-seven percent of nests identified in the San Acacia Section from 1999-2003 were located within 164 feet of surface water when the site was first occupied. The average distance from an active nest to surface water was 78 feet.

In New Mexico, the Rio Grande Recovery Unit includes two river segments that lie within the planning area. The proposed Upper Rio Grande Management Unit extends 46 miles from the Taos Junction Bridge (State Route 520) downstream to the Otowi Bridge (State Route 502). The Middle Rio Grande Management Unit extends 129 miles, beginning 4.2 miles north of the intersection of Interstate Highways 25 and 40 downstream to the overhead powerline near Milligan Gulch at the northern end of Elephant Butte State Park (FR 2004). Progress toward meeting recovery goals in the Rio Grande Recovery Unit has been variable, as shown in Table 3-7. The Middle Rio Grande Recovery Unit is the most likely to be affected by changing operations from the Project. This unit has met or exceeded its goals, to date, for recovery of SWFL and maintenance of quality habitat, primarily in the San Acacia Section.

Table 3-7. Known Abundance and Distribution of Southwestern Willow Flycatcher Territories and Habitat in Rio Grande Recovery Units (2002-2004) Recovery Plan Goals (FWS 2002a)

River Section	Rio Grande SWFL Recovery Management Unit	River Reaches with Known Territories	Known Active SWFL Territories	Recovery Goal Territories	Recommended Acres Suitable SWFL Habitat to Meet Recovery Goal	Acres of Suitable SWFL Habitat[1] (% mapped vegetation)	Progress Toward Recovery Goal
Northern Section (Reaches 1,2)	San Luis Valley	1,2	40–65*	50	271	Not mapped	Goal met; availability unknown
Northern Section (Reaches 3,4,8,9)	Upper Rio Grande Unit	4	12**	75	407	172 5% (Reach 4 only)	Goals not met; habitat may be adequate
Rio Chama Section		8	1			137 5% (Reach 7 only)	
Central Section	Middle Rio Grande Unit	13	10**	100	543	942 5%	Goals met; habitat abundant
San Acacia Section		14	149**			1,374 7%	
Southern Section	Lower Rio Grande Unit	16	6*	25	136	Not mapped	Goals not met; habitat availability unknown

[1] All suitable habitat within 50 meters of open water and within 10 miles of occupied sites.
*Moore and Ahlers 2003; **Moore and Ahlers 2004; Stone 2003

Bald Eagle

The FWS reclassified the bald eagle (*Haliaeetus leucocephalus*) from endangered to threatened on July 12, 1995 (FR 1995b). In 1999, the FWS proposed the bald eagle be removed from the list of Threatened and Endangered Wildlife (FR 1999). Wintering bald eagles frequent all major river systems in New Mexico from November through March, including the Rio Grande. Bald eagle prey includes fish, waterfowl, and small mammals. Bald eagles prefer to roost and perch in large trees near water. Suitable perch sites occur within the project area, typically where large cottonwoods occur at the river's edge or in large snags near reservoirs. The main threats to New Mexico's wintering bald eagle population are impacts to their prey base and availability of roost sites.

Special Status State-Listed Species and Other Species of Concern

The states of Colorado, New Mexico, and Texas recognize additional threatened, endangered, or special status species not listed under the ESA. In Appendix L, 136 species are listed, several of which may appear more than once (e.g., threatened in Colorado and as a species of concern in New Mexico). Most of these species were removed from further consideration within this EIS because they: (1) have not been found at all in the project area; (2) are not a riparian/wetland species and therefore not affected by water operations; or (3) are an uncommon migrant that occurs outside the project area. As a result, impact would be negligible to nonexistent. **Table 3-8** shows only those species currently endangered in Colorado, New Mexico, or Texas. Any of these species that are also federally listed are described above in the Federally Listed Species section of this chapter.

Table 3-8. State-Endangered Species Possibly Found in the Project Area

SPECIES	State Status			Standing			
Common / Scientific Name	**CO**	**NM**	**TX**	**1**	**2**	**3**	**4**
PLANTS							
Pecos sunflower (*Helianthus paradoxus Heiser*)	—	E	—	—	□	—	—
FISH							
Rio Grande silvery minnow (*Hybognathus amarus*)	—	E	—	■	—	—	—
AMPHIBIANS and REPTILES							
Western boreal toad (*Bufo boreas boreas*)	—	E	—		—	□	—
BIRDS							
American peregrine falcon (*Falco peregrinus anatum*)	—	T	E	■	—	—	—
Brown pelican (*Pelecanus occidentalis carolinensis*)	—	E	—	—	—	—	□
Common ground dove (*Columbina passerina pallescens*)	—	E	—	—	—	□	—
Interior least tern (*Sterna antillarum athalassos*)	—	E	—	—	—	—	□
Northern aplomado falcon (*Falco femoralis septentrionalis*)	—	E	E	—	—	□	—
Piping plover (*Charadrius melodus circumcinctus*)	—	E	—	—	—	—	□
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	E	E	■	—	—	—
White-tailed ptarmigan (*Lagopus leucurus altipetens*)	—	E	—	—	—	□	—
Whooping crane (*Grus americana*)	E	E	E	—	—	—	□
MAMMALS							
Black-footed ferret (*Mustela nigripes*) ►	E	—	E	—	—	□	—
New Mexico meadow jumping mouse (*Zapus hudsonius luteus*)	—	T	—	■	—	—	—
Botta's pocket gopher (*Thomomys bottae*)	E	—	—	—	□	—	—
Canada lynx (*Lynx canadensis*)	E	—	—	—	—	□	—
Desert bighorn sheep (*Ovis canadensis mexicana*)	—	E	—	—	—	□	—
Gray wolf (*Canis lupus*) ►	—	—	E	—	—	□	—
Wolverine (*Gulo gulo*) ►	E	—	—	—	—	□	—

■ Will be further evaluated because species may receive possible affects
□ Will be removed from further consideration because species is:
- not in project area
- not a riparian/wetland species and therefore not affected by water operations
- an uncommon migrant with distribution outside project area—effects negligible

► Believed to be extirpated from area
E = Endangered; T = Threatened
Source: FWS 2003b; NMDGF 2004a

Rio Grande Silvery Minnow (*Hybognathus amarus*)

See Federally Listed Species section.

American Peregrine Falcon (*Falco peregrinus anatum*)

The peregrine falcon is an FWS Species of Concern and a New Mexico Threatened species. This raptor nests in the canyons upstream of Cochiti Lake and frequently hunts for waterfowl along the Rio Grande corridor. The Santa Fe National Forest identified nest sites within the canyons adjacent to the Rio Grande (NMDGF 2004b).

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

See Federally Listed Species section.

Yellow-billed Cuckoo (*Coccyzus americanus*)

The western population of the yellow-billed cuckoo experienced a severe decline in distribution and abundance throughout the western United States. This is a federally listed candidate species. Candidate species have no formal protection under the ESA, but are considered in this document for planning purposes. This species prefers riparian habitat with dense willow and cottonwood, but non-natives like saltcedar are also used (FR 2001). Nesting territories are located in dense or narrow saltcedar stands or mixed saltcedar/willow habitat.

New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*)

The meadow jumping mouse is an NMDGF Threatened species and is considered a Species of Concern. It requires dense vegetation to persist and typically occupies marshes, moist meadows, and riparian habitats. The species has recently been found occupying constructed habitats such as irrigation drains and canals, and many question whether the species is threatened by habitat destruction. The meadow jumping mouse is found in the Northern, Rio Chama, Central and San Acacia Sections. Reports indicate that the key habitat areas for the species include wetlands in the Española, Rio Cebolla, Isleta Marsh, and Bosque del Apache NWR (NMDGF 2001).

3.3.4 Biodiversity

Biodiversity is defined in several different ways. Ecologists focus on the species level and define species diversity as (1) the quantity of species in any given community (species richness) and (2) the relative abundance of different species (species evenness) within the community (Molles 1999). All plant, insect, and wildlife species have not only adapted to the environmental conditions in which they live, but are also intricately connected to all other living creatures. When environmental conditions change, not only are some species lost altogether, but the established interactions between remaining species are disrupted.

Changes in biodiversity along the Rio Grande have been documented since the turn of the 20th century (e.g., Scurlock 1998). Such changes result from multiple complex factors including physical modifications, water operations, and geomorphic change. Natural events such as drought, violent weather patterns, or disease can cause considerable change at the ecosystem level, affecting biodiversity.

3.4 Water Quality

3.4.1 Regulations Protecting Water Quality

The Clean Water Act (formally titled the Federal Water Pollution Control Act, 33 U.S.C. §1251, as amended) and various state regulations, such as the New Mexico Water Quality Act, require the development of water quality standards to protect public and private interests, wildlife, and the quality of waters. Within the project area there are three states (Colorado, New Mexico, and Texas) and 10 Pueblos (Taos, Ohkay Owingeh, Santa Clara, San Ildefonso, Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta) with distinct jurisdictional boundaries and direct concerns related to water quality in the project area. Within these boundaries, water quality is regulated by standards from each of the three states, the Rio Grande Compact, and four of the Pueblos (Ohkay Owingeh, Santa Clara, Sandia, and

Isleta). The remaining Pueblos have either not developed explicit water quality standards or the U.S. Environmental Protection Agency (EPA) has not yet adopted their standards.

Each set of regulations has numeric, narrative (or general), and antidegradation standards to ensure the quality of water. Numeric standards provide a known threshold with which water quality conditions can be compared and are set for constituents that can be quantified and for which accurate background conditions have been established. Antidegradation standards can be applied to all waters with or without numeric standards. Antidegradation standards were developed to ensure that waters are not degraded beyond their current condition unless otherwise authorized. When water bodies are not in compliance with these standards or numeric or narrative standards have been exceeded, water bodies are subject to enforcement actions under Clean Water Act sections 303(d) and 305(b).

3.4.2 Water Quality Assessment

Applicable state, tribal, and compact standards and jurisdictional boundaries were reviewed within the five river sections. Boundaries of these reaches were set either when a change in water quality regulations or land governance occurred, or when waters entered or left a reservoir. A more detailed discussion of water quality reaches and subreaches, regulatory standards, and agency jurisdiction is provided in Appendix M.

Water quality resource indicators were developed by assessing data availability in the project area and by identifying specific water quality constituents most likely to be affected by reservoir operations. Generally, only constituents with numeric standards were selected as indicators. However, additional constituents were included if it was determined that they posed a specific human health threat, were uniquely influenced by reservoir operations, or were subject to antidegradation standards. The following water quality resource indicators were evaluated: water temperature, dissolved oxygen, suspended sediments/turbidity, total dissolved solids (TDS), pH and arsenic. Dissolved hydrogen sulfide in and downstream from reservoirs was also evaluated.

3.4.3 Trends in Water Quality Conditions

The water quality assessments summarized in Appendix M are based upon a database containing water quality records for the Rio Grande, its tributaries, and mainstem reservoirs that was compiled from sources including U.S. Geological Survey (USGS), EPA, USIBWC, and New Mexico Environment Department (NMED). Data collected after 1975 and subjected to standard quality control practices were utilized. Two reservoirs (Abiquiu Reservoir and Cochiti Lake) and 18 USGS gages were selected for detailed analysis based on data availability at those sites and their locations within the basin. Generally, water temperature, dissolved oxygen, and TDS/conductivity datasets were adequate for analysis. Arsenic, turbidity/suspended sediment, mercury, and hydrogen sulfide datasets were extremely limited with small amounts of data present at a few select gages. The remaining reservoirs and gage locations in the basin were not selected for further evaluation due to the lack of suitable water quality data. See Appendix M for a listing of gage locations by river section, more detailed water quality data, and a description of the methodology used.

Water Temperature

Each of the selected gages has sufficient water temperature data to establish baseline conditions from 1975 to 2003. Overall, temperature increased latitudinally, from north to south, throughout the system (**Figure 3-13**). The highest water temperatures in the system occurred during summer months in the Central, San Acacia, and Southern Sections. Lowest water temperatures were recorded in Northern and Rio Chama Sections during winter months. All sections exhibited highest water temperatures in summer months when air temperatures were highest. Analyses demonstrated that water temperature is highly correlated with air temperatures at most locations in the upper Rio Grande basin.

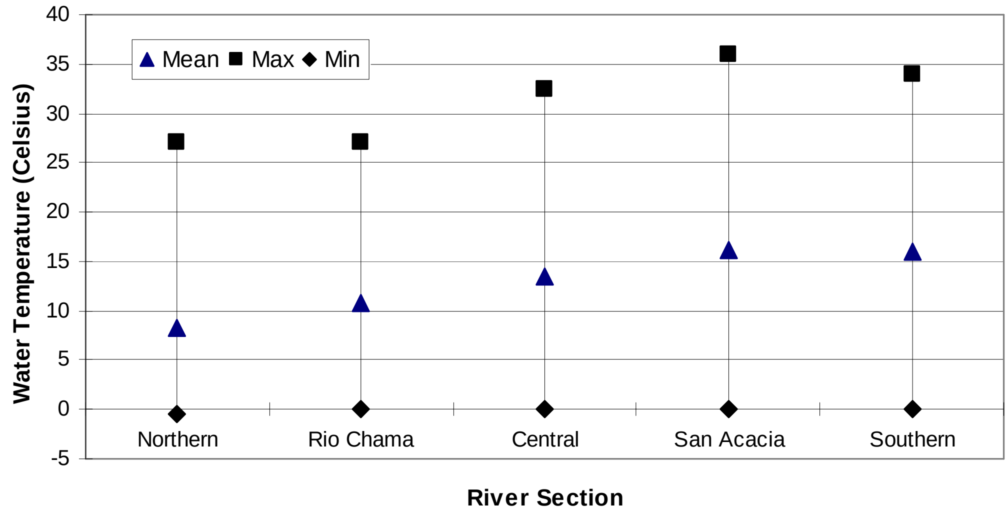


Figure 3-13. Mean, Maximum, and Minimum Water Temperature by River Section (1975-2003)

Slight differences in maximum temperatures were observed below Elephant Butte Reservoir. These data indicate that maximum summer temperatures were approximately 8 degrees Celsius lower below the dam than in the reservoir inflow near San Marcial. However, the average and minimum temperatures were not noticeably different. There was no noticeable difference between water temperatures at inflows and outflows of the remaining reservoirs.

