APPENDIX N
AGRICULTURE, LAND USE, FLOOD CONTROL, RECREATION, AND ECONOMICS

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Table of Contents

List of Tables

Table ***Page***

1.0 AGRICULTURE—LAND USE

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. This buffer comprises a total of 2,811,370 acres, of which about 7 percent overall is devoted to agriculture (**Table N-1.1**). The Southern Section of the project area has the highest percent of its land devoted to agriculture (13 percent); the Rio Chama and San Acacia Sections have the least (2 percent each). Agricultural acreage includes irrigated and non-irrigated 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.

Table N-1.1 Agricultural Acreage in the 5-km Buffer

River Section	Reach No.	Reach Acreage	Agriculture Acreage/ Reach	% Agricultural/ Reach
Northern	1	158,990	7,111	4%
	2	284,563	39,718	14%
	3	271,016	833	0%
	4	38,664	1,657	4%
	Subtotal	753,233	49,319	7%
Rio Chama	5	76,914	2,815	4%
	6	179,061	82	0%
	7	105,231	2,158	2%
	8	52,847	2,716	5%
	9	97,109	26	0%
	Subtotal	511,162	7,797	2%
Central	10	117,623	4,344	4%
	11	37,060	0	0%
	12	133,423	7,436	6%
	13	161,072	22,666	14%
	Subtotal	449,926	34,446	8%
San Acacia	14	439,926	10,441	2%
	Subtotal	439,926	10,441	2%
Southern	15	102,247	665	1%
	16	399,810	46,665	12%
	17	155,814	35,196	23%
	Subtotal	657,871	82,526	13%
	Total	**2,811,370**	**184,529**	**7%**

Source: USGS and EPA 2000

1.1 Irrigated Agriculture Crop Types

1.1.1 Northern Section

The Northern Section includes portions of the Rio Grande in Colorado and in New Mexico. Within the 5-km buffer along the Rio Grande, the Northern Section of the river comprises 753,233 acres, of which about 7 percent is agricultural (Table N-1.1). The region of the Northern Section in Colorado includes Reach 1 (Rio Grande from Alamosa to the Colorado-New Mexico border) and Reach 2 (Conejos River from Platoro Reservoir to the Rio Grande confluence).

Up to 98,000 acres in this region are agricultural lands that have access to irrigation water from the two rivers (Vandiver 2003). This acreage includes a significantly larger area than is designated by the 5-km buffer. The number of acres that is actually irrigated in this region varies dramatically from year to year depending on the size of the water year and the extent of snow pack. Most of Reach 1 runs through two large ranches and the Alamosa National Wildlife Refuge, where 8,000 acres of native pasture are irrigated. The remaining irrigated acreage lies within Reach 2, and is devoted to alfalfa, small grains, potatoes and native grasses.

In the New Mexico portion of the Northern Section (Reaches 3 and 4), about 70 percent of the agricultural land is devoted to forage; about 6 percent is divided between small grains and fruits and vegetables (**Table N-1.2**). The rest (23 percent) is left fallow. Reach 3 (Rio Grande from the Colorado-New Mexico border to Velarde) runs through the Carson National Forest and through the Taos and Picuris pueblos. The negligible amount of agricultural land (less than 0.5 percent) recorded along this reach falls in the pueblo lands. The majority of Reach 3 flows through Taos County. In Taos County, forage crops account for most (70 percent) of the irrigated lands (**Table N-1-3**). Almost half of the forage crop acreage is planted in alfalfa; the rest is divided between planted pastures and native pastures.

Table N-1.2 Percent Crop Type Acreage for River Sections in New Mexico

Crop type	Northern	Rio Chama	Central	San Acacia	Southern
small grains	3%	2%	3%	8%	3%
corn	0%	3%	5%	3%	3%
forage	70%	65%	52%	76%	23%
fruit/veg	3%	4%	8%	4%	14%
orchard	1%	2%	1%	0%	17%
cotton	0%	0%	0%	0%	26%
fallow	23%	24%	31%	9%	14%

Source: Derived from Lansford et al. 1993a, b; 1996
Notes: Data 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.
Fruits/vegetables—potatoes, vineyards, melons, beans, peanuts, other field crops, lettuce.
Tree Crops— fruit and nut orchards.
Other—idle and fallow irrigated cropland.

Table N-1.3 Percent Crop Type in Counties of Northern and Rio Chama Sections

Crop Type	Taos	Rio Arriba	Santa Fe
	%	%	%
Grains	4%	1%	5%
Corn	0%	0%	23%
Forage	70%	71%	46%
Fruits/Vegetables	3%	3%	7%
Tree Crops	0%	2%	2%
Cotton	0%	0%	0%
Other	22%	23%	17%
Total	**100%**	**100%**	**100%**

Source: Lansford et al. 1993a,b; 1996
Note: Data averaged over the years 1991-1995
Crop Types are categorized as follows:
Grains—wheat, barley, sorghum grown for grain, other small grains (unspecified).
Forage—alfalfa, other hays, planted pasture, native pasture.
Fruits/Vegetables—potatoes, beans, peanuts, other field crops, lettuce.
Tree Crops—fruit orchards.
Other—idle and fallow irrigated cropland

Reach 4 (Rio Grande from Velarde to the Rio Chama confluence), which runs through San Juan Pueblo, Española, and the small communities immediately north of Española, contains a somewhat higher proportion of agricultural lands (4 percent) (Table N-1.1). This entire reach falls within Rio Arriba County, in which forage crops account for most (71 percent) of the irrigated lands (Table N-1.3). Almost 75 percent of the forage crop acreage is in planted pastures; the rest is divided between alfalfa and native pasture.

1.1.2 Rio Chama Section

Within the 5-km buffer along the Rio Grande, the Rio Chama Section of the river (Reaches 5 through 9) comprises 511,162 acres, of which relatively little (2 percent) is agricultural (Table N-1.1). The percentages of crop types in this section are similar to those in the Northern Section (Table N-1.2). 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.

Reaches 5, 6, and 7 lie along the Rio Chama. Little is known about agricultural land along Reach 5 (from Heron Reservoir to El Vado); most of this reach runs through Heron Lake and El Vado Lake state parks (Wells 2003),

Along Reach 6 (from El Vado to Abiquiu reservoir), there are approximately 100 acres of land with access to irrigation by the Rio Chama. The U.S. Forest Service (USFS) has most of this acreage in irrigated rangeland pasture. A small amount of the irrigated acreage belongs to a monastery that has a vegetable garden (Wells 2003). This information corresponds with the statistics for Rio Arriba County described above (Table N-1.3), which is the county through which Rio Chama runs.

Reach 7 (Rio Chama from Abiquiu Reservoir to the Rio Grande confluence) runs through San Juan Pueblo and the small communities to northwest of Española. There are approximately 5,250 irrigated acres (Newville 2003), of which 94 percent is planted in alfalfa and pasture (Wells 2003). The remaining irrigated acreage is devoted to family orchards and a few small organic gardening ventures. This information corresponds with the statistics for Rio Arriba County, through which the entire Rio Chama runs (Table N-1.3).

Reach 8 (Rio Grande from the Rio Chama confluence to the Otowi gage) runs through the alluvium of the Española Valley. Here, the San Juan, Santa Clara, Pojoaque, and San Ildefonso pueblos, along with the communities immediately south of Española, contribute to a somewhat higher degree of agriculture (5 percent). The major portion of Reach 8 runs through Santa Fe County, in which nearly half of the agricultural acreage is devoted to forage crops (mostly alfalfa) and a significant portion (23 percent) to corn (Table N-1.3). The remaining acreage is divided between small grains (mostly wheat), fruits and vegetables, and orchards.

Reach 9 (Rio Grande from Otowi gage to Cochiti Dam) runs through Santa Fe National Forest and Bandelier National Monument, which is why there is almost no land along this reach that is considered agricultural (Table N-1.1).

1.1.3 Central Section

The Central Section of the project area begins at Cochiti Dam and ends at Elephant Butte Reservoir. This region includes Reaches 10 through 13. 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. Within the 5-km buffer along the Rio Grande, the Central Section comprises about 449,178 acres, of which about 8 percent is agricultural (Table N-1.1). In general, from the Northern to the Central Section, there is a steady decrease in land devoted to pasture forage and an increase in land planted in crops (Table N-1.2). 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.

All of Reach 10 falls within Sandoval County, in which 59 percent of the irrigated agricultural lands are devoted to forage crops (mostly planted pasture) (**Table N-1.4**). A small portion of the agricultural lands (7 percent) is devoted to fruits and vegetables, and 24 percent is irrigated idle or fallow land. The rest is divided between small grains, corn, and orchards. Reach 11 (the small portion of the Jemez river between Jemez Dam and the Rio Grande confluence) is assumed to fall within the 5-km buffer along Reach 10 and therefore to be included in the data presented for Reach 10.

Table N-1.4 Percent Crop Type for Counties in Central Section

Crop Type	Sandoval	Bernalillo	Valencia
	%	%	%
Grains	1%	1%	7%
Corn	2%	9%	6%
Forage	40%	64%	53%
Fruits/Vegetables	9%	11%	6%
Tree Crops	2%	1%	0%
Cotton	0%	0%	0%
Other	45%	15%	28%
Total	**100%**	**100%**	**100%**

Source: Lansford et al. 1993a,b; 1996.
Note: Data averaged over the years 1991-1995.
Crop Types are categorized as follows:
Grains—wheat, barley, sorghum grown for grain, other small grains
Forage—alfalfa, sorghum, planted pasture, native pasture.
Fruits/Vegetables—beans, vineyards, chilies, other field crops lettuce.
Tree Crops—fruit orchards
Other—idle and fallow irrigated cropland

Most of Reach 12 falls within Bernalillo County, in which 64 percent of the agricultural lands is devoted to forage crops (two-thirds of which is alfalfa; the rest is planted pasture) (Table N-1.4). Approximately 15 percent is idle or fallow irrigated land. The remaining irrigated acreage is divided between corn, and fruits and vegetables, with a very small amount of land planted in small grains and orchards.