Dissolved Oxygen

Concentration of dissolved oxygen in water is dependent on water temperature and atmospheric pressure. Dissolved oxygen levels are affected by three primary mechanisms: diffusion from surrounding air, oxygen production during photosynthesis, and aeration caused by natural and artificial turbulence processes. All gages, with the exception of the gages immediately above and below Abiquiu Reservoir, had sufficient data to establish baseline conditions. Dissolved oxygen varies greatly by season, with the lowest dissolved oxygen values were directly correlated with higher air and water temperatures. Highest average dissolved oxygen levels were recorded in the Northern Section (**Figure 3-14**).

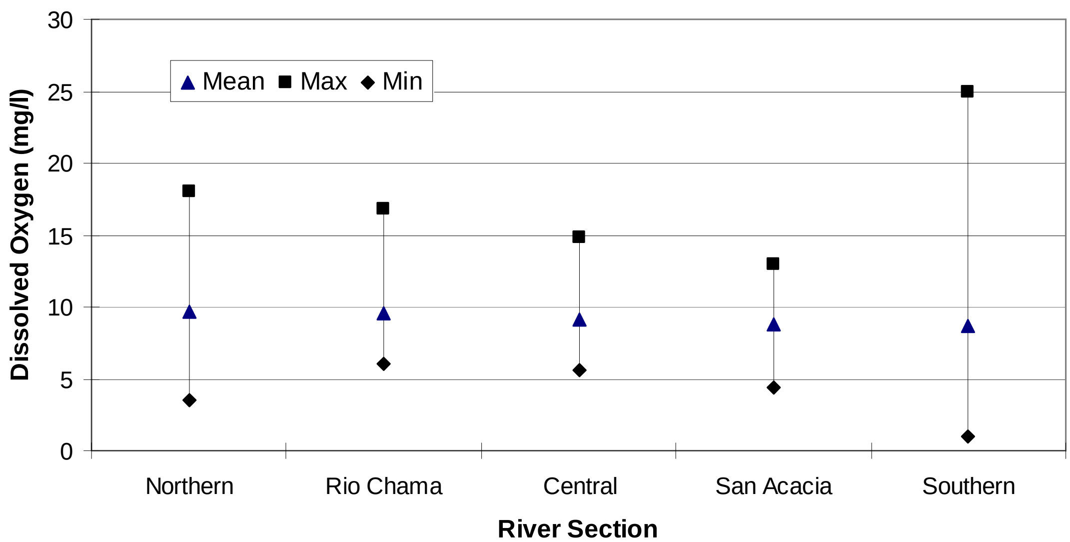


Figure 3-14. Mean, Maximum, and Minimum Dissolved Oxygen by River Section (1975-2003)

Trends in dissolved oxygen concentrations measured at the gage below Elephant Butte Dam were noticeably different from those observed at the other gage locations in the project area. During winter months, the Elephant Butte gage exhibited the highest average dissolved oxygen concentrations in the basin, but had the lowest dissolved oxygen concentrations during summer and fall months. Average dissolved oxygen concentrations during summer months below Elephant Butte Reservoir were more than 50 percent less than those measured at the San Marcial gage during the same period. No other gages had average dissolved oxygen concentrations below 7.2 milligrams per liter (mg/l).

Total Dissolved Solids

TDS are comprised of dissolved organic matter, salts, and minerals and metals originating from both natural and human-caused sources. Human-caused impacts include increased evapotranspiration rates from reservoirs, leaching of agricultural chemicals, and wastewater effluent. Natural sources include mineral dissolution and natural water cycle phenomena such as precipitation and evapotranspiration (Moore and Anderholm 2002).

TDS are highest in the Southern Section and lowest in the Northern Section (**Figure 3-15**). Gages in the Northern and Rio Chama Sections have relatively low TDS (100-300 mg/l). TDS starts to increase in the Central Section, with higher values identified at the Jemez River gage and below the Albuquerque gage. There is a slight seasonal increase at the Bernardo gage but values increase considerably in the San Acacia Section. The greatest TDS concentrations occur during summer and fall months with lowest average TDS values detected during snowmelt runoff.

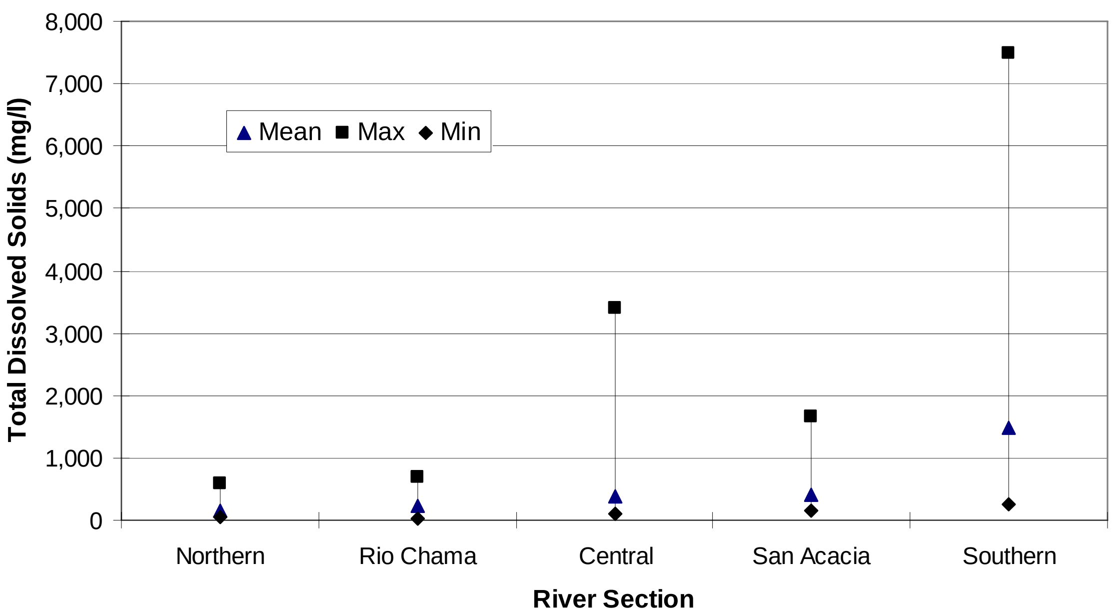


Figure 3-15. Mean, Maximum, and Minimum Total Dissolved Solids by River Section (1975-2003)

pH

Sufficient data exist for establishing baseline conditions for pH at all selected locations with the exception of the Above and Below Abiquiu Reservoir gages. Average pH values did not change between gages in the basin. Average pH for all gages was 8.1 (the minimum was 8.0 at LFCC near San Acacia, the maximum was 8.3 at Leasburg). Very few relationships were evident between pH and other water quality constituents. However, pH was strongly correlated with dissolved oxygen at Elephant Butte. When dissolved oxygen decreased at the Elephant Butte gage, a corresponding decrease in pH (an increase in acidity) was evident.

Turbidity/Suspended Sediments

Turbidity varies by season and latitude throughout the system. The lowest values occurred in the Northern and Rio Chama Sections between November and February; the highest values occurred in the Central and San Acacia Sections during summer months when runoff from storm events can rapidly increase river discharge and increase turbidity and sediment loads.

Reservoirs have an obvious influence on suspended sediment and turbidity levels with noticeable differences observed downstream of Abiquiu, Cochiti, and Elephant Butte Reservoirs. Reservoirs sequester the turbid and suspended sediment rich waters and allow the suspended loads to settle to the reservoir bottom preventing their movement downstream.

Fecal Coliform

Data for fecal coliform loads are limited in the project area. However, the loads follow the same general pattern as is exhibited by turbidity/suspended sediments. Generally, fecal coliform concentrations are highest following natural inflows from summer storm events. These events mobilize fecal material from upland sources and transport them to the rivers. During winter and spring runoff events, fecal coliform concentrations may be limited by low water temperatures. Reservoirs act as a sink for fecal loads with noticeable decreases in the mean values downstream from both Cochiti and Elephant Butte Reservoirs.

Arsenic

Arsenic contamination usually occurs in groundwater rather than in surface water. However, arsenic can be detected in surface water as a result of either natural or human-caused sources. Natural sources of arsenic include minerals that may leach arsenic into surface water and groundwater. Human-caused sources include pesticides, industrial compounds, and fertilizers. Arsenic data were limited throughout the river sections. However, the limited data suggest that arsenic loads remain consistent throughout the year with little seasonal variation. Arsenic concentrations were highest in the Rio Jemez and may contribute to increased arsenic loads downstream in the Central and San Acacia Sections. Arsenic concentrations in the Northern and Rio Chama Sections are lower than those found below Cochiti Lake.

Mercury

Insufficient data exists to establish conditions of mercury in the surface waters within the project area. Most of the mercury in surface water is likely associated with atmospheric deposition or natural background levels. Some human-caused sources of mercury, such as metal processing, medical wastes, or atmospheric deposition related to coal-burning, may also be important in the basin (USGS 2000a).

Hydrogen Sulfide

Very few data were identified for hydrogen sulfide. However, recent studies on Elephant Butte Reservoir (Canavan 1999) indicate that hydrogen sulfide is problematic during summer months when deeper portions of the reservoir become starved for oxygen. Conditions suitable for the generation of hydrogen sulfide may only occur when the reservoir is at relatively high storage levels and mixing does not occur in the lower levels of the water column. Releases of waters with high levels of hydrogen sulfide may contribute to the lower pH levels observed below the dam when dissolved oxygen levels are low. When hydrogen sulfide comes in contact with oxygen in the outlet works of Elephant Butte, it may react with the oxygen and produce low levels of sulfuric acid, causing a corresponding decrease in pH.

Other Water Quality Issues

Many communities located along the Rio Grande discharge their treated wastewater effluent into the river. This effluent is regulated by 40 CFR 122, the Clean Water Act. Although the treatment facilities are located outside the levees, the effluent discharge pipelines are typically located within the floodplain. Flow alterations, defined broadly by the alternatives in this EIS and again in future actions, may affect these outfall structures. Additionally, differences in river discharges under the alternatives in this EIS may increase or decrease the effect of these discharges on overall water quality through dilution or concentration processes. As future actions become defined and proposed, the impacts to these outfall structures and effluent discharge will be carefully evaluated.

3.5 Indian Trust Assets

Indian Trust Assets (ITAs) are defined as legal interests in assets held in trust by the federal government for Indian Tribes or individual tribal members. Examples of ITAs are lands, minerals, water rights, other natural resources, money, or claims. An ITA cannot be sold, leased, or otherwise transferred without the approval of the federal government. For a proposed action, federal agencies, in cooperation with any tribe affected by a project, must inventory and evaluate any assets held in trust. These responsibilities include the following:

- To recognize and fulfill their legal obligation to identify, protect, and conserve the trust resources of federally recognized Indian Tribes and tribal members (the term “Tribes” include Pueblo Indians).
- To consult with pueblos and tribes on a government-to-government basis for plans or actions that could affect tribal trust resources, trust assets, or tribal health and safety.

Native Americans use the Rio Grande for traditional and cultural purposes. Many pueblos and tribes have implemented habitat restoration projects along the river and are committed to protecting the river and riparian ecosystem. The trust resources identified through consultation meetings and correspondence as being of concern for this EIS include water flows, water quality, cultural resources, and riparian areas within the tribal lands.

3.6 Cultural Resources

Among the cultural resources known in the project area are archaeological sites, historic and prehistoric buildings, potential cultural landscapes, and traditional cultural properties (TCP), as discussed below. They are of concern based on numerous laws and mandates, including the National Historic Preservation Act, Archaeological Resources Protection Act, and Native American Graves Protection and Repatriation Act. More detail on cultural resources is provided in Appendix O.

3.6.1 Types of Cultural Resources

Archaeological Sites and Historic Buildings

The New Mexico Archaeological Records Management System (NMARMS) and the Colorado Historical Society databases were queried for information regarding cultural resources in the project area. More than 6,800 prehistoric and historic archaeological sites are known in the New Mexico portion of the project area (NMARMS 2002). It is estimated that over 480 sites are known in the Colorado portion of the project area.

Cultural Landscapes

It is difficult to determine whether cultural landscapes—Native American, Spanish, or Anglo—will emerge as important in the project area. However, recent changes in zoning regulations in Rio Arriba County now protect agricultural lands, suggesting that such lands may constitute Spanish cultural landscapes in the statutory sense of the term. Similarly, it is likely that certain parts of the project area may be deemed cultural landscapes by Native American communities.

Traditional Cultural Properties

The following general classes of TCPs occur within the project area.