Most of Reach 13 falls within Valencia County, in which half (53 percent) of the irrigated agricultural lands is devoted to forage crops (mostly alfalfa and planted pasture) (Table N-1.4) and 28 percent is idle or fallow. The rest of the irrigated acreage is divided, for the most part, between small grains, corn, and fruits and vegetables.

1.1.4 San Acacia Section

The San Acacia Section of the river flows near the La Joya Wetland Game Refuge, the Sevilleta and Bosque del Apache National Wildlife Refuges, and Elephant Butte State Park, which may account for the somewhat lower levels of agricultural land use in this section. Within the 5-km buffer along the Rio Grande, the San Acacia Section (Reach 14) comprises approximately 439,926 acres, of which about 2 percent is agricultural (Table N-1.1). 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 pasture; about 15 percent is planted in small grains, fruits and vegetables (Table N-1.2). Only about 9 percent is left fallow. Most of Reach 14 falls within Socorro County, in which 77 percent of the irrigated agricultural land is devoted to forage (mostly alfalfa) and only 8 percent is idle or fallow. The rest is divided between small grains, corn, and fruits and vegetables (**Table N-1.5**).

1.1.5 Southern Section

The Southern Section includes lands along the Rio Grande from Elephant Butte Reservoir in New Mexico to American Dam at El Paso near the New Mexico-Texas border to Fort Quitman in Texas. This region includes Reaches 15, 16, and 17.

Within the 5-km buffer along the Rio Grande, the Southern Section comprises approximately 657,871 acres, of which about 12.5 percent are agricultural (Table N-1.1), the highest level of agricultural land use in the project area. Overall, fallow land decreases and land devoted to field crops (most notably cotton) and orchards increases in the Southern Section (Table N-1.2). Acreage devoted to forage pasture decreases to a low of 23 percent, about the same amount as is planted in cotton (26 percent). Land planted in fruits and vegetables and fallow land are all about 15 percent of the total agricultural acreage.

All of Reach 15 is in Sierra County, in which most of the irrigated agricultural land is devoted either to forage crops (31 percent) or to fruits and vegetables (27 percent). Small grains and corn each account for over 10 percent of the irrigated acreage. The remaining 4 percent is divided between tree crops and cotton (Table N-1.5).

Table N.1-5 Percent Crop Type for Counties in San Acacia and Southern Sections

Crop Type	Socorro	Sierra	Doña Ana
	%	%	%
Grains	8%	7%	4%
Corn	3%	5%	5%
Forage	77%	31%	16%
Fruits/Vegetables	3%	27%	16%
Tree Crops	0%	3%	18%
Cotton	0%	1%	21%
Other	8%	25%	20%
Total	**100%**	**100%**	**100%**

Source: Lansford et al. 1993a,b; 1996.
Note: Data averaged over the years 1991-1995
Crop Types are categorized as follows:
Grains—wheat, unspecified small grains.
Forage—alfalfa, sorghum, planted pasture, native pasture.
Fruits/Vegetables—beans, vineyards, chilies, lettuce, other field crops.
Tree Crops—fruit and nut orchards.
Other—idle and fallow irrigated cropland.

Most of Reach 16 lies within Doña Ana County, where the irrigated acreage is more or less evenly divided between forage crops, fruits and vegetables, pecans, cotton, and fallow or idle lands (Table N-1.5). Less than 10 percent is divided between small grains and corn. The total land irrigated in the two counties in the southern region is estimated at 109,934 acres.

All of Reach 17 lies within Texas between El Paso and Fort Quitman. There are 155,814 acres within the 5-km buffer, of which 23 percent is considered agricultural (Table N-1.1). According to U.S. Bureau of Reclamation (Reclamation) data (2001), there are 49,396 agricultural acres irrigated per year in this region (**Table N-1.6**). Nearly 50 percent of this land is used for growing cotton. Almost 25 percent is planted in pecans and another 25 percent in forage. The small amount of remaining acreage (less than 3 percent) is planted in fruits and vegetables and in family gardens and orchards.

Table N-1.6 Texas Crop Acreage (For the Year 2001)

Crop Type	Acreage 2001	% of Total
Grains	0	0%
Corn	0	0%
Forage	12,298	25%
Fruits/Vegetables	1,226	2%
Nuts	11,484	23%
Cotton	24,277	49%
Other	111	0%
Total	**49,396**	**100%**

Source: Reclamation 2001
Note: Crops categorized as follows:
Forage—silage, alfalfa, other hay, pasture.
Fruits/Vegetables—onions, peppers, other miscellaneous field crops.
Tree Crops—pecans.
Other family gardens and orchards (*not* fallow or idle lands).

1.1.6 Irrigation Water Source

In general, when surface water is available from the Rio Grande or one of its tributaries, this is the source of water used for irrigating agricultural lands. Some lands have access only to surface water. Some lands have access to both groundwater (through private wells) and to surface water. The lands that use a combination of sources only use the wells in years when the surface water is insufficient. A smaller portion of lands use groundwater exclusively.

1.1.7 Colorado

All water used for agricultural irrigation in the Closed Basin region of the Project Area is surface water delivered from the Rio Grande and Rio Conejos by irrigation ditches.

1.1.8 New Mexico

The overall trend indicates that irrigation in the northern part of the state relies most heavily on surface water, whereas farther south, groundwater becomes increasingly important. More specifically, in the counties of northern New Mexico, most (81 percent) of the irrigated acreage is served by surface water only. A substantial portion (17 percent) is served by groundwater only (**Table N-1.7**). A negligible portion (2 percent) is served by surface water that is supplemented by well water as needed.

In the counties of central New Mexico, the acreage irrigated by only surface water decreases (to 59 percent), while the acreage served by surface water that is supplemented by well water increases (to 39 percent). Only 2 percent is served by groundwater only. This practice contrasts with the counties in southern New Mexico, where negligible acreage is served by surface water only (3 percent). Most of the land is served by surface water that is supplemented by well water as needed (86 percent); 11 percent is served by groundwater only.

1.1.9 Texas

All irrigation of agricultural lands in Texas from El Paso to Fort Quitman has involved the use of surface water for a number of years (Grajeda 2003). However, due to the short supply of water in 2003, groundwater may be used during following growing seasons.

Table N-1.7 Acreage of Land Irrigated by Surface Water Only or Groundwater Only or a Combination of Surface Plus Groundwater

County	Reach No.	Acreage	% Surface	% Ground	% Combination
Taos	3	41,900	86%	12%	2%
Rio Arriba	4,5,6,7	41,110	98%	1%	1%
Santa Fe	8	18,070	32%	63%	5%
Northern New Mexico		101,080	81%	17%	2%
Sandoval	9,10	17,270	95%	0%	5%
Bernalillo	12	10,630	64%	3%	33%
Valencia	13	28,542	66%	0%	34%
Socorro	14	21,240	16%	6%	78%
Central New Mexico		77,682	59%	2%	39%
Sierra	15	11,400	27%	26%	47%
Doña Ana	16	96,030	0%	10%	90%
Southern New Mexico		107,430	3%	11%	86%

Source: Lansford et al. 1993a, 1993b, 1996
Notes: Data averaged over the years 1991–1995.
Reach No. refers to associated reach and is not an exact match with the reaches.

1.2 Non-Irrigated Crop Types

1.2.1 Colorado

No information is available concerning dryland farming in Colorado.

1.2.2 New Mexico

The overall trend indicates that non-irrigated agriculture is practiced more in the northern regions of New Mexico where there is more rain and the summers are cooler. Non-irrigated agriculture is practiced less the farther south the farmland is located.

Non-irrigated agriculture accounts for 9 percent to 13 percent of the agricultural acreage in the counties of northern New Mexico (**Table N-1.8**). In three of the central counties, dryland farming accounts for less than 9 percent of the total farmland cultivated. In one central county (Bernalillo) dryland farming is practiced on 45 percent of the land. No dryland farming is practiced in the southern counties of New Mexico.

According to one review, there is a historical trend as well (SSPA 2002). Approximately 30 percent of agricultural lands in the MRGCD were dry cropped prior to and during the 1970s. This average shifted to the current levels of dryland farming in the 1980s.

Table N-1.8 Dry Crops (Percent Farmland Acreage Irrigated and Dry Cropped in New Mexico Data Averaged Over the Years 1991–1998)

County/Region	Associated Reach No.	Total Acres Farmed	% Irrigated	% Dry Cropped
Taos	3	47,900	87%	13%
Rio Arriba	4,5,6,7	45,110	91%	9%
Santa Fe	8	20,100	90%	10%
Northern New Mexico		113,110	89%	11%
Sandoval	9,10	19,070	91%	9%
Bernalillo	12	11,630	91%	9%
Valencia	13	28,542	100%	0%
Socorro	14	38,740	55%	45%
Central New Mexico		97,982	79%	21%
Sierra	15	11,400	100%	0%
Doña Ana	16	96,030	100%	0%
Southern New Mexico		107,430	100%	100%

Source: Lansford et al. 1996; USDA 1997, 1998
Note: Irrigated farmland includes idle and fallow land that is irrigated.

1.2.3 Texas

Approximately 15 percent of the agricultural acreage in Texas is dry cropped (Reclamation 2001).

1.3 Impact Analysis

The review for agricultural resources evaluates whether operational actions could change conditions needed to support the type, extent, and quantity of agriculture currently practiced within the Upper Rio Grande Basin. Drought and population growth have had incremental impacts on land use, crop types, and harvest levels over time and will continue to do so. This analysis is primarily concerned with identifying distinguishable differences between the alternatives for key issues that directly affect agriculture in the Basin. These include:

- Impacts to delivery of water to irrigators and growers (Central and San Acacia Sections);
- Impacts to acequia diversion structures (Rio Chama Section);
- Loss of viable agricultural land and crops through inundation;
- Loss of or reduced productivity of agricultural lands due to saturated soil conditions (Rio Chama).

The analysis relies on summarized outputs from URGWOM and FLO-2D to make broad comparisons using the following measurable criteria:

- Average seasonal shortfall in meeting irrigator water requests; number of years with shortfalls; number of days with shortfalls;
- Number of days when diversion elevation are exceeded by river elevation;
- Extent and duration of inundated agricultural land (Reach 7, 8, 9, 12, 13, 14);
- Frequency of prolonged "bank full" flows (Reach 7).

1.3.1 Assumptions and Limitations

Proposed water operations evaluated in the Review may affect about 53,000 acres of agricultural land located immediately adjacent to the Rio Chama, Central and San Acacia Sections. This represents less than 30 percent of the agricultural land in the entire upper Rio Grande basin. Other sections and reaches that are outside the influence of the proposed changes to water operations within the authority of this review are not evaluated further, including the Northern Section, Reach 5 in the Rio Chama Section, Reach 11 in the Central Section, and the Southern Section.

- The demand schedule for irrigators below Cochiti is assumed to be the same as current demands over the next 40-years;
- Several existing agreements will ensure meeting water needs to irrigators along the Rio Chama, and therefore issues revolve around performance of the diversion structures, soil saturation, and inundation.

Tables N-1.9 through **N-1.15** provide data analyses for key criteria that may affect agriculture associated with the upper Rio Grande system. These criteria are indicative but not all-inclusive of river-related factors that affect growers, and illustrate the relative difference between the alternatives in responding to agricultural needs. Complex agreements between the State of New Mexico and the City of Albuquerque allow irrigation water demands of growers along the Rio Chama to be maintained (Gallegos 2004).

Table N-1.9 provides aggregated data on deliveries to four diversions that supply irrigators in the Rio Chama, Central, and San Acacia Sections. For this analysis, delivery shortfalls occur when water supply to irrigators is less than what is requested. The delivery shortfalls shown in the table are primarily a function of the water available in the system due to the hydrograph, and is summarized using data from the 40-year sequence used in the URGWOM Planning Model. The URGWOM Planning Model was set up to meet irrigation demands when possible. For that reason, there are insignificant differences across the alternatives as a result of any proposed changes to water operations.

Table N-1.9 Delivery Shortfalls—Aggregated Data from URGWOM Planning Model for Four Diversions

Diversion	Alternatives						
	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Average Shortfall per Day (cfs)							
Cochiti	-24.6	-24.6	-33.6	-24.2	-23.9	-26.0	-32.9
Isleta	-369.1	-368.6	-368.0	-367.7	-369.1	-369.2	-368.5
San Acacia	-53.7	-53.4	-53.3	-53.7	-53.8	-53.7	-53.7
San Felipe	-139.3	-135.0	-137.8	-137.9	-137.9	-138.5	-138.9
Average Number of Days of Shortfall During years of Shortfall (# days)							
Cochiti	21	22	21	24	25	20	20
Isleta	137	138	140	139	138	139	139
San Acacia	49	49	50	50	49	50	50
San Felipe	50	54	48	50	50	48	48
Number of Years of When Shortfalls Occur (# years)							
Isleta	40	40	40	40	40	40	40
San Acacia	37	37	37	37	37	37	37
San Felipe	25	23	26	25	25	26	26

Diversion	Alternatives						
	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Average Seasonal Shortfall (cfs)							
Cochiti	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2	-0.3
Isleta	-205.0	-206.6	-208.7	-207.7	-206.6	-208.1	-208.6
San Acacia	-10.3	-10.3	-10.4	-10.4	-10.3	-10.5	-10.5
San Felipe	-14.5	-14.0	-14.3	-14.3	-14.5	-14.5	-14.5
Days of Shortfall over a 40-year period (# days)							
Cochiti	106	89	103	96	101	100	102
Isleta	5,464	5,516	5,581	5,557	5,507	5,545	5,571
San Acacia	1,805	1,828	1,843	1,834	1,814	1,840	1,845
San Felipe	1,245	1,241	1,243	1,243	1,262	1,256	1,250

Table N-1.10 summarizes the average annual seasonal requests for deliveries from irrigators in the Central and San Acacia Sections over the 40-year project life compared to diversions. The Cochiti Diversion is projected to receive most of its requested demand and the Isleta Diversion experiences significant shortfalls from requested demand. As described above for shortfalls, are primarily a function of the water available in the system due to the hydrograph, and the differences are insignificant across alternatives.

Table N-1.10. Irrigation Requests Vs. Demands in the Central and San Acacia Sections

Diversion	Alternatives						
	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Average Annual Seasonal Request (cfs)							
Cochiti	196.4	196.4	196.4	196.4	196.4	196.4	196.4
Isleta	494.2	494.2	494.2	494.2	494.2	494.2	494.2
San Acacia	103.4	103.8	104.1	103.9	103.7	103.9	104.1
San Felipe	229.9	229.9	229.9	229.9	229.9	229.9	229.9
Average Annual Seasonal Diversions (cfs)							
Cochiti	196.1	196.2	196.1	196.2	196.2	196.1	196.1
Isleta	289.3	287.6	285.5	286.6	287.6	286.2	285.6
San Acacia	93.2	93.5	93.7	93.5	93.3	93.5	93.6
San Felipe	215.4	215.9	215.6	215.6	215.4	215.4	215.4

Tables N-1.10 and **N-1.11** reflect the same pattern in the variation between the number of years and percentage of delivery days where shortfalls are estimated over the project life.

Table N-1.10 Average Annual Seasonal Shortfall to Irrigators over 40 Year-Sequence (Central and San Acacia Sections)

Alternative	Avg. Annual seasonal shortfall (%)	Cochiti Diversion[1] (cfs)	Isleta Diversion[1] (cfs)	San Acacia Diversion[2] (cfs)	San Felipe Diversion[2] (cfs)
No Action	31.7	0.2	61.6	15.5	7.8
B-3	31.9	0.1	62.1	15.7	7.5
D-3	32.2	0.2	62.7	15.7	7.7
E-3	32.1	0.2	62.4	15.8	7.7
I-1	31.9	0.2	62.1	15.6	7.8
I-2	32.2	0.2	62.5	15.8	7.8
I-3	32.3	0.2	62.7	15.9	7.8

Notes:

1. Central Section
2. San Acacia Section

Table N-1.11 Shortfalls in Delivery of Water to Irrigators over 40 Years (Central and San Acacia Sections)

Alternative	No. of years with shortfall				Number/% days with shortfall			
	A	B	C	D	A	B	C	D
No Action	5	40	37	25	106/1	5,464/56	1,805/18	1,245/10
B-3	4	40	37	23	89/1	5,516/56	1,828/19	1,241/10
D-3	5	40	37	26	103/1	5,581/57	1,843/19	1,243/10
E-3	4	40	37	25	96/1	5,557/57	1,834/19	1,243/10
I-1	4	40	37	25	101/1	5,507/56	1,814/19	1,262/11
I-2	5	40	37	26	100/1	5,545/57	1,840/19	1,256/11
I-3	5	40	37	26	102/1	5,571/57	1,845/19	1,250/10

Notes:

1. Cochiti diversion (Central Section)
2. Isleta diversion (Central Section)
3. San Acacia diversion (San Acacia Section)
4. San Felipe diversion (San Acacia Section)

Inundation is another key criterion evaluated because crops may be damaged or destroyed by flooding, depending on the time and duration of the event. Output from FLO-2D provides the projected maximum extent, location, and duration of inundation over the 40-year sequence for the Rio Chama, Central and San Acacia Sections. This geospatial information of the extent of inundation was also examined in combination with aerial photography in order to discern land cover and use of inundated areas. **Table N-1.12** provides the aggregated data from FLO-2D modeling outputs for projected inundation of cropland by section. **Table N-1.13** summarizes acre-days of inundation by section estimated for the 40-year project period for the alternatives. Inundation of agricultural land is very localized, and is mostly concentrated at a few locations along the Rio Chama below Abiquiu. The No Action performs reasonable well in limiting inundation and potential impact on agriculture. The extent of inundation of agricultural land on tribal and pueblo areas is not included in these tables and the acre-days of inundation is recognized to be overestimated due to the model output that provided maximum inundation and maximum area inundated per year. Based on an examination of inundated areas, agricultural land would overall be least affected under the No Action on the Rio Chama. Based on information of all lands inundated, Alternative B-3 performs fairly well for both the Rio Chama and Central Section. Model outputs show no inundation on agricultural land below Bernalillo (i.e., Reaches 12, 13, and 14) under any alternative.

Table N-1.12 Inundation of Agricultural Lands

Alternative	Total inundation (acre-days)[1]			Inundated agricultural land (acre-days)[1]		
	Rio Chama Section	Central Section	San Acacia Section	Rio Chama Section[2]	Central Section[3]	San Acacia Section
No Action	58,173	442,721	2,832,820	9,496	0	0
B-3	61,730	399,937	1,180,849	11,340	0	0
D-3	142,153	493,045	532,531	23,547	0	0
E-3	109,085	442,045	592,805	19,279	0	0
I-1	163,010	509,956	518,686	28,279	0	0
I-2	133,150	478,655	2,332,710	23,529	0	0
I-3	112,595	430,853	2,136,233	19,933	0	0

Notes:

1. It is assumed for this analysis that areas outside levees would not be inundated.
2. Totals do not include agricultural land in tribal areas in Reach 9.
3. Some portion of inundated land in reach 10 in the Central Section, mostly in tribal and pueblo land, may be agricultural, but the quantity is unknown. No agricultural land in the reaches 12 or 13 in the Central Section is inundated.