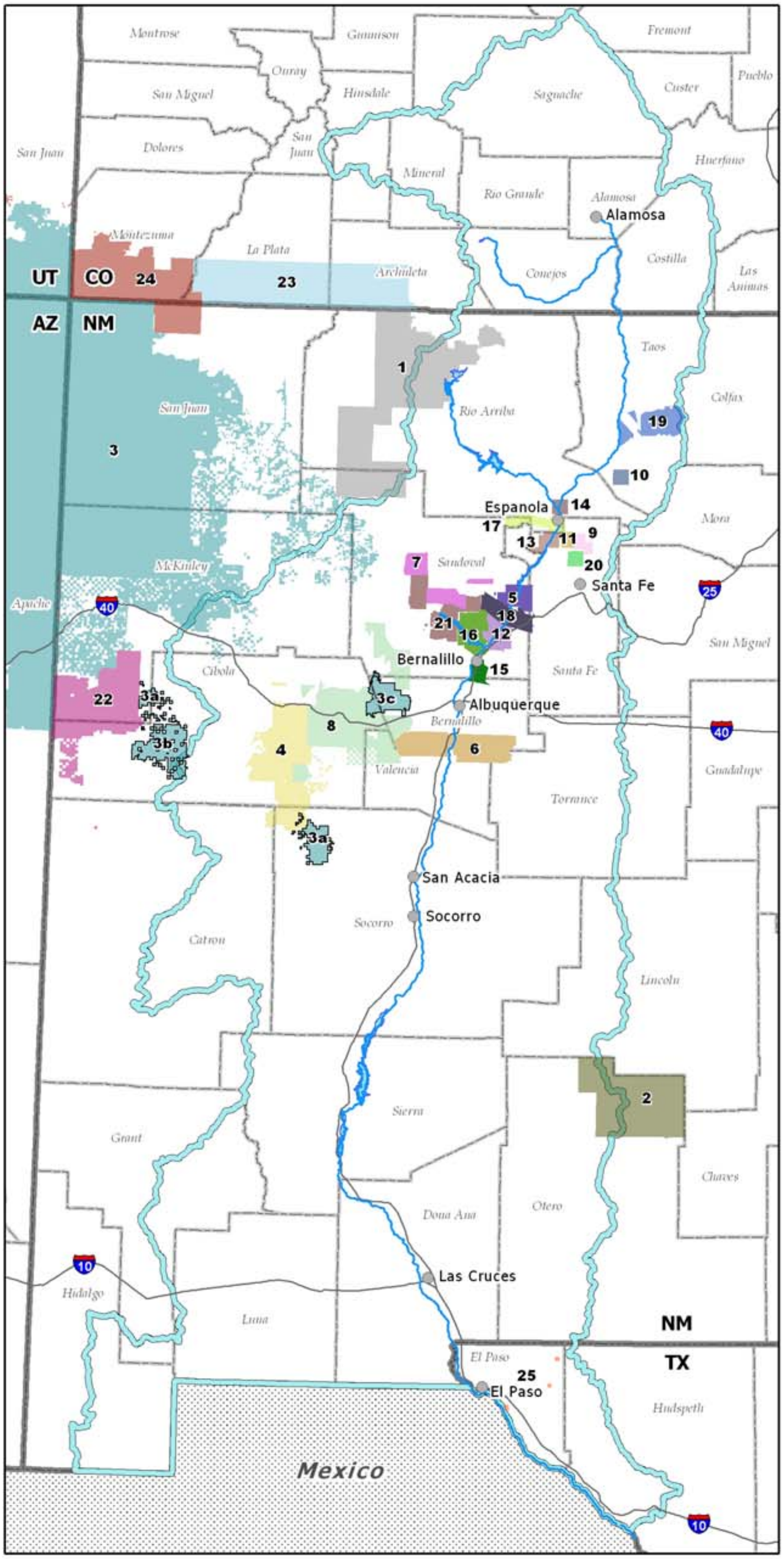
- New Mexico acequias have been determined by the New Mexico Office of Cultural Affairs, Historic Preservation Division, to be eligible for inclusion on the National Register of Historic Places (NRHP) as TCPs.
- Sites sacred to New Mexico’s Native American communities are eligible for inclusion on the NRHP as TCPs.
- Other, as yet unknown, TCPs may emerge. For example, reaches of the Rio Grande containing certain kinds of plants may be found to be TCPs, since these plants are used in religious and other ceremonies.

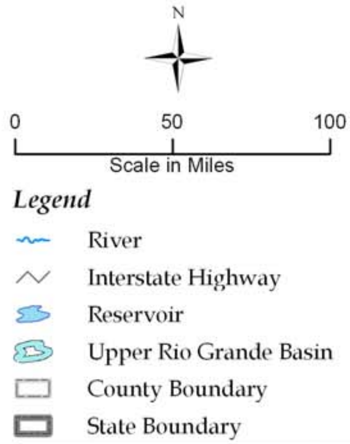
Culture History

While cultural resources occur throughout the basin, specific cultural resources site survey information was retrieved from the New Mexico ARMS database along a 5-km buffer bordering the Rio Chama and Rio Grande (NMARMS 2002). Current boundaries of sovereign lands within the basin are displayed on **Map 3-6**.

Prehistory

The project area contains evidence of prehistoric occupations designated by archaeologists as “Anasazi” and “Mogollon,” a distinction predicated on differences in ceramics, architecture, and other archaeological evidence. Generally, the northern sections of the project area contain remains typical of Anasazi occupations, while Mogollon occupations are typical of the southern sections. The term “occupations” recognizes that many sites (i.e., locations) may contain evidence of occupations spanning substantial periods of time. Included are phase sequences for the San Juan, Middle Rio Grande, Gallina, Rio Abajo, and Jornada portions of the project area. These regional phase sequences are then contrasted with the more generalized Pecos sequence that was used during the early years of archaeological investigations across the region. The term “site” refers specifically to a bounded geographic location that contains evidence of past human occupations.





Label	Name	Chapter
1	Jicarilla Apache Tribe	
2	Mescalero Apache Tribe	
3	Navajo Nation	
3a	Navajo Nation	Alamo
3b	Navajo Nation	Ramah
3c	Navajo Nation	To'Ha'ji'lee
4	Pueblo of Acoma	
5	Pueblo of Cochiti	
6	Pueblo of Isleta	
7	Pueblo of Jemez	
8	Pueblo of Laguna	
9	Pueblo of Nambe	
10	Pueblo of Picuris	
11	Pueblo of Pojoaque	
12	Pueblo of San Felipe	
13	Pueblo of San Ildefonso	
14	Pueblo of Ohkay Owingeh	
15	Pueblo of Sandia	
16	Pueblo of Santa Ana	
17	Pueblo of Santa Clara	
18	Pueblo of Santo Domingo	
19	Pueblo of Taos	
20	Pueblo of Tesuque	
21	Pueblo of Zia	
22	Pueblo of Zuni	
23	Southern Ute Tribe	
24	Ute Mountain Ute Tribe	
25	Ysleta del Sur Pueblo	

Map 3-6. Sovereign Lands in the Upper Rio Grande Basin

PaleoIndian (10,000 B.C. to 5000 B.C.)

PaleoIndian sites have been found in a variety of settings, reflecting highly mobile hunting groups. These are generally along the margins of small ephemeral lakes, along ridge lines paralleling large drainages, and immediately adjacent to the main stem of the Rio Grande (Marshall and Walt 1984; Scheick 1996). Seventeen sites with Paleo-Indian occupations occur in the planning area, constituting approximately 0.2 percent of the total number of identifiable time-sequent occupations or components. Although Paleo-Indian sites are found in approximately 60 percent of the planning area, they are most common in the Rio Chama Section.

Archaic Period (5500 B.C. to A.D. 400)

Consonant with a subsistence shift in the planning area is the appearance of new classes of artifacts, notably ground stone implements used to process plant foods for consumption, and projectile points appropriate for hunting smaller animals. There are an estimated 650 sites with Archaic occupations in the planning area, constituting approximately 8 percent of the total number of identifiable components in that area. Archaic sites are most prevalent in the Northern and Rio Chama Sections, but are found in all project reaches.

In the Northern Section, records obtained from the Colorado Historical Society, Office of Archaeology and Historic Preservation, indicate that 481 sites are situated within a 5-km buffer adjacent to Reaches 1 and 2. Reach 1 contains 127 recorded sites; Reach 2, which encompasses the margins of the Rio Grande mainstem, contains 354 known sites. The majority of sites in Reaches 1 and 2 are of unknown affiliation and time period. However, of those that can be assigned to specific time periods, most date to the middle to late Archaic period.

In northern New Mexico, including the project area, Archaic sites are best known from the Navajo Reservoir region southward to Gallegos Mesa, the Española basin, the Rio Santa Cruz basin, the Galisteo basin, the Chuska Valley, the Chaco region, and Arroyo Cuervo (Scheick 1996). In the southern New Mexico portion of the project area, Archaic sites are generally situated along the East and West Mesas adjacent to Las Cruces and parallel to the Rio Grande (Ackerly 1999; Camilli et al. 1988; Marshall and Walt 1984; Lekson 1999; Ravesloot 1988; Seaman et al. 1988).

Formative Period (A.D. 500 to A.D. 1492)

The appearance of the “Chaco phenomenon,” a sequence of development centered in the Chaco Canyon region, had profound effects, primarily in the northern part of the project area. The Chaco locations were marked by large towns, housing complexes, and kivas.

The northern New Mexico portion of the planning area contains remains typically referred to as “Anasazi.” Archaeological sites affiliated with Anasazi occupations are common in the Rio Chama Section (Schaafsma 1976; Whitten and Powers 1980), the Central Section along the main stem of the Rio Grande into the Cochiti Lake area (Biella and Chapman 1977), and southward into the Albuquerque region (Schutt and Chapman 1992). The sequence of prehistoric development in this area progresses through Basketmaker and Puebloan occupations from A.D. 200 to A.D. 1540.

The San Acacia and Southern Sections (Reaches 14-17) center on the Mogollon area of southern New Mexico, where a shift from nomadic hunting and gathering occurred about 2,000 years ago, reflected in progressively greater emphasis on the cultivation of crops prompted by increasing population growth. The subsequent Formative period is subdivided into Mesilla, Doña Ana, and El Paso phases, culminating in above-ground adobe pueblos, ceramics, some documented crops, tools, and more extensive regional interaction.

Historic Periods

The northern portion of the project area remained occupied from the arrival in 1598 of Spanish explorers through the Colonial, Mexican, and Euro-Anglo periods. In contrast, much of the southern project area was not occupied until the close of the Mexican Period, and settlements did not really expand until the arrival of Euro-Anglo settlers after 1848.

Spanish Period (A.D. 1540 to 1821)

Following earlier explorations by Coronado and other Spaniards, in 1598 Oñate established the first permanent settlement, San Gabriel village, near the present-day Ohkay Owingeh Pueblo (Hammond and Rey 1938). Navajo elements were also identified in the Rio Chama basin upstream of Santa Clara Pueblo at this time (Schaafsma 2002). Many other pueblos were already established on major tributaries of the Rio Grande.

Extensive descriptions of the project area are included in the 1630 narrative of Benavides (Ayer 1965), as described in Appendix O, the Cultural Resources Appendix. By 1643, the overall number of pueblos in the project area had declined from 93 at the time of contact to only 38 (Barrett 2002) due to losses of land and the encomienda system with its forced labor. By the 1670s, the pace of pueblo abandonment had accelerated. Most Spanish settlements were concentrated along the Rio Grande corridor, while many outlying towns were abandoned because of raiding.

After the Pueblo Revolt of 1680, the 1,600-mile Camino Real de Tierra Adentro connected Mexico City with the far-flung colonies in New Mexico. Supply trains traveled back and forth between Santa Fe and Mexico City every 18 months. Although portions of its precise location remains uncertain, the Camino Real parallels the Rio Grande through the entire project area and has recently been designated a National Historic Trail.

In the 18th century, sheep production became important for furnishing meat for the Spanish mines in northern Mexico and as a medium of exchange throughout much of New Mexico. The Old Spanish Trail was also established in the 18th century, and, by the early 19th century had become one of the major trading routes connecting New Mexico with Spanish settlements in Arizona area (Swadesh 1974).

Mexican Period (A.D. 1821 to 1848)

Mexico’s declaration of independence from Spain in 1821 was accompanied by the opening of the Santa Fe Trail. This period is also characterized by additional Mexican land grants and other settlements along the Central Section and to the east of Santa Fe. There was progressively greater interaction among American Euro-Anglos and New Mexico’s Native American and Hispanic residents. In recognition of increased trade with Americans from the east, Taos (in the Northern Section) was made an official port of trade in 1837.

The Mexican Period in the southern portions of the project area were typified by establishment of a number of new land grants (Bowden 1971; Williams 1986). These included, in chronological order, Santa Teresa (1790), Canutillo (1824), Bracito (alt. Brazito, 1824), Doña Ana Bend Colony Grant (1844), Refugio Colony Grant (1850), Mesilla Civil Colony Grant (1852), José Manuel Sanchez Baca Grant (1853), and the Santo Tómas de Yturbide Grant (1853). The almost immediate acquisition of this region by the U.S. under the Treaty of Guadalupe-Hidalgo (1848) and subsequent Gadsden Purchase (1854) resulted in the Mexican Period in this part of the project area having little impact.