Diversion structures along the Rio Chama are frequently washed out and some level of seasonal maintenance and repairs after high flow events is normal. While overtopping diversions does not necessarily result in damage, this criterion is indicative of which alternatives may be more maintenance intensive than others. **Table N-1.13** shows the number of times any diversion on the Rio Chama is overtopped at least once in the runoff season over 40 years. Under the No Action, this occurs 219 times out of a total of 520 possible occurrences over 40 years. The No Action represents the projected 40-year hydrology sequence with current water operations. Overtopping of diversion structures require maintenance and possible interruptions in delivery of irrigation water along acequias.

Table N-1.13 Overtopping Events of Diversions Along the Rio Chama – 40-Year Sequence

Alternative	No. of years with one diversion overtopped	Number of overtopping events[1]	Difference from No Action (%)
No Action	38	219	-
B-3	35	174	21
D-3	34	199	9
E-3	36	210	4
I-1	38	225	-3
I-2	36	214	2
I-3	36	210	4

Source: FLO-2D , Reach 7, maximum elevation; diversion grid cells

Notes:

1. Sum of annual tally of diversions overtopped at least once in any given year.

Saturated soils along the Rio Chama (below Abiquiu) is an ongoing concern for crops planted adjacent to the river. Saturated soils are unsuitable for roots for most crops and can inhibit seed germination. In addition, growers may be unable to "work" saturated soils. These conditions result when the river runs at "bank full" for extended periods. **Table N-1.14** provides aggregated data derived from URGWOM outputs for this criterion. To compare the potential for this problem to occur, **Table N-1.15** shows the number of events when discharges out of Abiquiu are 1,500 cubic feet per second (cfs) or greater for durations of 7 days or more over the 40-year project period. Under the No Action, this situation may result 33 times over the next 40-years during the spring and summer run-off season. The No Action performs least favorably of the alternatives on these criteria. (Other events may occur because of precipitation outside the modeled spring and summer runoff season.) Alternative B-3 provides the most favorable conditions for Reach 7 with the least potential for bank full conditions.

Table N-1.14 Bankfull Conditions Reach 7

times flows exceed 1500 cfs for more than 7 days by alternative

Alternative	Total # times	Total # times during growing season
Alt B	0	0
Alt D	24	20
Alt E	24	19
Alt I-1	32	32
Alt I-2	27	27
Alt I-3	24	19
No Action	33	33

Total # days when flows exceed 1500 cfs

Alternative	Total # days	Total # days during growing season
Alt B	3	0
Alt D	852	741
Alt E	895	773
Alt I-1	1,214	1,213
Alt I-2	989	989
Alt I-3	903	780
No Action	1,255	1,253

Table N-1.15 Extended Bank Full Events over 40-years in Reach 7

Alternative	Number of bank full events
No Action	33
B-3	0
D-3	20
E-3	19
I-1	32
I-2	27
I-3	19
Average	21

Source: URGWOM, 40 year daily flows at gauge below Abiquiu

Agriculture is one of the uses of pueblo and tribal land along the river. Delivery of irrigation water to tribes and pueblos is provided for as one of the non-discretionary operational criteria and therefore would not vary between alternatives. Climate and weather can affect deliveries. However, impact of drought on deliveries to tribes is beyond the scope of this evaluation. The difference in impacts between the alternatives from inundation of agricultural lands on pueblos may be similar to the effects reported for inundation in Reach 7 in **Table N-1.16**. Based on this, inundation of agricultural lands on pueblos may be slightly less extensive under the No Action.

Table N-1.16 Inundation by Reach – Aggregated Grid Cell Data Showing Inundation of Agricultural Land in Reach 7

Alternative	Reach 7 (Rio Chama Section)
Agricultural Land Inundation over 40-Year Sequence (acre-days)	
No Action	783
B-3	1,390
D-3	14,369
E-3	10,700
I-1	17,803
I-2	13,859
I-3	10,631
Area of Agricultural Land Affected (Max. acres)	
No Action	691
B-3	126
D-3	673
E-3	507
I-1	694
I-2	591
I-3	488
Agricultural Land Inundation over 40-Year Sequence (Max. days)	
No Action	1,734
B-3	4,970
D-3	32,847
E-3	24,016
I-1	39,121
I-2	30,641
I-3	23,903

The No Action alternative would overall perform better than other alternatives evaluated for agriculture activity. Particularly, this alternative provides a minor benefit over the other alternatives for the large number of small-scale operations in the middle valley below Cochiti (including hobby farming, family subsistence farming, and local specialty and produce growers) because water deliveries may be somewhat more reliable.

1.3.2 Dryland farming

Dryland farming may be affected both positively and negatively by inundation depending on the timing of the event. The San Acacia Section has the highest percentage of dryland farming (about 45 percent). This reach experiences the greatest variation between alternatives in potential inundation with No Action resulting in about 2.8 million acre/days of inundation over 40 years. This reflects no diversion to the LFCC under the No Action. Alternatives I-2 and I-3 also have relatively high inundation in the San Acacia Section. Alternatives D, E and I-1 result in about 80 percent less inundation reflecting more diversion to the LFCC. However, the analysis assumed that no agricultural land along the Rio Grande would be inundated due to protection by the levees.

Dry pastures along the Rio Chama would have the highest potential for total inundation of agricultural land over the 40-year planning period under Alternative I-1 (17, 803 acre-days) and the least under the No Action (with 783 acre-days). If only the acreage of agricultural land inundation in Reach 7 were considered, then the most area would occur under Alternatives I-1 and No Action and the least under Alternative B-3.

1.3.3 Groundwater Use

Groundwater use for irrigating may increase in dry years, and when irrigator requests are not met. This criterion can only be evaluated for Reaches 10 through 14 with the information available and the operating assumptions for reaches below Elephant Butte.

As shown in Tables N-1.8 and N-1.9, there is little variation in the overall performance of the alternatives to meet irrigator demands. Therefore, over the 40-year period, water operations should have no appreciable influence on the portion irrigation water supplied through surface only, surface and ground, or ground-only sources. During drought years, under all alternatives, it is likely that groundwater sources would supplement surface sources where possible.

2.0 LAND USE—AFFECTED ENVIRONMENT

2.1 Description of Resource

Land use is a reflection of the evolution of social frameworks and of human activities in response to the natural attributes of the land. The Rio Grande has been a thread of life for centuries past and the focus of the most intensive development in New Mexico. As a source of water, fertile land, and diverse habitat, the river and its tributaries have sustained a long and diverse history of human uses. Human-modified land use categories include residential, commercial, industrial, transportation, communications and utilities, agricultural, institutional, and recreational. Management plans and zoning subdivision regulations 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 the public health, welfare, and safety.

The attributes of land use addressed in this section include land status (or categorization of land by ownership), general land use patterns and activities, land use and land management plans and zoning (where applicable), and special-use or specially protected areas.

2.2 Area of Potential Effect

Several areas of potential impact relative to human and social uses along the Rio Grande are being considered. The primary area of impact covers the floodplain of the Upper Rio Grande and the Rio

Chama. Flooding directly affects existing structures and the activities they support, from residential to access. It can displace or alter existing uses either temporarily or permanently. Flooding can also incur significant costs due to disrupted enterprise and reconstruction (see Section 3.0). The area of maximum flood impact is being calculated based on a range of alternatives for this Environmental Impact Statement (EIS). This report characterizes land within 5 kilometers of the river centerline as the area of potential effect.

An area of potential effect for agricultural lands within the Upper Rio Grande Basin covers both the floodplain and land that irrigated by the surface waters of the Upper Rio Grande and its tributaries. The official irrigation districts primarily serve these areas, although they also include some land that is dry cropped and irrigated through groundwater sources.

A larger affected region, defined as the Project Area, includes the entire Upper Rio Grande Basin and watershed. This region encompasses portions of several jurisdictional and planning entities. These include counties, regional water planning units, regional councils of government, and municipal bodies (such as the cities of Albuquerque and El Paso. A county and regional scale is used to evaluate social and economic impacts.

2.3 Existing Conditions

2.3.1 Land Status and Management

The Upper Rio Grande Basin encompasses over 36 million acres of land. The majority falls within the state of New Mexico (83 percent), with 13 percent in Colorado and 4 percent in Texas. Ownership of these lands is a mixture of federal, state, tribal, and private. About 8 percent of the basin is within an area of 5 km on either side of the main river channel (totaling almost 3 million acres). Almost half the surface in this buffer area is privately owned, about one-third is federally owned, and tribes hold about one-tenth as sovereign lands. Only about 4 percent of the land in the buffer area is state-owned. **Table N-2.1** summarizes the ownership of land within the 5-km buffer by reach. The upper reaches that encompass the more mountainous watersheds of the river comprise a higher proportion of federal land (at least half the land within the 5-km buffer in Reaches 1, 2, 3, 6, 7, 9, 14, and 15). The majority of the land in Reaches 8, 10, and 11 are tribal.

Table N-2.1 Land Ownership Within 5-km Buffer by Reach

Reach	Federal	Tribal	Private	State	State Park	Total Acres
1	72.7%	0.0%	19.6%	7.7%	0.0%	58,893
2	58.4%	0.0%	38.1%	3.6%	0.0%	284,564
3	52.9%	5.8%	31.7%	9.6%	0.0%	270,976
4	34.8%	19.3%	44.9%	1.0%	0.0%	38,664
5	0.0%	48.7%	51.3%	0.0%	0.0%	76,472
6	58.6%	4.7%	34.3%	2.4%	0.0%	179,061
7	54.9%	3.4%	39.5%	2.1%	0.0%	105,231
8	8.9%	72.7%	15.9%	2.4%	0.0%	52,847
9	61.4%	32.4%	5.6%	0.7%	0.0%	97,109
10	7.9%	81.8%	10.3%	0.0%	0.0%	117,624
11	5.7%	91.4%	2.7%	0.2%	0.0%	37,060
12	0.3%	21.6%	75.2%	2.9%	0.0%	133,422
13	4.5%	11.7%	83.8%	0.0%	0.0%	161,073
14	50.6%	0.0%	46.4%	3.0%	0.0%	439,926
15	65.5%	0.0%	27.5%	7.0%	0.0%	102,247
16	24.2%	0.0%	67.8%	7.9%	0.1%	526,864
17	0.0%	0.0%	99.7%	0.0%	0.3%	175,792
Total Acs.	1,029,007	320,014	1,392,478	115,461	865	2,857,825
Total %	36%	11%	49%	4%	<1%	100%

Source: BLM 2004; FWS and BLM 1993

Federal land is primarily managed by the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) under the authority of existing laws. The basin encompasses several national forests and BLM administrative districts (listed by reach in **Table N-2.2**). Both agencies manage public land primarily for multiple uses according to directions set in Resource Management Plans. Forestry, grazing, and recreation are predominant activities on USFS land, and grazing, mineral development, and recreation are predominant uses on BLM lands. There are also specific uses and sites on federal lands (e.g., quarries, communication towers), improvements used by permitees (e.g., water pipelines and stock tanks), and developed sites, such as campgrounds and research and monitoring site facilities. Some areas are designated or delineated for special management actions or protection, such as wilderness areas and wild and scenic river corridors.