In the San Acacia and Southern Sections, in the area between the Rio Puerco and El Paso, the early history is somewhat different from that observed in the Northern and Rio Chama Sections. Spanish and Mexican Period occupations are virtually absent, and most archaeological remains are associated with the Euro-Anglo Period. In that period, conditions between New Mexican statehood and the Civil War remained largely unchanged, with the few Hispanic settlements concentrated primarily in the Mesilla

Valley and sparse Anglo settlements largely centered in existing towns and villages. Settlement in the El Paso area did not expand greatly until the Apaches were subjugated by the U.S. in 1881.

Euro-Anglo Period (1848 to Present)

In 1846, Doniphan's California Column entered New Mexico, ushering in a new era in the region's history. With the subsequent defeat of the Mexican Army, New Mexico officially became a territory of the U.S.

Conditions during the period between 1848 and the outbreak of the Civil War (1860) remained largely unchanged from those observed during the Mexican Period. Hispanic settlements were very few in number and still concentrated mostly in the Mesilla Valley, while Anglos settled largely in existing towns and villages.

The planning area was impacted by the Civil War, during which Confederate forces seized Union posts beginning in El Paso and extending northward up the Rio Grande toward Santa Fe. Order returned to the area only after the Confederates were defeated at the Battle of Glorieta Pass in l862 (east of Santa Fe, New Mexico) and the Homestead Act was passed in that same year, facilitating Anglo settlement. From 1848 to 1880, virtually all of the Rio Grande floodplain between modern-day Las Cruces, New Mexico, and El Paso, Texas, had been claimed by the U.S.

After passage of the Homestead Act of 1862, the Reclamation Act of 1902 supported settlement by inaugurating large-scale water projects—notably Elephant Butte Dam—to stabilize water supplies to the newly arrived homesteaders.

In the mid- to late l9th century, farming and ranching constituted the major economic activity in the area and focused on sheep, although cattle became increasingly important. Development in the southern reaches of the Rio Grande basin began during the latter l9th century. Among the most important factors affecting development in the region was (1) resolution of water disputes between the U.S. and Mexico and (2) the appearance of large-scale irrigation and flood control projects under the auspices of the Bureau of Reclamation and the Corps.

Many initial economic activities typical of the mid-late l9th century focused on farming and ranching. Farming varied from rainfall-based dryland farming in upland areas to irrigated agriculture in river valleys that had relatively permanent flows. The establishment of settlements was frequently accompanied by the immediate construction of irrigation ditches (Ackerly 2002).

3.7 Agriculture

Within the upper Rio Grande basin, most of the agricultural acreage falls within a 5-km buffer on either side of two major rivers, the Rio Grande and Rio Chama. Approximately 7 percent of this buffer is devoted to agriculture (USGS and EPA 2000). The distribution of agricultural acreage by section is shown in **Figure 3-16**. Agricultural acreage includes irrigated and nonirrigated land, field crops, planted and native grass pastures, orchards, vineyards, and fallow fields in rotation. Irrigation is accomplished by using either surface water directed from the rivers or groundwater pumped up from wells. More detailed information concerning agriculture is contained in Appendix P-1.

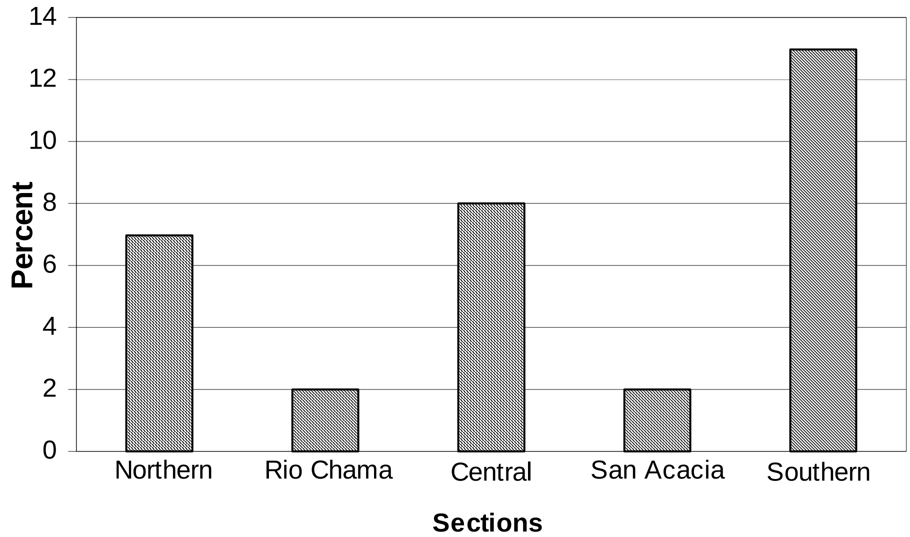


Figure 3-16. Percentage of Total Acreage of Agricultural Land along Each River Section

Source: USGS and EPA 2000

3.7.1 Irrigated Agriculture

Surface water is diverted along the Rio Chama and Rio Grande providing water for agriculture. Diverted water is distributed through ditches and acequia directly to growers. Several entities have authority and responsibility for distributing water and maintaining the diversion structures and channels that carry the water. New Mexico has over 800 acequia associations, ranging from small to large, mostly in the north part of the state (NMOSE 1998). The MRGCD is the main irrigation district/purveyor for growers between Cochiti Lake and Elephant Butte Reservoir. In addition, pueblos, private irrigators, and other users (such as the Bosque del apache), also divert water. The Elephant Butte and El Paso Irrigation Districts serve most growers in the Southern Section.

Northern Section

Most of the acreage in the Colorado portion of this section is devoted to pastures of native grasses grown for forage, with some acreage planted in alfalfa, small grains, and potatoes. In the New Mexico portion of this section, about 70 percent of the agricultural land is devoted to forage (irrigated pasture); about 6 percent is divided between small grains and fruits and vegetables (**Figure 3-17**). The rest (23 percent) is left fallow or used as rangeland (Lansford et al. 1993a, b, 1996).

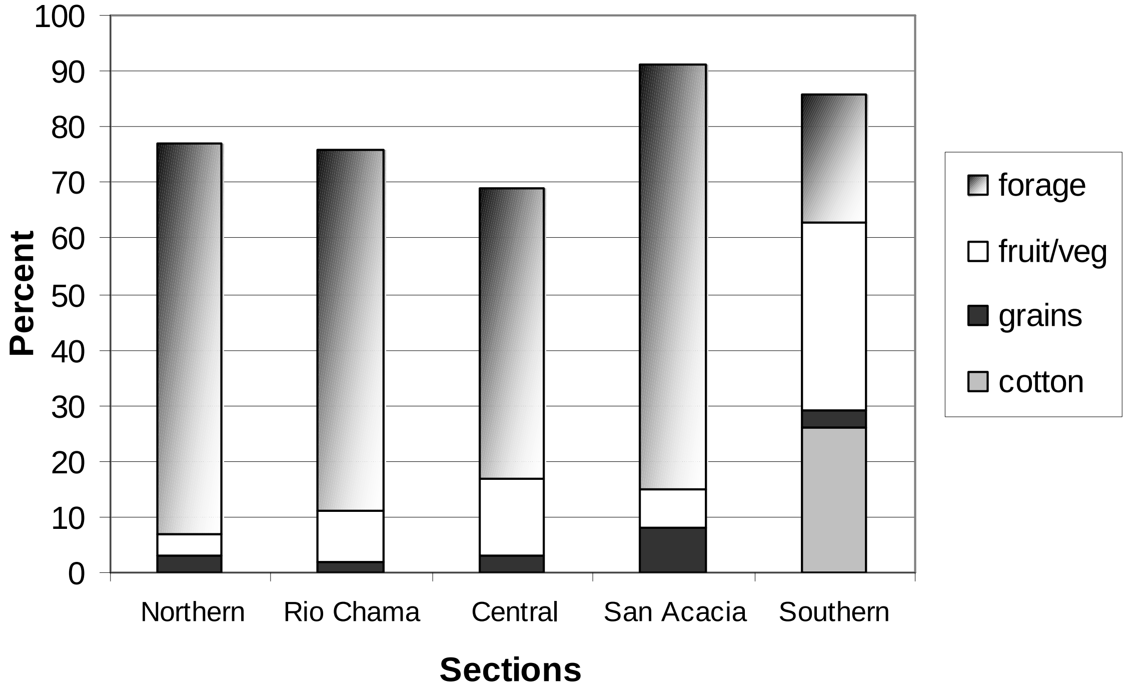


Figure 3-17. Percentage of Crop Type by River Section in New Mexico and Texas

Notes: Totals do not equal 100% because fallow pastures and rangeland were excluded.
Data are averaged from 1991 through 1995.
Crop types are categorized as follows:
Grains—wheat, barley, sorghum grown for grain, unspecified small grains
Forage—alfalfa, other hays, planted pasture, native pasture (all irrigated)
Fruits / vegetables—vegetables, vineyards, melons, peanuts, orchard fruits/nuts

Source: Derived from Lansford et al. 1993a, b, 1996.

Rio Chama Section

The percentages of crop types in the Rio Chama Section are similar to those in the Northern Section (Figure 3-17). Approximately 65 percent of the agricultural lands are devoted to forage (predominantly alfalfa); about 11 percent divided between small grains and fruits and vegetables. The rest (about 24 percent) is left fallow or used as rangeland. Water is diverted to several community acequia systems and tribal lands, including Ohkay Owingeh, Santa Clara, Pojoaque, and San Ildefonso Pueblos.

Central Section

The Central Section includes a number of tribal lands (Cochiti, San Felipe, Santa Ana, Santa Domingo, Zia, Sandia, and Isleta Pueblos), as well as the cities of Albuquerque, Belen, and Socorro, which may account for the somewhat higher level of agricultural land use. The MRGCD is the primary irrigation entity for growers along this section. In general, from the Northern to the Central Section, there is a decrease in land devoted to pasture forage and an increase in land planted in crops (Figure 3-17). Approximately 52 percent of the irrigated farmland is devoted to forage; about 17 percent is planted in grains, fruits and vegetables. The rest (about 31 percent) is left fallow or used as rangeland.

San Acacia Section

The San Acacia Section of the river flows near the La Joya Waterfowl Management Area, the Sevilleta and Bosque del Apache NWR, and Elephant Butte State Park, which may account for the somewhat lower levels of agricultural land use in this section. Overall, there is an increase in acreage devoted to pasture and a decrease in the amount of acreage left fallow. Approximately 76 percent of the agricultural acreage is devoted to forage; about 15 percent is planted in small grains, fruits and vegetables (Figure 3-17). Only about 9 percent is left fallow or used as rangeland.

Southern Section

The highest level of agricultural land use occurs in the Southern Section. Overall, fallow land decreases and land devoted to field crops and orchards increases in the Southern Section (Figure 3-17). Acreage devoted to forage decreases to a low of 23 percent, about the same amount as is planted in cotton (26 percent). Land planted in nuts, fruits, and vegetables represents about 15 percent of the total agricultural acreage. Fallow land and rangeland represent approximately 15 percent of the agricultural acreage.

3.7.2 Irrigation Water Source

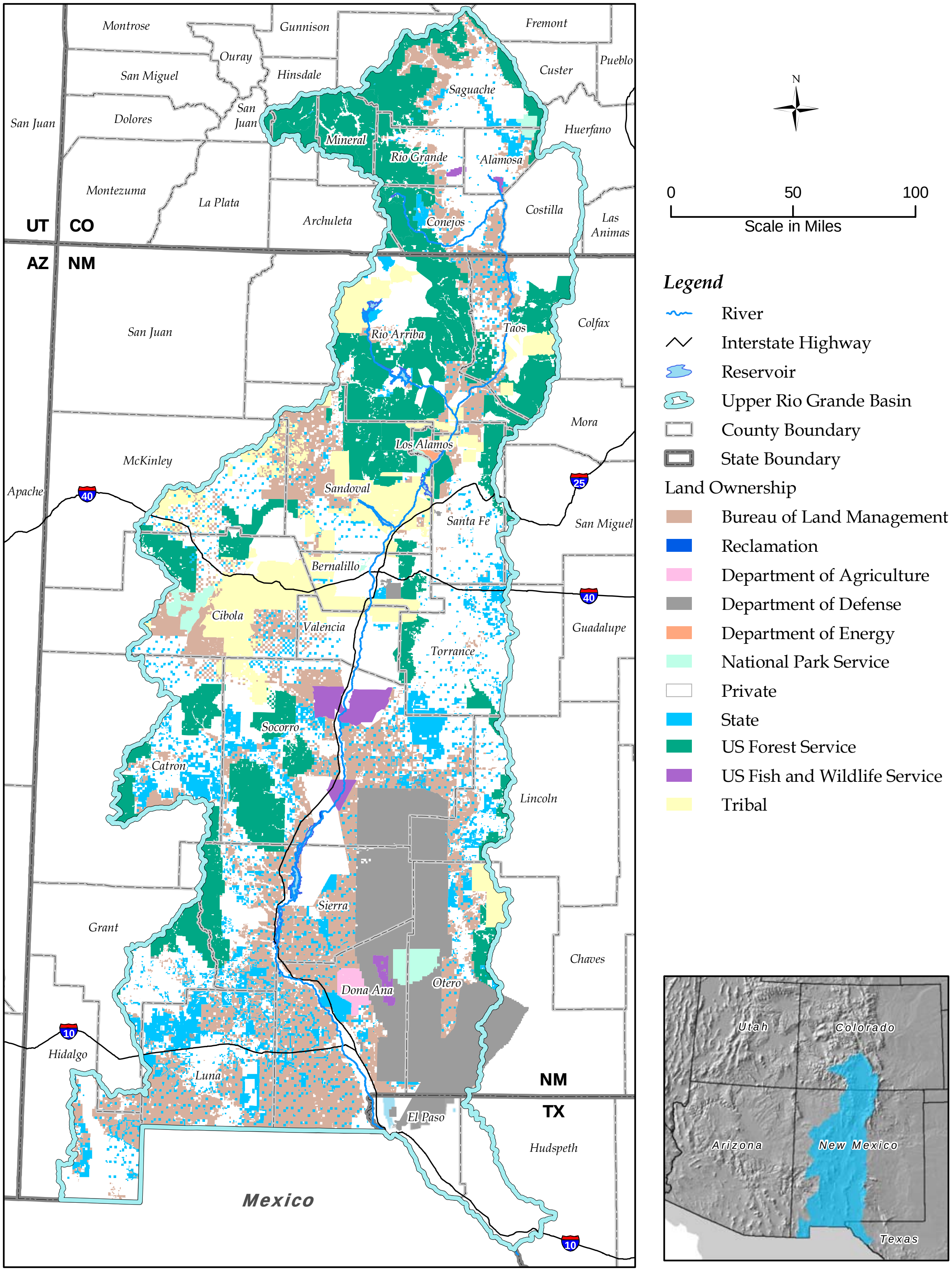
Most water used for agricultural irrigation in the Colorado portion of the Northern Section is diverted from surface water delivered from the Rio Grande and Rio Conejos by irrigation ditches or acequias (Vandiver 2003). Similarly, in the New Mexico portion of the Northern Section and in the Rio Chama Section, most irrigation of agricultural lands is accomplished by diverting surface water from the Rio Grande, Rio Chama, or their tributaries. In the Central Section, some of the irrigation involves a combination of diverted river water and groundwater pumped from private wells. The lands that use a combination of water sources tend to use the wells only in years when the surface water supply is insufficient. In the San Acacia and Southern Sections, lands are also irrigated using a combination of surface and groundwater (Landsford 1993a, b, 1996).