The state of New Mexico also owns and manages land for purposes similar to those of federal land. The State also manages several sites for specific uses, including state parks, wildlife areas, and monuments. Those within the buffer zone are listed in **Table N-2.2**. Most state lands are held in trust to benefit public schools and other public institutions from the revenues they generate (in taxes, royalties, permit fees).

Table N-2.2 Designated Areas and Jurisdictional by Reach (Within the 5-km Buffer)

Reach	Federal	Tribal Lands	State	County
1	Alamosa NWR (USFWS) San Luis Hills WSA La Jara FO (BLM)		Colorado state lands	Alamosa, Costilla, Conejos
2	Rio Grande NF (USFS) South San Juan Wilderness (Rio Grande NF) San Luis Hills WSA La Jara FO (BLM)		Conejos River SWA Sego Springs SWA	Conejos, Rio Grande

Reach	Federal	Tribal Lands	State	County
3	Taos FO (BLM) Rio Grande Wild and Scenic River Wild Rivers (BLM) Orilla Verde Recreation Area (BLM) Carson NF (USFS)	Taos Picuris	Red River Hatchery (NMDGF) Rio Grande Gorge SP	Taos, Rio Arriba
4	Taos FO (BLM) BLM public lands	San Juan	New Mexico state lands	Rio Arriba
5	Taos FO (BLM) Albuquerque FO (BLM)	Jicarilla Apache	Rio Chama State Recreation Area Rio Chama SWA Heron Lake SP El Vado Lake SP	Rio Arriba
6	Santa Fe NF (USFS) Chama River Canyon Wilderness (Santa Fe NF) Chama River Wild and Scenic River Carson NF (USFS) Taos FO (BLM)	Jicarilla Apache	El Vado Lake SP Heron Lake SP	Rio Arriba
7	Carson NF (USFS) Santa Fe NF (USFS) Taos FO (BLM)	San Juan	New Mexico state lands	Rio Arriba
8	Taos FO (BLM) Santa Fe NF (USFS)	San Juan Santa Clara Pojoaque San Ildefonso	New Mexico state lands	Rio Arriba, Santa Fe, Los Alamos
9	Santa Fe NF (USFS) Dome Wilderness (SFNF) Bandelier NM (NPS) Bandelier Wilderness Taos FO (BLM) Albuquerque FO (BLM)	Cochiti San Ildefonso	New Mexico state lands	Santa Fe, Sandoval
10	Santa Fe NF (USFS) Taos FO (BLM) Albuquerque FO (BLM)	Cochiti San Felipe Santa Ana Santa Domingo		Santa Fe, Sandoval
11	Albuquerque FO (BLM)	San Felipe Santa Ana Zia	New Mexico state lands	Sandoval
12	Cibola NF Sandia Military Reservation Albuquerque FO (BLM)	Sandia Isleta	Coronado SP Coronado SM Rio Grande Nature Center SP Indian Petroglyph SP	Santa Fe, Sandoval, Bernalillo

Reach	Federal	Tribal Lands	State	County
13	Sevilleta NWR Albuquerque FO (BLM) Socorro FO (BLM)	Isleta	Senator Willie M. Chavez SP La Joya Waterfowl Area Belen Waterfowl Area Bernardo SWA (NMDGF)	Bernalillo, Valencia
14	Sevilleta NWR Bosque del Apache NWR Bosque del Apache Wilderness San Lorenzo Canyon (BLM) The Box (BLM) Socorro FO (BLM) Las Cruces FO (BLM)		Elephant Butte Lake SP Fort Craig SM	Valencia, Socorro, Sierra
15	BLM public lands Las Cruces FO (BLM)		Caballo Lake SP Elephant Butte Lake SP	Sierra
16	Organ Mountains Recreation Area (BLM) Las Cruces FO (BLM)		Percha Dam SP Caballo Lake SP Leasburg Dam SP Fort Selden SM Franklin Mountains SP	Sierra, Doña Ana, El Paso, Mexico
17	Chamizal National Memorial Fort Bliss Military Reservation Feather Lake Wildlife Sanctuary Fort Quitman		Franklin Mountains SP	El Paso, Hudspeth, Mexico

Sources: NMRHG 1992; NAUS et al. 2003; GDT and ESRI 2003; BLM 2002a,b; NMDGF 2004

BLM	Bureau of Land Management	SFNF	Santa Fe National Forest
FO	Field Office	SM	State Monument
NF	National Forest	SP	State Park
NM	National Monument	SWA	State Wildlife Area
NMDGF	New Mexico Department of Game and Fish	USFS	U.S. Forest Service
NPS	National Park Service	USFWS	U.S. Fish and Wildlife Service
NWR	National Wildlife Refuge	WSA	Wilderness Study Area

The majority of the reaches within the 5-km river corridor are comprised of more than one county (**Table N-2.3**). Counties may exert control over use of privately held lands, although few counties have land use-based controls in effect (such as zoning ordinances). Most counties limit development within Federal Emergency Management Agency (FEMA) floodplains by not issuing building permits for structures within designated floodplains. However, past and ongoing development, although not widespread, occurs in floodplains in some areas and is at risk from water operations, particularly during wet seasons. This issue was identified during scoping for areas along the river between the dam at Abiquiu and the confluence of the Rio Chama and Rio Grande near Española where homes have been built within the flowage easement boundaries and floodplain. Flowage easement lands are private lands that the U.S. Army Corps of Engineers (COE) has the right to flood when the need exists for the purpose of flood management. In addition, around Abiquiu Lake itself, most of the shoreline is privately owned, and owners have built private boat docks and ramps. As the lake has no authorized shoreline management plan, the construction of private docks is not permitted (Corps 2002).

Two major urban areas, the cities of Albuquerque and El Paso, also straddle the river. Use and development of lands within each city is guided by comprehensive plans and controlled through zoning ordinances.

Table N-2.3 County Jurisdictions in 5-km Buffer Along Upper Rio Grande and Rio Chama

Reach	5-km Buffer Acreage	County Association
1	158,991	Alamosa, Costilla, Conejos
2	284,564	Conejos, Rio Grande
3	271,015	Taos, Rio Arriba
4	38,664	Rio Arriba
5	76,914	Rio Arriba
6	179,061	Rio Arriba
7	105,231	Rio Arriba
8	52,847	Rio Arriba, Santa Fe, Los Alamos
9	97,109	Santa Fe, Sandoval
10	117,624	Santa Fe, Sandoval
11	37,060	Sandoval
12	133,422	Santa Fe, Sandoval, Bernalillo
13	161,073	Bernalillo, Valencia
14	439,926	Valencia, Socorro, Sierra
15	102,247	Sierra
16	404,981	Sierra, Doña Ana, El Paso
17	175,792	El Paso, Hudspeth, Mexico
	2,857,825	

Source: BLM 2004; FWS and BLM 1993

2.3.2 Existing Land Use

Table N-2.4 summarizes the amount of undeveloped and developed land (both for agricultural and urbanized uses) for both the basin as a whole and for the 5-km buffer. Within the entire 36 million-acre basin, 9 percent of the land area is categorized as developed for urban purposes, about 2 percent is developed for agriculture, and about 89 percent is undeveloped. Overall, the vast majority of the land in the Project Area is undeveloped. From these data, it would appear that water operations would have only minimal impact on land use along the Rio Grande (e.g., from potential inundation).

Within the 5-km buffer area, a higher percentage of land has been developed for agriculture (7 percent), about 5 percent is urbanized, and 88 percent is undeveloped and natural. This illustrates the influence of the river in the process of land transformation into agricultural functions that support and sustain human activities and presence.

Table N-2.4 General Land Characteristics in Project Area and 5-km Buffer

Type of Land	Project Area		5-km Buffer	
	Acres	%	Acres	%
Undeveloped/natural	32,305,802	89%	2,474,656	88%
Developed/agriculture	795,610	2%	184,530	7%
Developed/urbanized	3,272,711	9%	152,184	5%
Total	**36,374,123**	**100%**	**2,811,370**	**100%**

Source: Derived from USGS and EPA 2000.

Table N-2.5 breaks down this same information for each reach within the 5-km buffer. Of note is the relatively high percentage of agricultural land in the Costilla Valley (Reach 2) where the Closed Basin Project provides water for agriculture. Agriculture is also more prominent south of Albuquerque in Reaches 13, 16, and 17. Urbanization is more prominent (comprising about one-fifth to one-quarter of the land area) for Reaches 9, 10, and 12. Development in Reaches 9 and 10 reflects the presence of the railway corridor; Reach 12 encompasses the Albuquerque metropolitan area.

Table N-2.6 provides a more detailed accounting of land use and land cover for the entire project area. The table shows that most of the area is herbaceous grassland, shrubland, and evergreen forest. Using the same classifications, **Table N-2.7** indicates that only 10 percent of the land within the 5-km buffer of Reach 12 (the Albuquerque area) is herbaceous grassland. A larger portion of undeveloped land is shrubland and bare rock or sand and clay. About 16 percent of land is developed in low-intensity residential development and about 5 percent and is used to grow pasture crops. The variance in these data to those in Table N-2.5 is due partially to differences in classification categories, but also time and methodology.

Table N-2.5 General Land Characteristics by Reach Within the 5-km Buffer of the Upper Rio Grande and Rio Chama

5-km buffer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Undeveloped/ natural	150,262	243,583	269,835	36,579	74,046	178,643	96,956	45,246	76,612	83,791	37,030	92,885	126,325	426,899	99,665	339,853	96,446	2,474,656
Developed/ agriculture	7,111	39,718	833	1,657	2,815	82	2,158	2,716	26	4,344	0	7,436	22,666	10,441	665	46,665	35,196	184,530
Developed/ urbanized	1,617	1,262	348	427	53	336	6,116	4,885	20,471	29,488	30	33,103	12,081	2,586	1,917	13,292	24,172	152,184
Total	**158,990**	**284,563**	**271,016**	**38,664**	**76,914**	**179,061**	**105,231**	**52,847**	**97,109**	**117,623**	**37,060**	**133,423**	**161,072**	**439,926**	**102,247**	**399,810**	**155,814**	**2,811,370**
% by Reach																		
Undeveloped/ natural	95%	86%	100%	95%	96%	100%	92%	86%	79%	71%	100%	70%	78%	97%	97%	85%	62%	88%
Developed/ agriculture	4%	14%	0%	4%	4%	0%	2%	5%	0%	4%	0%	6%	14%	2%	1%	12%	23%	7%
Developed/ urbanized	1%	0%	0%	1%	0%	0%	6%	9%	21%	25%	0%	25%	8%	1%	2%	3%	16%	5%

Source: Derived from USGS and EPA 2000.

Table N-2.6 Generalized Land Use/Land Cover Characteristics for the Project Area

Land Cover	Acres				% of Project Area
	Texas	New Mexico	Colorado	Total	
No Data	—	399,720	—	399,720	1.1%
Open Water	1,100	96,537	21,009	118,647	0.3%
Perennial Ice/Snow	—	1	1,288	1,289	0.0%
Low-Intensity Residential	30,254	76,258	4,894	111,406	0.3%
High-Intensity Residential	—	1,284	863	2,147	0.0%
Commercial/Industrial/Transportation	28,006	3,088,064	3,186	3,119,256	8.6%
Bare Rock/Sand/Clay	95,492	1,054,263	101,087	1,250,842	3.4%
Quarries/Strip Mines/Gravel Pits	2,700	26,102	—	28,801	0.1%
Transitional	—	1,879	1,253	3,132	0.0%
Deciduous Forest	127	94,030	199,162	293,319	0.8%
Evergreen Forest	188	5,755,357	1,262,865	7,018,410	19.3%
Mixed Forest	—	41,480	40,213	81,693	0.2%
Shrubland	646,076	6,431,474	1,161,941	8,239,491	22.7%
Orchards/Vineyards/Other	1,100	6,720	—	7,820	0.0%
Grasslands/Herbaceous	442,773	12,913,269	1,511,258	14,867,300	40.9%
Pasture/Hay	7,005	89,500	283,868	380,373	1.0%
Row Crops	40,021	123,813	220,203	384,038	1.1%
Small Grains	—	20,066	—	20,066	0.1%
Fallow	—	3,313	1	3,314	0.0%
Urban/Recreational Grasses	715	7,228	26	7,969	0.0%
Woody Wetlands	—	4,746	458	5,204	0.0%
Emergent Herbaceous Wetlands	99	3,908	25,881	29,887	0.1%
Total Acres	**1,295,655**	**30,239,012**	**4,839,456**	**36,374,123**	**100.0%**
Percent of Project Area Within State	4%	83%	13%	100%	

Source: USGS and EPA 2000

Table N-2.7 General Land Use/Land Cover in Reach 12

Land Use	Acres	Percent
No Data	1,646	1%
Open Water	125	0%
Perennial Ice/Snow	0	0%
Low-Intensity Residential	20,959	16%
High-Intensity Residential	201	0%
Commercial/Industrial/Transportation	9,444	7%
Bare Rock/Sand/Clay	28,430	21%
Quarries/Strip Mines/Gravel Pits	721	1%
Transitional	0	0%
Deciduous Forest	38	0%
Evergreen Forest	751	1%
Mixed Forest	38	0%
Shrubland	46,586	35%
Orchards/Vineyards/Other	440	0%
Grasslands/Herbaceous	13,245	10%
Pasture/Hay	6,800	5%
Row Crops	163	0%
Small Grains	33	0%
Fallow	0	0%
Urban/Recreational Grasses	1,778	1%
Woody Wetlands	1,827	1%
Emergent Herbaceous Wetlands	198	0%
Totals	**133,423**	**100%**

Source: USGS and EPA 2000

2.3.3 Future Land Use and Trends

Several planning initiatives are underway for different parts of the Project Area, both at the regional and local scale. Many of these are focusing on issues related to future growth and development, including land use, transportation, and water resources planning. Most of these efforts are built around future population projections, with likely scenarios both in terms of numbers of people and distribution. For the purpose of this study, development in the Project Area contributes to runoff that reenters the river system. The Upper Rio Grande Water Operations Model (URGWOM) accounts for storm water and treated wastewater inputs at certain locations along the existing channel. As land changes from essentially undeveloped or pervious land into urbanized areas with varying degrees of permeability, this results in changes to these inputs. Both the U.S. Geological Survey (USGS) and the Mid-Region Council of Governments (MRCOG) have been studying change in land use and developing future land use framework based on trends and certain assumptions for projected growth. Some statistics highlighting the degree of change over time in the Middle Rio Grande Basin (MRGB) study by USGS (USGS 2000) are as follows:

- In the Albuquerque area, irrigated land declined from 14,000 acres in 1975 to 9,600 acres in 1992;
- The Albuquerque area accounts for 90 percent of the residents in the MRGB;
- The metropolitan area grew 70 percent (by 35,000 acres) between 1973 and 1991, and grew from 2,000 acres in 1891 to 103,000 acres in 1995;

- The MRGB population is estimated to increase from approximately 700,000 persons today to about 1.55 million by 2050.

The USGS and MRCOG have developed multiple scenarios of future development for the Middle Rio Grande Basin, based on differing assumptions about growth, trends, and land use patterns. **Table N-2-8** summarizes the existing land use inventory compiled of both current and projected future land use for the MRGB, based on a reasonable estimation for future development. The table indicates a reduction in agricultural land (both irrigated and dry) and vacant (undeveloped land). By 2025, the percentage of residential land, and to a lesser degree, commercial and industrial land, is projected to increase along the river. With this trend will come additional pavement, increasing the volume of storm water runoff. This may contribute to local inflows to the river.

Table N-2.8 General Land Use/Land Cover in Reach 12

Land Use	Current		2025	
	Acres	Percent	Acres	Percent
Residential—Single Family	32,406	25	44,208	35
Residential—Multi-Family	1,324	1	2,154	2
Commercial—Major	456	<1	781	1
Commercial—Minor	3,342	3	5,332	4
Office	475	<1	757	1
Industrial	5,305	4	6,326	5
Institutional	180	<1	537	<1
Schools/Universities	1,950	2	2,183	2
Airport	1,755	1	1,629	1
Transportation/Utility	173	<1	158	<1
Urban—Vacant	17,388	14	5,997	5
Landfill/Sewage	269	<1	257	0
Urban—Non-Residential	902	1	1,254	1
Agriculture—Irrigated	7,564	6	5,723	4
Range—Dry Agriculture	35,220	28	31,160	24
Open—Parks	9,439	7	9,756	8
Riparian	9,439	7	9,375	7
Kirtland Air Force Base	150	<1	148	<1
Total	**127,726**	**100**	**127,726**	**100**

Source: MRCOG 2002

2.3.4 Specially Managed Areas

There are federal- and state-run lands in each of the reaches within the 5-km buffer of the Rio Grande corridor. Table N-2.2 provides a list of these entities and special areas that they manage, for example, parks, wildlife refuges, and recreation areas. These areas can be directly affected by water operations (such as inundation). Areas that have a recreation emphasis are described in more detail in the Recreation section. As described above, federal lands are mostly managed according to goals and objectives described in land and resource management plans. Of particular interest are several wildlife refuges that have specific purposes for protecting wildlife and whose functioning is interdependent on the riparian environment and water deliveries from the river.

Most prominent among the wildlife areas in the basin is the Bosque del Apache National Wildlife Refuge (NWR) established in 1939 and located in Reach 14. Its main purpose is to serve as a refuge and breeding grounds for migratory birds. These include aquatic birds such as the sandhill crane (whose population has increased from 14 individuals to 20,000 individuals since 1939), the whooping crane, and lesser snow geese, as well as Neotropical songbirds such as the yellow-billed cuckoo and southwestern flycatcher. The Bosque del Apache NWR is also a designated critical habitat for the Rio Grande silvery minnow. Refuge management habitat programs focus on managing wetlands and providing essential winter food resources, such as agriculturally grown and maintained grains in the “managed” part of the refuge. The areas located on the west side of the levees use both surface and groundwater sources. The refuge has access to five points of surface diversion and 16 wells. The interaction of water sources with the LFCC is complex, but so long as the LFCC is in place, whether serving as a canal with diverted water, or as a drain (without diverted water), it provides a dependable source of surface water for the refuge. Groundwater from the wells can supplement surface water diversions. When the LFCC is empty (or not being used for diversion), is acts as a drain, leaving the river less wet. This can affect habitat on the east side of the levees. These areas are not actively managed by the refuge (Dello Russo 2004).