3.8 Land Use

Much of the land in the project area is undeveloped and natural. However, about 12 percent has been modified for a range of purposes including residential, commercial, industrial, transportation, communications and utilities, agricultural, institutional, and recreational uses. The attributes of land use addressed in this section include land status (ownership), general land use patterns and activities, land use management and specially protected areas on public, private, and tribal areas, and future land use trends. More detailed information concerning land use is contained in Appendix P-2.

3.8.1 Land Status (Ownership)

The upper Rio Grande basin encompasses over 36 million acres of land. The majority (83 percent) falls within the State of New Mexico; 13 percent falls within Colorado; and 4 percent within Texas. Ownership of these lands is a mixture of federal, state, tribal, and private. In a 2.8-million acre area within 5 km of the main river channel, almost 50 percent of the land is privately owned; about 36 percent is federally owned; and about 10 percent is sovereign land held by tribes and pueblos (NAUS, USGS, and ESRI 2003; GDT & ESRI 2003; BLM 2004). Only about 4 percent of the land is state owned. Land in the Northern Section, encompassing the more mountainous watersheds of the river, is predominantly federally owned. Sovereign lands are concentrated in the lower Rio Chama and Central Sections. Below these areas, the proportion of private land increases in New Mexico. In Texas, the land is almost entirely privately owned. **Map 3-7** shows the general land ownership for the upper Rio Grande basin.



Map 3-7. Land Ownership in Rio Grande Basin

3.8.2 Generalized Land Use

Land Management and Special Areas

Public Lands

Federal land is primarily managed by the BLM and the U.S. Forest Service (FS). The land within 5 km of the river encompasses four national forests and five BLM administrative offices (BLM 2004; GDT and ESRI 2003). Both agencies manage public land primarily for multiple uses according to land and resource management plans under the authority of existing laws. Forestry, grazing, and recreation are common activities on FS land; grazing, mineral development, and recreation are common activities on BLM lands. New Mexico state lands are held in trust to benefit public schools and other public institutions from the revenues they generate (in taxes, royalties, permit fees) and have a similar range of productive uses.

Some areas are designated or delineated for special use or protection, such as parks and monuments, wilderness areas, wildlife refuges, and wild and scenic river corridors. There are 14 national and state parks and monuments within 5 km of the river (GDT and ESRI 2003). Two national monuments (Bandelier and Chamizal) are close to the river. Most reservoirs are associated with a state park. Areas with a recreation emphasis are described in more detail in the River and Reservoir Recreation section.

There are several national and state wildlife refuges each with specific guidelines for protecting wildlife. Their functioning is dependent on the riparian environment and on water deliveries from the river. The most prominent among the wildlife areas, occurring in the San Acacia Section, is the Bosque del Apache NWR established in 1939. Its main purpose is to serve as a refuge and breeding grounds for migratory birds.

Over 60 miles of the Rio Grande in the Northern Section and 6 miles of the Rio Chama have the Wild and Scenic River (W&SR) designation (BLM 2000). The Rio Grande W&SR is jointly managed by BLM and the Carson National Forest. Maintaining the visual and natural qualities of these areas is a high priority. The Northern and Rio Chama Sections offer exceptional recreational opportunities for rafting and kayaking and limited camping along the river. In Colorado, 41 miles of the Rio Grande are under interim protection pending W&SR designation.

The planning area also includes several wilderness areas, managed for their pristine and natural qualities. Wilderness areas in the planning area include:

- South San Juan Wilderness located at the headwaters of the Rio Grande in Colorado;
- Rio Chama Wilderness, which straddles the Rio Chama below El Vado Lake;
- Dome and Bandelier Wilderness areas, which are just north of Cochiti Lake and link the Bandelier National Monument to the river through hiking trails;
- Bosque del Apache Wilderness, an extension of the NWR in the San Acacia Section.

Private Lands

Counties may exert control over use of privately held lands, although few counties have controls in effect that are based on land use, such as zoning ordinances. Most counties limit development within Federal Emergency Management Agency floodplains by not issuing building permits for structures within designated floodplains. Despite controls, development occurs in floodplains in some areas and is at risk from water operations, particularly during high flows. Privately owned reservoir shoreline occurs at Abiquiu Lake, where owners have built private boat docks and ramps to access the lake (Corps 2002).

Major urban areas (e.g., Santa Fe, Albuquerque, Rio Rancho, Las Cruces, and El Paso) as well as smaller municipalities (e.g., Taos, Española, Bernalillo, Belen, Socorro, and Truth or Consequences) include river floodplains within their corporate boundaries. Development of floodplains within each municipality is guided by comprehensive plans and controlled through zoning ordinances and subdivision regulations.

These determine the type and extent of land use allowable in specific areas and are intended to promote the use of land for the benefit of public health, welfare, and safety.

Rights-of-Way and Easements

Easements and rights-of-way allow certain entities to use or access land along the river and reservoirs for specific purposes (Horner 2004). Flowage easements exist around some reservoirs. Land in the easements may be flooded when the need exists for flood management. In some cases, encroachment into easement lands is occurring. For example, at Abiquiu Lake, private owners have built structures in easements that may be flooded (Dunlap 2001). Along the river, irrigation districts and acequias have rights-of-way to perform duties associated with distribution of water to growers and to maintain equipment, ditches and diversion structures (Horner 2004).

Pueblo and Tribal Lands

Pueblos and tribes control and manage sovereign lands and infrastructure along the river (Map 3-6). The planning area includes almost 2.6 million acres of sovereign lands. The 5-km buffer along the river includes about 320,000 acres of sovereign land, including 16 pueblo and tribal entities. Sovereign land accounts for a substantial portion of land immediately adjacent to the river in the Rio Chama and Central Sections. Deliveries of surface water are made to pueblos and tribes for municipal, industrial, agricultural, recreation, and various customary uses. Pueblos and tribes manage their lands according to their own policies and purposes, including fishing and boating.

3.8.3 Future Land Use Trends

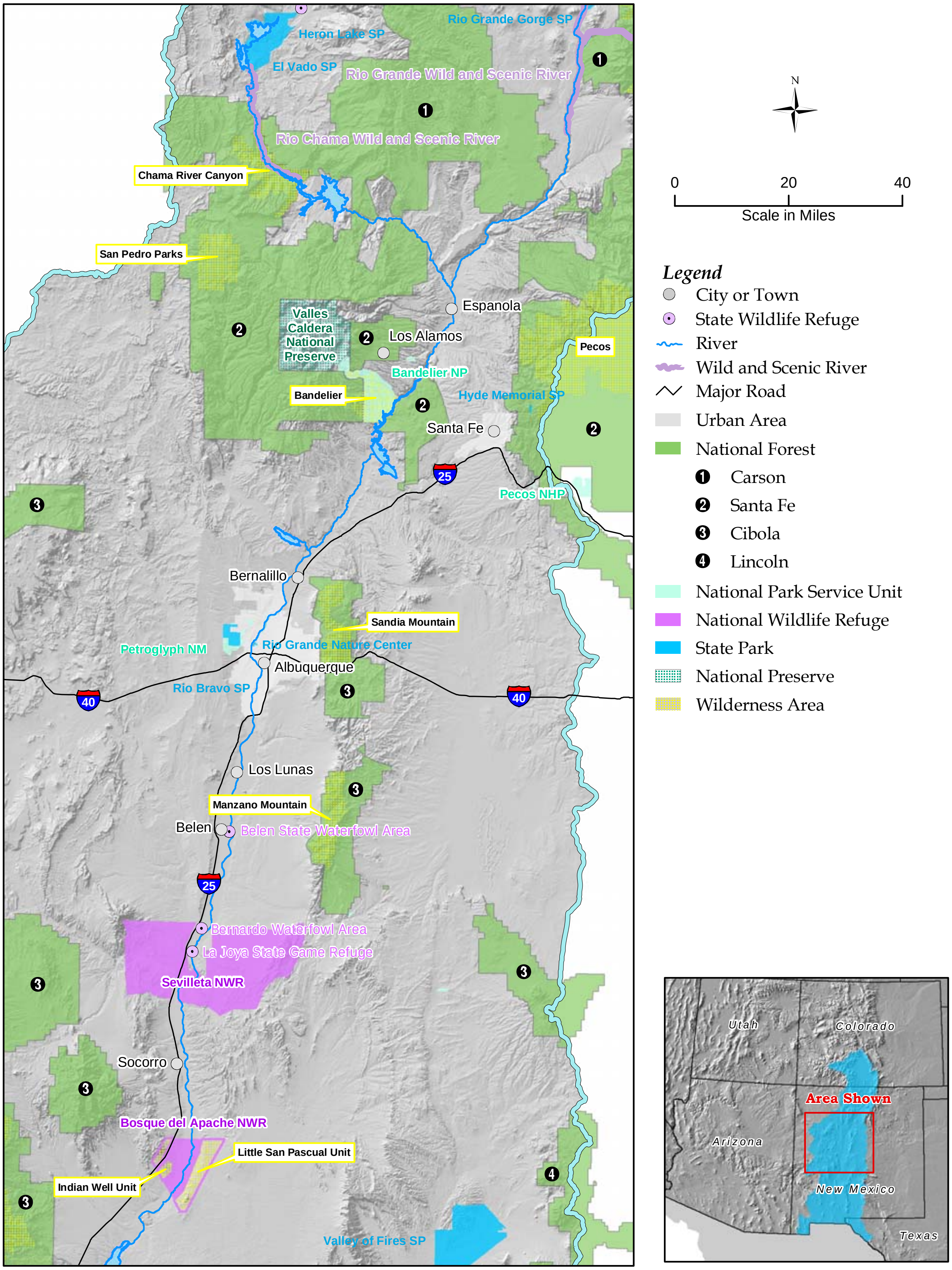
Regional and local planning initiatives are underway. These initiatives focus on issues related to future growth and development, such as land use, transportation, and water resources planning, that are built on future population projections. Development contributes to runoff that may enter the river system. The area of greatest projected land use change along the river is in the Central Section. Both the USGS and the Mid-Region Council of Governments studied changes in land use and developed a future land use framework based on trends and certain assumptions for projected growth in this area (USGS 2000b; MRCOG 2002). The URGWOM planning model did not consider population growth or land use changes over the 40-year period. Additional information on the URGWOM planning model is provided in Appendix I.

3.9 Recreation

In the dry west, where surface water is limited and variable from year to year, riverine water provides unique opportunities for recreation. Reservoir recreation occurs as a byproduct of dams built to store irrigation waters and to control floodwaters and sedimentation. Due to congressional action, certain reservoirs along the Rio Grande also serve wildlife enhancement purposes. More detailed information is contained in Appendix P-5. **Map 3-8** shows the location of public recreational lands along the river corridor.

3.9.1 River Recreation Sites and Activities

Within 5 km of the river, about 36 percent of the land is federally- or state-owned and generally open to the public. Dispersed recreation is enjoyed on these public lands. The Rio Chama and Rio Grande flow through or are adjacent to five National Forests; five Wilderness Areas; six wildlife areas; two W&SR sections; and several national and state parks, monuments, and developed recreation sites that provide a variety of recreational opportunity. The primary recreational activities along the river are rafting and fishing, while dispersed recreation activities, such as camping, walking, biking, hiking, wildlife viewing, and picnicking, are also popular.