The Sevilleta NWR, established in 1973, is also located in Reach 14. Management programs have focused on returning the area to the natural conditions. A wide range of native mammals (elk, deer, coyotes, mountain lions), birds (bald eagles, peregrine falcons, great blue herons, sandhill cranes, burrowing owls), and reptiles (the endangered horned lizard) has become more abundant since the establishment of the refuge. In addition, there are special endangered species release programs devoted to acclimating the Mexican wolf and the desert bighorn sheep. All of these programs use water from the Rio Grande as part of the growth of breeding habitat and essential food resources.

2.3.5 Wilderness and Wild and Scenic Rivers

The Wild and Scenic River (W&SR) designation applies to 64 miles of the Rio Grande in the Project Area in northern New Mexico (Reach 3). The Rio Grande W&SR is jointly managed by BLM and the Carson National Forest. Of this, 48 miles in the Upper Gorge is managed for both wild and scenic values, and 12 miles in the Lower Gorge (south of Taos Junction Bridge) is designated as scenic. Maintaining the visual qualities of these areas is a high priority. They also offer exceptional recreational opportunities for rafting and kayaking and limited camping along the river (see Recreation) (BLM 2000). In Colorado, 41 miles are under interim protection pending W&SR designation (Reach 1).

The Rio Chama Canyon Wilderness straddles the Rio Chama River below El Vado Lake (Reach 6). The Wilderness lies in Santa Fe National Forest, with a portion in Carson National Forest. A 30-mile stretch of the Rio Chama has the W&SR designation. It is also very popular for both personal and outfitter rafting and kayaking use. Trail access is poor above the sandstone bluffs. A few put-ins provide access for rafts, kayaks and canoes, which are the primary means of enjoying this area.

2.3.6 Tribal and Pueblo Lands

The Upper Rio Grande Basin includes almost 2.6 million acres of sovereign lands. The 5-km buffer includes about 320,000 acres and 16 discrete pueblo and tribal entities, and accounts for most of the land immediately adjacent to the river in Reaches 8, 10, and 11. Deliveries of surface water are made to tribes and pueblos for “municipal and industrial” use, agriculture, and other customary uses. Tribes and pueblos manage their lands according to their own policies and purposes. As part of interagency and intergovernmental coordination for this project, tribal and pueblo governments have been contacted.

2.4 Land Use—Impact Analysis

2.4.1 Issues and Concerns

Primary concerns that could affect land use include:

- Maintaining reliable water delivery for agricultural and municipal and industrial purposes;
- Public safety and flood control;

- Damage to property and productive uses from inundation;
- Land conversion from agriculture to developed use; and
- Impacts of flooding on specially managed areas and recreational opportunities.

2.4.2 Limitations and Assumptions

- The analysis is limited to reaches 6, 7, 8, 9, 10, 12, 13, and 14. Other reaches are not influenced by operations under the authority or review of this effort. Operations for flood control (below Elephant Butte reservoir) would not vary between alternatives.
- Operations will not cause changes in overall land status and ownership.
- All levees function adequately and areas protected by levees will not be inundated.

2.4.3 Evaluation Criteria

Three overall criteria were assessed for desirable land uses:

- Degree to which an alternative promotes recreational use;
- Degree to which an alternative preserves suitable conditions for agriculture;
- The degree to which damage to property or loss of productive uses is minimized.

2.4.4 Impact Analysis

Table N-2.9 summarizes overall performance on the three evaluation criteria above. These reflect a roll-up of performance on the indicator measures in report N-1 (Agriculture), report N-5 (Recreation), and report N-3 (Flood Control). The values are "weighted", according to the **Table N-2.10** provides the values used to generate the relative value of damages for each alternative.

Table N-2.9 Desirable Land Use Performance

Criteria	No Action	Alt B-3	Alt D-3	Alt E-3	Alt I-1	Alt I-2	Alt I-3
Minimizes damages	6.6	9.0	9.8	8.6	7.4	8.8	9.8
Promotes Recreation	5.3	5.6	5.9	6.0	5.0	5.5	6.0
Promotes agriculture	7.7	8.3	6.6	7.9	7.6	7.7	7.9
Total score	19.6	22.9	22.3	22.5	19.6	22.0	23.7
Ranking	7	2	4	3	6	5	1

Table N-2.10 Evaluation of Flood Damage

Summary of desirable uses - derived from start of damages values

	Reach 7	Reach 9	Reach 12	Reach 13	Reach 14	Total
No Action	4,970.60	202,656.50	3,111.40	0.00	4,269,805.00	4,480,543.50
ALT B	1,280.40	151,776.50	51,414.30	35,980.00	1,054,421.00	1,294,872.20
ALT D	4,091.00	175,294.00	690.20	0.00	53,729.00	233,804.20
ALT E	2,810.10	162,659.60	84,657.40	53,111.70	1,462,439.00	1,765,677.80
ALT I-1	4,775.10	200,740.40	784.90	0.00	3,228,308.00	3,434,608.40
ALT I-2	3,560.30	183,190.40	696.40	0.00	1,431,151.00	1,618,598.10
ALT I-3	2,835.60	166,405.30	653.60	0.00	52,708.00	222,602.50
	24,323.10	1,242,722.70	142,008.20	89,091.70	11,552,561.00	13,050,706.70

	Reach 7	Reach 9	Reach 12	Reach 13	Reach 14	Total
No Action	20%	16%	2%	0%	37%	34%
ALT B	5%	12%	36%	40%	9%	10%
ALT D	17%	14%	0%	0%	0%	2%
ALT E	12%	13%	60%	60%	13%	14%
ALT I-1	20%	16%	1%	0%	28%	26%
ALT I-2	15%	15%	0%	0%	12%	12%
ALT I-3	12%	13%	0%	0%	0%	2%

Score for damages (high score is lower damage values)

	Reach 7	Reach 9	Reach 12	Reach 13	Reach 14	Total
No Action	80%	84%	98%	100%	63%	66%
ALT B	95%	88%	64%	60%	91%	90%
ALT D	83%	86%	100%	100%	100%	98%
ALT E	88%	87%	40%	40%	87%	86%
ALT I-1	80%	84%	99%	100%	72%	74%
ALT I-2	85%	85%	100%	100%	88%	88%
ALT I-3	88%	87%	100%	100%	100%	98%

2.4.5 No Action

Under the No Action, land use would continue to evolve along the river in response partially to climatic events, but more in response to jurisdictional and management controls, and to some degree market-driven forces and population growth.

Delivery of water for municipal and industrial purposes is a priority. The recently approved State Water Plan provides the framework and vision for equitable and wise use of water into the future. Delivery of water for agriculture is addressed above under agriculture. The Isleta diversion in the Central Section will continue to experience significant shortfalls from the amount of water requested under the No Action.

Appendix N3 reports the projected value of damages resulting over the project life for each alternative. The No Action recorded the highest potential losses, mostly in the San Acacia Section (**Table N-2.10**). Section 4.2.7 provides an evaluation of economic impacts of damages from flooding on structures and land use. FLO2 D model outputs of the spatial extent and duration of inundation over the 40-year project period show localized areas of inundation, mostly within the historic floodplain. When viewed in combination with aerial photography, none of the inundated land south of Bernalillo appears to have the characteristics of agricultural land. These areas are either natural and undeveloped, or used for grazing and dispersed recreation. A few structures south of Bernardo may be at risk of flooding.

Overall, periodic inundation immediately along the river would not alter land use patterns that have evolved in response to periodic flood events and controls on development in floodplains. These issues may continue to be a local problem, for example, in floodplain lands near the confluence. Coordination between county planning and permitting officers and the water operators should continue. This effort should emphasize the need to control encroachment in order to protect public safety and preserve flexibility for water operators. Similarly, management and control of private development in public flood easements, particularly around Abiquiu Lake, would provide flexibility for operators to meet multiple objectives and prevent incompatible encroachment in the future. Establishing approved management plans for use of lands in flood easements around reservoirs is recommended.

Water operations under the No Action would not cause change in the distribution of private versus publicly held or sovereign land. Stream flows and inundation would continue to be a variable for managers of public land along the river, particularly in relation to habitat management, recreation and grazing activities. However, continuation of current water operations is not expected to exert pressures that would change the use of these areas. Special consideration of agricultural and recreational uses along the river is addressed in more detail in Appendix N1 and N5, respectively.

2.4.6 Alternative B-3

This alternative provides relatively good performance for all criteria, and is preferable for agriculture (**Table N-2.9**).

2.4.7 Alternative D-3

This alternative performs well on limiting damage to property and uses, but is least beneficial overall for agriculture.

2.4.8 Alternative E-3

This alternative is balanced in terms of providing satisfactory conditions for developed uses along the river.

2.4.9 Alternative I-1

Alternative I-1 is least beneficial for recreation, and average for agriculture and impact of flood damage.

2.4.10 Alterative I-2

Alternative I-2 is balanced but not preferred in terms of promoting desirable land use conditions.

2.4.11 Alternative I-3

Overall, this alternative provides the most favorable conditions for human activity along the river.

3.0 FLOOD CONTROL

3.1 Introduction

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

3.2 Relevant Affected Geographic Area and Historical Flooding

Total flood control benefits from Corps projects along the Rio Grande and its tributaries since their inception through 2002 have totaled over $1 billion (Corps 2003). In addition, there are significant damages prevented in terms of river sedimentation. There are many other projects along the Rio Grande that have prevented significant flood damages as well. These include Elephant Butte/Caballo, El Vado, the International Water Boundary Commission levees on the Rio Grande, and numerous dams constructed by the Natural Resources Conservation Service. The benefits computed for Corps projects are as follows:

Table N-3.1 Cumulative Flood Control Benefits in the Rio Grande Basin for U.S. Army Corps of Engineers Projects

($000)	
Project	**Flood Control Benefits**
Abiquiu	386,499
Cochit	431,787
Jemez Canyon	23,227
Platoro	6,049
Socorro	580
Rio Grande Floodway	48,759
Albuquerque Diversions	
North	171,281
South	6,491
El Paso	12,023
Willow Creek	331

*Note that estimates for these benefits are conservative. Past years have not been adjusted to current dollars. Total through fiscal year 2003.