Map 3-8. Recreation Areas within the River Corridor

Fishing is one of the primary recreational opportunities along the Rio Grande and its tributaries. The NMDGF recorded a total of almost 3.7 million angler-days during 1998/1999, of which about 25 percent was along the mainstem in the project area (derived from NMDGF 2000). Popular fish include river trout, bass, Kokanee salmon, lake trout, walleye, and pike. The trend over the last decade shows a general increase in fishing (Hansen 2003a).

Northern and Rio Chama Sections

In the Northern and Rio Chama Sections, kayaking, rafting, fishing, and wildlife viewing are the predominant recreational activities on the river. Recreation sites include the Wild River and Orilla Verde Recreation Areas in the Northern Section; and the area below El Vado Dam and El Vado State Wildlife and Fishing area in the Rio Chama Section (Hansen 2003b; BLM 2000).

High quality river rafting and kayaking provide the bulk of river recreation in the Northern and Rio Chama Sections. Rafting occurs during the spring and summer when there are sufficient flows. About 50,000 people float the Rio Grande annually in the Northern Section. About 5,000 people per year float the Rio Chama. Portions of the river have special designations to protect their primitive, wild, and scenic qualities (BLM 2000). Drought conditions and fire risk in the surrounding forests can seriously affect rafting opportunities and rafter numbers from year to year.

The Northern and Rio Chama Sections offer coldwater fishing. Popular fishing locations along the Rio Grande in these sections occur above and below Pilar. On the Rio Chama, fishing is popular below El Vado and Abiquiu Dams. Local flow rates are important to the quality of fishing conditions (Hansen 2003a).

Central Section

In the Central Section, recreation along the river includes activities such as boating, biking, hiking, and wildlife viewing along the river. Key access points include Coronado State Park, the Rio Grande Valley State Park, and Valley Nature Center. Hiking, walking, biking, and nature wildlife viewing are popular on MRGCD lands.

Popular fishing locations occur at Tingley Aquatic Park in Albuquerque; along the Albuquerque and Corrales irrigation ditches and drains; and along the Belen and Peralta drains. High flows out of Cochiti tend to improve conditions for fishing (Hansen 2003b).

San Acacia and Southern Sections

Flow rates in the San Acacia and Southern Sections are generally lower than in the Northern and Rio Chama Sections and do not support extensive instream recreation. Wildlife viewing, particularly birding, is enjoyed all along the river due to the high diversity of habitats. The San Acacia and Southern Sections both offer warmwater fishing.

In the San Acacia Section, wildlife viewing is popular at Bosque del Apache NWR. The river flows through or adjacent to four national wildlife refuges and three state refuges, all of which feature migratory birds and water fowl. The most notable of these is the Bosque del Apache NWR and Wilderness Area in the San Acacia Section, renowned for its sandhill crane population. Over the past five years, about 150,000 people have visited the refuge annually (FWS 2004).

3.9.2 Reservoir Recreation Sites and Activities

The project area includes eight reservoirs with recreational uses that include sightseeing, camping, picnicking, hiking, wildlife viewing, biking, hunting, fishing, swimming, boating and winter sports. Visitation to reservoir facilities has declined over the last several years, with a similar trend observed for all parks and monuments in the state (NMEMNRD 2001, 2002). Fishing is popular at reservoirs, both from the shore and from boats. Angler days exceeded 1 million at reservoirs in the project area in the 1998/1999 fishing cycle (NMDGF 2000), but declined to about 660,000 in 2000/2001 (Hansen 2003a).

This decrease corresponds to the overall trend of declining visitation to state parks in general and reservoirs in particular throughout New Mexico.

Northern and Rio Chama Sections

Reservoirs in the Northern and Rio Chama Sections (Heron/El Vado, Abiquiu and Cochiti) generally experience relatively low use; combined, they account for only about 26 percent of the 2.7 million reservoir visits in 2000 (**Figure 3-18**). Distance from concentrated populations, lower water levels and boating restrictions may account for visitation preference. For example, Heron Lake allows no powered boats, but provides for a quieter experience for camping, fishing, swimming, and sailing. Trout and salmon are the primary sport fish at coldwater reservoirs (Heron, Abiquiu, El Vado, Platoro). Cochiti Lake is primarily a warmwater fishery.

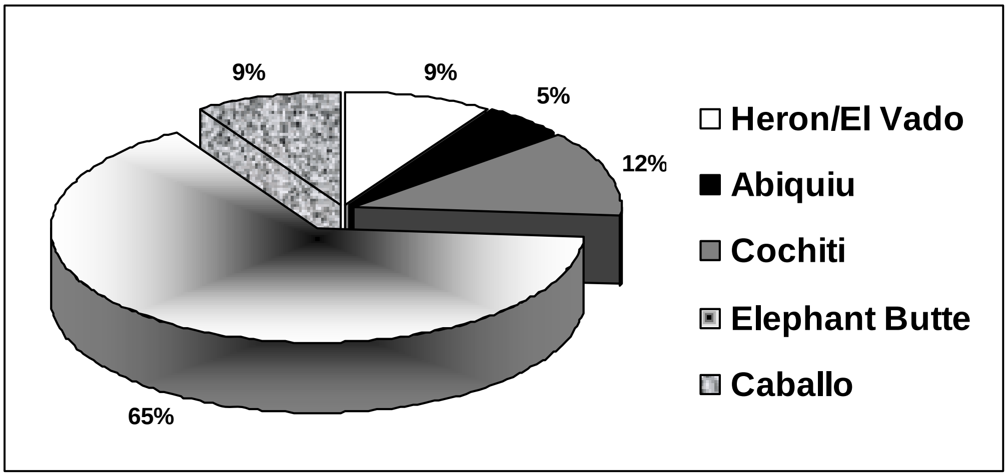


Figure 3-18. Reservoir Visitation in Project Area (2000)

Note: No data available for Platoro Reservoir. Jemez Canyon is a dry dam without recreational facilities and is not included.
Source: Casados 2001; NMEMNRD 2001, 2002

Southern Section

In the Southern Section, Elephant Butte State Park, Caballo State Park, Leasburg Dam State Park, and Percha Dam State Park are all popular recreation sites, along with several historic parks and the Feather Lake Wildlife Sanctuary in Texas. Both Elephant Butte and Caballo serve New Mexico residents and out-of-state visitors from El Paso and beyond.

Elephant Butte Reservoir received 65 percent and Caballo Reservoir received 9 percent of total visits to reservoirs in the project area in 2000 (Figure 3-18). Both locations allow use of motorized watercraft. Commercial marina facilities are operated at Elephant Butte. In New Mexico, all state parks combined receive between 4 and 5 million visitors, annually. Almost 40 percent of these visits are to Elephant Butte State Park and Reservoir. Warm water at Elephant Butte and Caballo Reservoirs support crappie, bass, and catfish sport fishing.

3.10 Flood Control

Along the Rio Grande and its tributaries, there are many flood control structures, from dams to levees. There have been no property damages sustained nor anticipated from direct releases by the flood control facilities under consideration in this EIS. However, residual flood damages could occur from unregulated drainages depending on flows. Evaluation of alternatives, therefore, focuses on changes in residual flood damages associated with the proposed operation changes. The affected environment includes both the current flood control structures and benefits as well as the areas that remain threatened by floods.

3.10.1 Relevant Affected Geographic Area and Historical Flooding

Major floods occurred in the 1940s. However, since the inception of total flood control by the Corps along the Rio Grande and its tributaries, benefits have totaled more than $1.1 billion (Corps 2003). In addition, significant damages have been prevented in terms of river sedimentation. Historically, however, the Northern and Southern Sections, the primary areas that have sustained damages as a result of flooding from the Rio Grande since 1979, are not influenced by operations at any of the facilities under consideration in this EIS. Historical flooding since 1979 in the Northern and Southern Sections is discussed in Appendix P-3.

Northern Section

Some agricultural damages and some minor damages to structures were sustained in areas of Colorado (Del Norte, Monte Vista, and Alamosa). There were no Corps flood control projects in these areas at the time of the damage, although a levee system for Alamosa was recently completed.

In New Mexico, damages occurred along the Rio Grande from Pilar to the confluence of the Rio Chama during several high runoff years since 1979. Damage has occurred primarily to bridges, diversion structures, pastures, orchards, and low-lying agricultural areas.

Rio Chama Section

Abiquiu Dam has provided over $391.5 million in cumulative flood control benefits since its construction (Corps 2003). Minor bank erosion damages were periodically sustained between Abiquiu Dam and Cochiti Lake along the Rio Chama and the Rio Grande.

Central and San Acacia Sections

Cochiti Dam has provided over $435.5 million in cumulative flood control benefits since it was constructed (Corps 2003). No flood damages have been reported in these sections since 1979. However, as a result of nonengineered levees or other factors such as large uncontrolled drainage areas, these sections may be prone to flooding and are currently under study by the Corps.

Southern Section

Major damages were sustained in Mexico in 1986 and 1987 as a result of 14 levee breaks in the Southern Section in the U.S. resulting from high flows on the Rio Grande. Structures as well as a significant amount of agricultural land were destroyed or damaged.

High flows in the Rio Grande in El Paso County, Texas, in 1986 caused damage to pecan orchards and to the diversion structure of the El Paso Irrigation District. The pecan orchards were primarily damaged from the high groundwater table resulting from the Rio Grande flows. The Riverside Diversion, which was designed to carry water into the El Paso Irrigation District from the Rio Grande, was permanently damaged from high river flows. As of September 2003, the remaining structure is serving only as a weir and grade control structure.

Damages occurred in Hudspeth County, Texas, where high releases from Elephant Butte in 1986 and 1987 caused damage primarily to agricultural lands. The total damages estimated from the 1986 Elephant Butte Reservoir releases include more than $1 million to clean up sediment; more than $200,000 in pump purchases and operation to prevent the Hudspeth County Irrigation drainage ditches from overflowing; $220,000 in lost yields and production (compensable by the Agricultural Stabilization and Conservation Services); and an immeasurable impact on future yields due to increased salinity.

High reservoir levels at Elephant Butte increased the amount of sedimentation at the head of the reservoir, creating a risk of river flows overtopping the levee and flooding the low flow conveyance channel.

Historically, damages occurred on many of the tributaries to the Rio Grande (e.g. Hatch, New Mexico and parts of Socorro County). However, consideration of damages in the Southern Section are not explicitly analyzed in this Review and EIS because proposed changes to operating plans would not affect these areas.

3.11 Hydropower

Hydropower production is affected by storage regulation and allocation at various reservoirs in the upper Rio Grande basin. These areas are at the El Vado Reservoir, Abiquiu Reservoir, and Elephant Butte Reservoir. The first two are located on the Rio Chama, and the latter is on the Rio Grande near the city of Truth or Consequences in the Southern Section. Power is generated by “run of the river” facilities at El Vado and Abiquiu. In other words, power generation occurs incidentally with flow releases from these dams. Elephant Butte power production depends on scheduled block releases and demand for power. Changes in operation will affect the total generation from these plants. More detailed information concerning the hydropower facilities along the Rio Grande is contained in Appendix P-3. **Figure 3-19** shows the output of the hydropower plants at El Vado, Abiquiu, and Elephant Butte in thousands of megawatt hours.

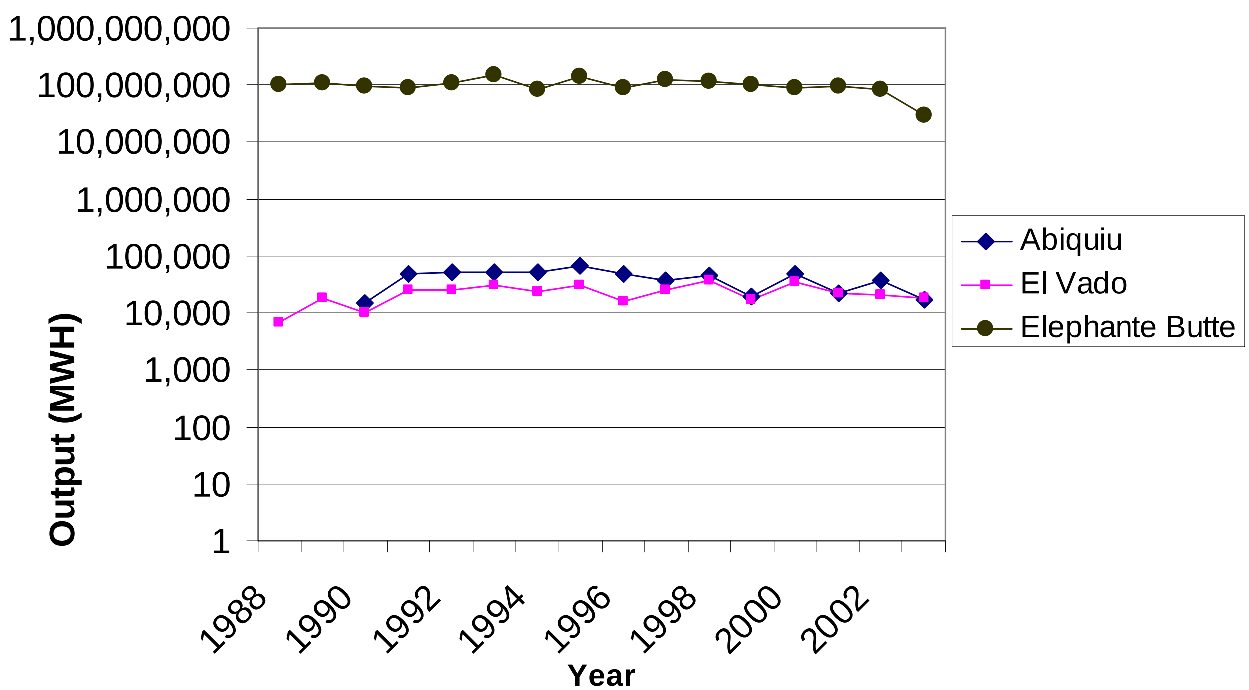


Figure 3-19. Historic Hydropower Generation

Sources: Treers 2004; Biggs 2004

3.12 Socioeconomics

The region of influence for socioeconomics includes 14 counties adjacent to the Rio Grande, Conejos River, and the Rio Chama, and two additional counties linked through economic and social ties. There are two major urban centers located in the three-state planning area: Albuquerque, New Mexico and El Paso, Texas. Together these two cities account for about 73 percent of the total planning area population. There are smaller municipalities located throughout the planning area that make important contributions to the regional economy. Agriculture, recreation, tourism, and manufacturing are important sectors in the regional economy. More detailed information concerning socioeconomics is contained in Appendix P-6.

3.12.1 Demographics

According to the 2000 Census, there were nearly 1.7 million people in the three-state project area above El Paso. About 18,900 of that 1.7 million live in the Colorado portion of the planning area. Approximately 50 percent of these Colorado residents are of Hispanic origin; only about 2.5 percent are of Indian ancestry; the remainder are African American or white (Census 2000a).

Almost 1 million people were located in the New Mexico portion of the project area according to the 2000 Census. Of these residents, nearly 50 to 75 percent are of Hispanic origin; about 5.6 percent are of Indian origin; the remainder is largely white or African American (Census 2000b). Of the 681,100 residents of the Texas portion of the project area, about 75 percent are of Hispanic origin; only about 1 percent is of Indian origin; the remainder is white or African American (Census 2000c).

New Mexico population projections were developed for the recently approved New Mexico State Water Plan (NMISC 2003) to support regional water planning efforts. The State of Colorado Division of Local Government has generated official population projections by county and region for the years 2000 to 2030 (CDLG 2004). The Texas Office of the State Demographer has produced population estimates and projections to the year 2040 for Texas counties (Texas State Data Center 2004). **Table 3-9** summarizes projections and **Table 3-10** summarizes growth rates for the counties that contain segments of the Rio Grande and Rio Chama over the next 40 years (30 years for Colorado Counties).

Table 3-9. Projected County Population and Annual Average Growth Rate

2000 to 2040									
Counties/Key Municipalities	**Total County Population by Projection Year (5 year increments)**								
	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Colorado Counties									
Alamosa	15,132	15,946	17,066	18,308	19,609	20,926	22,223	—	—
Conejos	8,402	8,538	8,840	9,215	9,530	9,799	10,020	—	—
Costilla	3,665	3,792	3,958	4,134	4,277	4,415	4,546	—	—
Rio Grande	12,432	13,061	13,633	14,315	14,922	15,409	15,729	—	—
Saguache	5,954	6,634	7,125	7,581	8,002	8,341	8,603	—	—
New Mexico Counties									
Rio Arriba	41,307	43,694	46,030	48,196	50,027	51,451	52,519	53,269	53,676
Los Alamos	18,359	18,722	19,122	19,122	20,099	20,565	20,866	21,034	21,224
Santa Fe	129,936	143,987	158,624	174,400	191,403	208,801	226,112	244,751	264,778
Bernalillo	558,437	593,801	623,421	650,497	675,818	699,267	720,635	739,734	756,525
Valencia	66,699	76,503	86,670	97,242	107,906	118,339	128,527	138,590	148,563
Socorro	18,165	19,824	21,472	23,102	24,673	26,139	27,527	28,846	30,086
Sandoval	89,668	106,928	124,058	141,662	159,162	176,177	192,745	208,797	224,259
Sierra	13,355	15,058	16,700	18,281	19,774	21,172	22,485	23,644	24,567
Doña Ana	175,524	197,472	218,788	238,677	256,254	272,764	289,897	306,907	322,568

2000 to 2040									
Counties/Key Municipalities	**Total County Population by Projection Year (5 year increments)**								
	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Texas Counties									
El Paso (High)	679,622	748,258	824,786	904,596	981,274	1,051,853	1,118,871	1,181,836	1,237,030
El Paso (Low)	679,622	732,098	781,599	828,143	870,402	911,133	950,255	986,544	1,018,785
Hudspeth (High)	3,344	3,510	3,679	3,813	3,920	3,965	3,964	3,934	3,878
Hudspeth (Low)	3,344	3,646	3,919	4,098	4,255	4,331	4,350	4,317	4,239

Source: BBER 2003

Table 3-10. Projected Population Growth Rates

	Projected Growth Rate (%) of County Population by Projection Years							
	2000-05	**2005-10**	**2010-15**	**2015-20**	**2020-25**	**2025-30**	**2030-35**	**2035-40**
Colorado Counties								
Alamosa	1.10	1.40	1.40	1.40	1.30	1.20	—	—
Conejos	0.30	0.70	0.80	0.70	0.60	0.40	—	—
Costilla	0.70	0.90	0.90	0.70	0.60	0.60	—	—
Rio Grande	1.00	0.90	1.00	0.80	0.60	0.40	—	—
Saguache	2.20	1.40	1.20	1.10	0.80	0.60	—	—
New Mexico Counties								
Rio Arriba	1.12	1.04	0.92	0.75	0.56	0.41	0.28	0.15
Los Alamos	0.39	0.42	0.49	0.51	0.46	0.29	0.16	0.18
Santa Fe	2.05	1.94	1.90	1.86	1.74	1.59	1.58	1.57
Bernalillo	1.23	0.97	0.85	0.76	0.68	0.60	0.52	0.45
Valencia	2.74	2.50	2.30	2.08	1.85	1.65	1.51	1.39
Socorro	1.75	1.60	1.46	1.32	1.15	1.03	0.94	0.84
Sandoval	3.52	2.97	2.65	2.33	2.03	1.80	1.60	1.43
Sierra	2.40	2.07	1.81	1.57	1.37	1.20	1.01	0.77
Doña Ana	2.36	2.05	1.74	1.42	1.25	1.22	1.14	1.00
Texas Counties								
El Paso (High)	1.94	1.97	1.86	1.64	1.40	1.24	1.10	0.92
El Paso (Low)	1.50	1.32	1.16	1.00	0.92	0.84	0.75	0.64
Hudspeth (High)	1.74	1.45	0.90	0.75	0.35	0.09	-0.15	-0.36
Hudspeth (Low)	0.97	0.94	0.72	0.55	0.23	-0.01	-0.15	-0.29

Source: BBER 2003

Overall, the population in the New Mexico potion of the study region is projected to increase by almost 60 percent (from about 1 million in 2000 to about 1.6 million in 2040). The populations in Valencia and Santa Fe Counties may more than double over the next 40 years, whereas the northern areas will experience the slowest growth (BBER 2003). The population of El Paso County, Texas is projected to increase by 50 to 82 percent from 2000 to 2040, from about 680,000 people to 1.0 to 1.2 million people.

Growth in the rural areas of the Texas portion of the study area is expected to be much lower, with Hudspeth County growing by 16 to 27 percent over the 40 year period. Growth in the Colorado portion of the study region is projected to grow by about 34 percent from 2000 to 2030. This growth is projected to be spread out fairly evenly throughout the five Colorado counties.

3.12.2 Economics

The retail trade sector accounts for the largest portion of sales and business receipts in most of the region of influence (University of Virginia Library 2004). The large impact from retail trade is in part due to the large amount of tourism in the area, which is reflected in the healthy accommodations/food service sector. Other sectors that consistently account for large percentages of sales and receipts in the project area include manufacturing, wholesale trade, health care and social services, and professional and technical services. Manufacturing and wholesale trade are particularly important in the counties that include larger cities, such as Bernalillo, Santa Fe, Sandoval, Doña Ana, and El Paso Counties.

Agriculture

Agriculture remains an important part of the area's economy. In 1999, over 9,000 people were directly employed on farms within the region of influence. About 33 percent of the direct agricultural employment was in Colorado; 53 percent was in New Mexico, and the remaining 14 percent was in Texas.

Hay, wheat, and corn are the major crops grown in the Northern and Central Sections. Hay and chiles are grown in the San Acacia Section. Chiles, pecans, and cotton grown in the Southern Section provide significant farm income. Cattle ranching is also an important agricultural activity in the region. In 1999, within the region of influence, there were more than 200,000 head of cattle in New Mexico, about 100,000 head in Colorado, and about 64,000 head in Texas.

According to the 1997 Census of Agriculture (U.S. Department of Agriculture [USDA] 1998a, b, c), the total market value of agricultural products was $222 million in Colorado, $135 million in New Mexico, and $101 million in Texas. Total farm expenses were about $168 million in Colorado, $106 million in New Mexico, and $75.5 million in Texas.

Income and Employment

The Colorado and Texas portions of the 16-county region of influence generally have a lower income than the New Mexico portion. Per capita personal income data (all categories) show the same pattern, with the more urbanized New Mexico counties (Los Alamos, Bernalillo, and Santa Fe Counties) having higher incomes than the other portions of the planning area.

Median household income in most counties in the region of influence ranges from about $20,000 to $30,000 (Census 2000a, b, c). The most notable exception is the median household income of $78,993 in Los Alamos County in New Mexico, associated with Los Alamos National Laboratory. Median income, per capita income, and the percentage of the population below the poverty line within counties in the planning area and key municipalities are shown in **Table 3-11**.

Table 3-11. Comparison of Income Levels within the Planning Area to the Nation

Region	*Median Household Income*	*Per Capita Income*	*Population Below Poverty*
UNITED STATES	**$41,994**	**$21,587**	**12%**
COLORADO	**$47,203**	**$24,049**	**9%**
Alamosa County	**$29,447**	**$15,037**	**21%**
Alamosa	$25,453	$15,405	15%
Conejos County	**$24,744**	**$12,050**	**23%**
Costilla County	**$19,531**	**$10,748**	**27%**
Rio Grande County	**$31,836**	**$15,650**	**14%**
Monte Vista	$28,393	$13,612	15%
Saguache County	**$25,495**	**$13,121**	**23%**
NEW MEXICO	**$34,133**	**$17,261**	**18%**
Bernalillo County	**$38,788**	**$20,790**	**14%**
Albuquerque	$38,272	$20,884	14%
Tijeras	$34,167	$18,836	10%
Doña Ana County	**$29,808**	**$13,999**	**25%**
Hatch	$21,250	$14,619	34%
Las Cruces	$30,375	$15,704	23%
Mesilla	$42,275	$25,922	9%
Sunland Park	$20,164	$6,576	39%
Los Alamos County	**$78,993**	**$34,646**	**3%**
Los Alamos	$71,536	$34,240	4%
Rio Arriba County	**$29,429**	**$14,263**	**20%**
Chama	$30,513	$16,670	18%
Española	$27,144	$14,303	22%
Sandoval County	**$44,949**	**$19,174**	**12%**
Bernalillo	$30,864	$13,100	18%
Cuba	$21,538	$11,192	41%
Jemez Springs	$36,818	$19,522	21%
San Ysidro	$30,521	$14,787	15%
Rio Rancho	$47,169	$20,322	5%
Santa Fe County	**$42,207**	**$23,594**	**12%**
Santa Fe	$40,392	$25,454	12%
Edgewood	$42,500	$18,146	11%

Region	Median Household Income	Per Capita Income	Population Below Poverty
Sierra County	**$24,152**	**$15,023**	**21%**
Elephant Butte	$31,705	$21,345	11%
T or C	$20,986	$14,415	23%
Williamsburg	$23,750	$15,549	10%
Socorro County	**$23,439**	**$12,826**	**32%**
Magdalena	$22,917	$13,064	25%
Socorro	$22,530	$13,250	32%
Taos County	**$26,762**	**$16,103**	**21%**
Questa	$23,448	$13,303	24%
Red River	$31,667	$17,883	10%
Taos	$25,016	$15,983	23%
Valencia County	**$30,099**	**$14,747**	**17%**
Belen	$26,754	$12,999	25%
Los Lunas	$36,240	$14,992	14%
TEXAS	**$39,927**	**$19,617**	**15%**
El Paso County	**$31,051**	**$13,421**	**24%**
El Paso	$32,124	$14,388	22%
Fabens	$18,486	$6,647	43%
Hudspeth County	**$21,045**	**$9,549**	**36%**

Sources: Census 2000a,b,c

Unemployment in the region of influence averaged 5.4 percent in 2001. In New Mexico counties, the unemployment rate is 3.8 percent, compared to 7.1 percent for Colorado counties (CDOLE 2004), and 8.2 percent for Texas counties (State of Texas 2004). The unemployment rate for New Mexico counties is lower due to the below average rates in Los Alamos County (1.0 percent), Santa Fe County (2.6 percent), and Bernalillo County (3.5 percent) (New Mexico Department of Labor [NMDOL] 2004).

Recreation and Tourism

Recreation has a significant impact on the regional economy. Average recreation expenditures in New Mexico according to the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation was about $46 per trip for fishing, $57 per trip for hunting, and $63 per trip for wildlife watching (FWS 2002b). Reservoir recreation-related spending alone could exceed $100 million annually (FWS 2002b). Dispersed and river recreation usage is not recorded by trips or visits and cannot be assigned an economic value.

3.13 Environmental Justice

As of February 11, 1994, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that each federal agency consider environmental justice as part of its mission. The Executive Order has the following three objectives:

- To focus the attention of federal agencies on human health and general environmental conditions in minority and low-income communities with the goal of achieving environmental justice;
- To foster nondiscrimination in federal programs that could substantially affect human health or the environment; and
- To give minority and low-income communities greater opportunities for public participation on matters relating to human health and safety.

Environmental justice addresses the issue of disproportionate impacts on minority and/or low-income populations. Therefore, the locations of these populations must be known in order to evaluate potential environmental justice issues. For this analysis, populations with a high percentage of people of Hispanic origin, a high percentage of Native Americans, and a high percentage of low-income households or high poverty rates are identified. The locations of these identified populations are used to evaluate Environmental Justice concerns.

The greatest proportions of populations of Hispanic origin or Native American people are in New Mexico. All of the states in the planning area are well above the average proportion of Hispanic population for the entire U.S. (13 percent). The most useful comparison for evaluating environmental justice concerns within the planning area is to consider the percentage in individual counties and municipalities to the states and nation, as shown in **Table 3-12**.

Table 3-12. Comparison of the Racial/Ethnic Populations in the Planning Area and Nation

Region	Total Population	White	Black	American Indian	Asian	Other Race	More Than One Race	Hispanic or Latino
UNITED STATES	**281,421,906**	**75%**	**12%**	**1%**	**4%**	**6%**	**2%**	**13%**
COLORADO	**4,301,261**	**83%**	**4%**	**1%**	**2%**	**7%**	**3%**	**17%**
Alamosa County	**14,966**	**71%**	**1%**	**2%**	**1%**	**21%**	**4%**	**41%**
Alamosa	7,960	69%	1%	2%	1%	23%	4%	47%
Conejos County	**8,400**	**73%**	**<1%**	**2%**	**<1%**	**22%**	**4%**	**59%**
Costilla County	**3,663**	**61%**	**1%**	**2%**	**1%**	**30%**	**5%**	**68%**
Rio Grande County	**12,413**	**74%**	**<1%**	**1%**	**<1%**	**22%**	**3%**	**42%**
Monte Vista	4,529	63%	<1%	2%	<1%	32%	3%	58%
Saguache County	**5,917**	**71%**	**<1%**	**2%**	**<1%**	**23%**	**3%**	**45%**
NEW MEXICO	**1,819,046**	**67%**	**2%**	**10%**	**1%**	**17%**	**4%**	**42%**
Bernalillo County	**556,678**	**71%**	**3%**	**4%**	**2%**	**16%**	**4%**	**42%**
Albuquerque	448,607	72%	3%	4%	2%	15%	4%	40%
Tijeras	474	66%	0%	1%	<1%	28%	5%	56%
Doña Ana County	**174,682**	**68%**	**2%**	**1%**	**1%**	**25%**	**4%**	**63%**
Hatch	1,673	46%	<1%	1%	0%	3%	50%	79%
Las Cruces	74,267	69%	2%	2%	1%	4%	22%	52%
Mesilla	2,180	74%	<1%	1%	<1%	4%	21%	52%
Sunland Park	13,309	70%	1%	1%	<1%	26%	3%	96%

Region	Total Population	White	Black	American Indian	Asian	Other Race	More Than One Race	Hispanic or Latino
Los Alamos County	**18,343**	**90%**	**<1%**	**1%**	**4%**	**3%**	**2%**	**12%**
Los Alamos	11,909	89%	<1%	1%	4%	3%	2%	12%
Rio Arriba County	**41,190**	**56%**	**<1%**	**14%**	**<1%**	**26%**	**3%**	**73%**
Chama	1,199	68%	2%	3%	<1%	25%	3%	71%
Española	9,688	68%	1%	3%	<1%	26%	3%	84%
Sandoval County	**89,908**	**65%**	**2%**	**16%**	**1%**	**12%**	**3%**	**29%**
Bernalillo	6,611	60%	1%	4%	<1%	31%	4%	75%
Cuba	590	44%	<1%	27%	1%	24%	4%	60%
Jemez Springs	375	78%	0%	2%	2%	5%	13%	27%
San Ysidro	238	31%	1%	8%	<1%	54%	7%	72%
Rio Rancho	51,765	78%	3%	2%	1%	11%	4%	28%
Santa Fe County	**129,292**	**74%**	**1%**	**3%**	**1%**	**18%**	**4%**	**49%**
Santa Fe	62,203	76%	1%	2%	1%	15%	4%	48%
Edgewood	1,893	87%	<1%	2%	<1%	8%	2%	20%
Sierra County	**13,270**	**87%**	**<1%**	**1%**	**<1%**	**8%**	**3%**	**26%**
Elephant Butte	1,390	92%	<1%	2%	<1%	5%	1%	13%
T or C	7,289	85%	1%	2%	<1%	9%	3%	27%
Williamsburg	527	92%	2%	1%	<1%	2%	4%	13%
Socorro County	**18,078**	**63%**	**1%**	**11%**	**1%**	**20%**	**4%**	**49%**
Magdalena	913	63%	1%	10%	0%	5%	22%	48%
Socorro	8,877	66%	1%	3%	2%	23%	5%	55%
Taos County	**29,979**	**64%**	**<1%**	**7%**	**<1%**	**25%**	**4%**	**58%**
Questa	1,864	50%	<1%	1%	<1%	6%	43%	81%
Red River	484	93%	0%	1%	0%	3%	4%	9%
Taos	4,700	68%	1%	4%	1%	22%	5%	54%
Valencia County	**66,152**	**67%**	**1%**	**3%**	**<1%**	**24%**	**5%**	**55%**
Belen	6,901	68%	1%	2%	<1%	26%	4%	69%
Los Lunas	10,034	64%	1%	3%	1%	4%	28%	59%
TEXAS	**20,851,820**	**71%**	**12%**	**1%**	**3%**	**12%**	**2%**	**32%**
El Paso County	**679,622**	**74%**	**3%**	**1%**	**1%**	**18%**	**3%**	**78%**
El Paso	563,662	73%	3%	1%	1%	18%	3%	77%
Fabens	8,043	74%	1%	1%	<1%	22%	3%	96%
Hudspeth County	**3,344**	**87%**	**<1%**	**1%**	**<1%**	**9%**	**2%**	**75%**

Note: Columns do not total due to rounding and due to some double-counting of ethnic and racial populations.
Source: Census 2000a,b, c

To evaluate the relative income of each county, selected municipalities, and New Mexico pueblos in the study region, income and poverty rates for each were compared to their respective states. Those areas with income that is 70 percent or less than the state average and at least double the state poverty rate average are shown in **Table 3-13**.

Table 3-13. Comparison of Income and Poverty Rates to State Averages

County/Municipality	70% or Less Than State Median Household Income	70% or Less Than State Per Capita Income	At Least Double the State Poverty Rate
COLORADO			
Alamosa County	✓	✓	✓
Alamosa	✓	✓	—
Conejos County	✓	✓	✓
Costilla County	✓	✓	✓
Rio Grande County	✓	✓	—
Monte Vista	✓	✓	—
Saguache County	✓	✓	✓
NEW MEXICO			
Doña Ana County	—	—	✓
Hatch	✓	—	✓
Las Cruces	—	—	✓
Sunland Park	✓	✓	✓
Rio Arriba County	—	—	✓
Española	—	—	✓
Sandoval County	—	—	✓
Bernalillo	—	—	✓
Cuba	✓	✓	✓
Jemez Springs	—	—	—
Sierra County	—	—	✓
T or C	✓	—	✓
Williamsburg	✓	—	—
Socorro County	✓	—	✓
Magdalena	✓	—	✓
Socorro	✓	—	✓
Taos County	—	—	✓
Questa	✓	—	✓
Taos	—	—	✓
Valencia County	—	—	—
Belen	—	—	✓

County/Municipality	70% or Less Than State Median Household Income	70% or Less Than State Per Capita Income	At Least Double the State Poverty Rate
TEXAS			
El Paso County	—	✓	·
El Paso	—	—	✓
Fabens	✓	✓	✓
Hudspeth County	✓	✓	—

Sources: Derived from Census 2000a,b,c

3.14 Other Resources Considered

3.14.1 Air Quality

The National and New Mexico ambient air quality standards are listed in **Table 3-14**. In the New Mexico portion of the planning area, Doña Ana County is designated by EPA as a nonattainment area for failure to meet 10 micron particulate matter (PM10) and 1-hour ozone National Ambient Air Quality Standards (NAAQS). In the Texas portion of the planning area, El Paso County is in nonattainment for carbon monoxide, ozone (1-hr), and PM10. No Colorado counties in the planning area are in nonattainment for any pollutant.

Table 3-14. National and New Mexico Ambient Air Quality Standards

Pollutant	Averaging Time	NM Standards	National Standards
Ozone	1 hr	—	0.124 ppm
	8 hr	—	0.084 ppm
Carbon monoxide	1 hr	13.10 ppm	35 ppm
	8 hr	8.70 ppm	9 ppm
Nitrogen dioxide	annual	0.05 ppm	0.053
	24 hr	0.10 ppm	—
PM_{10}	annual	—	50 µg/m^3
	24 hr	—	150 µg/m^3
Sulfur dioxide	annual	0.02 ppm	0.03 ppm
	24 hr	0.10 ppm	0.14 ppm
Lead	quarter	—	1.5 µg/m^3

Sources: EPA 2004; NMED 2004

The major air pollutants at the various reservoirs are particulate matter in the form of windblown fugitive (transitory) dust. Under normal conditions, blowing dust in the general area depends on wind speed and soil moisture content. Local dust sources adjacent to reservoirs include the exposed, drying lake bed at the reservoir edges, recreational vehicles driving on dirt roads, and wind blowing over barren areas. Some of the existing air quality impacts at the reservoirs considered in this Review and EIS are from recreational ground and water vehicles and depend on the location of individual recreation facilities and management of those facilities, rather than from reservoir level fluctuations. As the area is currently responding to record drought and reservoir levels are historically low, reservoir recession has exposed large areas of the reservoir with subsequent invasion by vegetation. The vegetative cover helps stabilize sediments, reduces wind speed and exposed dust surface, and adds to habitat used by wildlife.

3.14.2 Noise

The lands adjacent to the reservoirs and rivers are relatively undeveloped, except where the river bisects established municipalities. Dominant sounds in the project area originate from natural sources: water, wind, and wildlife. Local traffic noise is generated by various highway crossings. Noise levels and patterns at developed recreation areas and frequently-used informal use areas are localized and typical of campground and day use recreational areas. Beyond these formal and informal recreation areas, the most conspicuous noise producers are power boats and jet skis on the reservoirs that allow these activities. noise levels above 85 decibels (dB) will harm hearing over time. Noise levels above 140 dB can cause damage to hearing after just one exposure. **Table 3-15** lists common noises and their decibel levels for reference.

Table 3-15. Points of Reference for Noise

dB or Decibels	Activities
1	The softest sound a person can hear with normal hearing
9	normal breathing
29	soft whisper
40	quiet residential area
50	rainfall
60	normal conversation
70	freeway traffic
80	whistling kettle
85	heavy traffic, noisy restaurant
90	truck, shouted conversation
95-110	motorcycle
100	snowmobile
110	busy video arcade
110	car horn
112	personal cassette player on high
120	thunder
125	chain saw
130	stock car races
150	jet engine taking off
162	fireworks (at 3 feet)
170	shotgun

Source: LHH 2001

3.14.3 Toxic or Hazardous Materials

Toxic and hazardous materials sites in the planning area include waste transportation, storage, treatment, and disposal facilities potentially exposed to flooding, scour or other damage. Examples of such facilities include pipeline river crossings and municipal sewage treatment facilities. Possible facilities of concern include: pipelines transporting compressed natural gas (CNG) and liquefied petroleum gas (LPG) that may become exposed with excessive river scour, downcutting, or erosion. If such damage occurred, the CNG would be considered an airborne hazard and LPG would become a waterborne petroleum contamination hazard.

3.14.4 Seismicity

The Rio Grande rift in north-central New Mexico and south-central Colorado was created by seismic action associated with the Laramide structural uplift, known for creating the Rocky Mountains. In the valley of the Rio Grande and Rio Chama, this uplift is manifested as a series of structural basins arranged in a right-stepping, en echelon pattern, with high heat flow, abundant late Quaternary faults and volcanism, as well as thick accumulations of basin sediments. It is these sediments that form the aquifer conditions that create a river basin of interconnected groundwater and surface water. Historical seismicity shows over 100 faults in the rift, with at least 20 exhibiting evidence for movement in Holocene (past 15,000 years) time (Wong et al. 2004). Besides naturally-occurring seismic events, reservoir-induced seismicity upon initial filling where storage depths exceed 80 to 100 meters (Allen 1982) and the seasonal recharge of groundwater through snowmelt events at higher elevations (Saar and Manga 2003) are reported to be able to trigger seismic events in some cases.

In this Review and EIS, no new facilities are being constructed. The proposed operational changes are for facilities in New Mexico, both on the Rio Chama and the Rio Grande above Elephant Butte reservoir. Seismic impacts, if any, are limited to the impacts of emptying and refilling these facilities, as most of the melting snow effects are in the project area where no changes in operations are proposed. Areas mapped with Holocene (less than 15,000 years) fault movement (Wong et al. 2004) do not underlie these facilities. As noted earlier, this Review and EIS proposes changes for existing facilities, which means that initial reservoir filling has already occurred. No reservoir-induced seismic events are known to have occurred when these reservoirs were initially filled.

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