There are seven primary areas that have received damages as a result of flooding from the Rio Grande since 1979.

- First, some agricultural damages and some minor damages to structures have been 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 completed in 1999.
- Second, damages have occurred along the Rio Grande from Pilar, New Mexico, to the confluence of the Rio Chama during several high runoff years since 1979. Losses have occurred primarily to bridges, diversion structures, pastures, orchards, and low lying agricultural areas.
- Third, minor bank erosion damages have been periodically sustained between Abiquiu Dam and Cochiti Lake along the Rio Chama and the Rio Grande.

- Fourth, major damages have been sustained in Mexico in 1986 and 1987 as a result of 14 levee breaks resulting from high flows on the Rio Grande. Both structures and a significant amount of agricultural land were destroyed and/or damaged.
- Fifth, high flows in the Rio Grande in El Paso County, Texas, in 1986 caused damage to pecan orchards and to the diversion structure of an irrigation district. Pecan orchards were primarily damaged from the high groundwater table resulting from the Rio Grande flows. The Riverside Diversion was permanently damaged from high river flows.
- Sixth, damages occurred in Hudspeth County, Texas, where high releases from Elephant Butte in 1986 and 1987 caused damage primarily to agricultural lands. The total damage estimated from the 1986 Elephant Butte Reservoir releases includes over $1,000,000 to clean up sediment; over $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.
- Seventh, high reservoir levels at Elephant Butte increased the amount of sedimentation at the head of the reservoir, thus creating a risk of river flows overtopping the levee and flooding the low flow conveyance channel.
- Lastly, damages have occurred on many of the tributaries to the Rio Grande (e.g. Hatch, NM and parts of Socorro County), however these are not included in this analysis since operating plans cannot impact these areas.

3.3 Potential Effects (Properties Impacted/ Average Annual Damages)

Potential flood effects occur at all the locations listed above. In addition, there are several areas along the Rio Grande that have not experienced flooding recently, but as a result of the deterioration of a non-engineered levee or other facilities, are prone to flooding at certain flows. These areas include Española, from Bernalillo to Belen, and from San Acacia to Elephant Butte. All of these areas are currently being analyzed in studies by the Corps of Engineers.

For purposes of currently available flood control analysis the Rio Grande and Tributary floodplains are broken down into several reaches.

- The upper reach is comprised of the Rio Grande as it flows through Colorado, primarily centered upon Del Norte, Monte Vista, and Alamosa.
- The next reach is comprised the area from Pilar, New Mexico through Española.
- The third reach is the Chama Valley from Abiquiu to the Rio Grande.
- The fourth reach is from Bernalillo to Belen.
- The fifth reach is from San Acacia to Elephant Butte.
- The sixth reach is in Hudspeth County to the east of El Paso. There are other areas that do not currently have flood control analysis, but there are potential damages. These include the area from Elephant Butte through El Paso, several points on the river north of Bernalillo, Mexico, and the area east of Fort Quitman.

Information regarding damages to Mexico is currently not available. Most damages in this reach are not readily converted into a damage-flow curve, because many occur from a rise in groundwater rather than direct overflow.

The following table (**Table N-3.2**) indicates the number of properties in each of the identified damage centers by quantity that is subjected to flooding by the events indicated. During the initial studies (date presented within the table), Corps hydraulic engineers developed floodplains and event stages for specific frequency flood events, which was then inventoried by Corps economists to determine the number and value of damageable property, as well as the single occurrence damages associated with each event. Some of these studies predate new GIS-related tools so data other than the flow-damage relationship is unavailable. Note that some growth may have occurred since the initial study, and further growth is expected, such that the damages associated with specific frequency events will be higher than indicated.

Table N-3.2 Number of Properties Subject to Flooding

Area	Study date		Storm Frequency and Number of Structure					
		Event						
Del Norte	-1986	Structures						
		Event						
Monte Vista	-1987	Structures						
		Event	100 yr	500 yr				
Alamosa	-1987	Structures	1026	1657				
		Event	25 yr	50 yr	100 yr	500 yr		
Española	-1995	Structures	111	138	163	215		
San Acacia to		Event	7 yr	10 yr	50 yr	100 yr	500 yr	
Elephant Butte	-1998	Structures	0	1010	1310	1384	1430	
		Event						
Hudspeth County,	-1989	Structures						
		Event	5 yr	25 yr	50 yr	100 yr	500 yr	
Velarde	-1991	Structures	0	18	24	34	55	
		Event	5 yr	25 yr	50 yr	100 yr	500 yr	
Lyden	-1991	Structures	0	18	24	34	55	
		Event	2 yr	10 yr	25 yr	50 yr	100 yr	500 yr
Abiquiu to Española	-1996	Structures	0	16	19	19	21	
		Event	13 yr	25 yr	50 yr	100 yr	SPF(625 yr)	
Corrales	-1994	Structures	0	61	72	81	1218	
		Event	100 yr	270 yr				
Albuquerque	-1977	Structures	0	35564				
		Event	7 yr	10 yr	25 yr	100 yr	500 yr	
Belen	-1997	Structures	0	171.1778	12418.7	12452.72	12452.57	

Note: In some cases, historical data omits number of structures though includes damage computations.

The following tables indicate the degree to which damages may be expected for given flows in the river, and represent the flow-damage relationship the Corps develops to compute the significance of a flood risk when considering flood control measures. Each flow is associated with a respective frequency, which is also indicated on the table. While this table is important in that it shows total damages (shown here in thousands of dollars) that can be expected for an event, it does not indicate at what point damages will start which is particularly important for this EIS to ensure that no alternative increases flood damages. Additionally, the table indicates the environment at the point in time the study was completed. There are expected levee projects by the U.S. Army Corps of Engineers that will impact the expected damages from San Acacia─Bosque del Apache, Bernalillo to Belen and Española Valley.

Table N-3.3 Degree to Which Damage May be Expected

Del Norte	CFS	7,500	9,800	11,000	12,000	18,000				
-1986	Damages	$0	$709	$863	$989	$2,775				
	Event									
	# Structures									
Monte Vista	CFS	7,000	9,900	13,000	16,800					
-1987	Damages	$0	$1,949	$12,292	$43,703					
	Event		10 yr	100 yr	500 yr					
	# Structures									
Alamosa	CFS	4,800	6,300	7,100	9,000	10,000	10,900	N/A	N/A	18,000
-1987	Damages	$2,175	$6,359	$7,824	$11,299	$27,370	$34,233	$42,942	$57,721	$63,918
	Event	10 yr	20 yr	25 yr	50 yr	75 yr	100 yr	150 yr	300 yr	500 yr
	# Structures				371		1026			1657
Española	CFS	5,100	11,000	14,500	17,000	20,000	27,000			
-1995	Damages	$0	N/A	$3,234	$4,710	$6,773	$11,124			
	Event	2 yr	10 yr	20 yr	50 yr	100 yr	500 yr			
	# Structures			111 (25 yr event)	138	163	215			
San Acacia to Elephant Butte	CFS	5,000	8,000	19,000	28,000	72,000				
	Damages	$0	$79,300	$131,089	$136,716	$153,618				
-1998	Event	7 yr	10 yr	50 yr	100 yr	200 yr				
	# Structures	0	1010	1310	1384	1430 (500 yr event)				
Hudspeth County, Texas (1989)	CFS	1,500	2,000	2,500	3,000	4,000				
	Damages	$869	$2,640	$4,352	$5,967	$7,583				
	Event									
	# Structures	(Predominantly agricultural damages)								
Velarde	CFS	7,200	15,000	17,900	21,200	29,800				
-1991	Damages	$0	$997	$1,567	$1,935	$2,610				
	Event	5 yr	25 yr	50 yr	100 yr	500 yr				
	# Structures	0	18	24	34	55				
Lyden	CFS	10,000	15,000	17,900	21,200	29,800				
-1991	Damages	$0	$1,225	$1,643	$2,137	$2,358				
	Event	10 yr	25 yr	50 yr	100 yr	500 yr				
	# Structures	0	45	45	45	45				

Abiquiu to Española	CFS	4,200	5,600	7,600	9,900	12,000	22,000	
-1996	Damages	$0	$191	$277	$339	$380	$542	
	Event	2 yr	10 yr	25 yr	50 yr	100 yr	500 yr	
	# Structures	0	16	19	19	21	29	
Corrales	CFS	7,054	8,700	14,540	23,270	42,000	73,900	
-1994	Damages	$0	$613	$1,184	$1,589	$67,714	$76,096	
	Event	13 yr	25 yr	50 yr	100 yr	270 yr	SPF(625 yr)	
	# Structures	0	61	72	81	0	1218	
Albuquerque	CFS	41,999	42,000	42,001	44,000	50,000	60,000	72,000
-1977	Damages	$0	$323,061	$1,542,482	$1,588,823	$1,681,504	$1,840,386	$2,025,749
	Event	100 yr	270 yr					
	# Structures	0		35564				
Belen	CFS	7,054	7,595	12,900	17,500	32,000		
-1997	Damages	$0	$677	$261,751	$284,696	$291,025		
	Event	7 yr	10 yr	50 yr	100 yr	500 yr		
	# Structures	0	171	12419 (25 yr)	12453	12453		

3.4 General Computational Procedures

The assumptions and procedures used to analyze and quantify the economic variables are presented in this section. The hydro-economic model used to develop expected annual damages is based on discharge-frequency, stage-frequency, and stage-damage curves used to develop a damage-discharge curve. Stage-percent damage curves express dollar damages resulting from varying depths of water based on a percentage of the value of structure and contents.

Each surveyed property was assigned to a category (*e.g.*, commercial, residential, public, outbuilding, transportation facilities, utilities, and vehicles) with as many subcategories (*e.g.*, contents) as necessary. Details of ground and first floor elevations were also noted. The depth-damage relationship for each category was expressed as a cumulative percentage of value for each foot of inundation. The depth-damage relationships were derived from historical data obtained from insurance companies, a commercial content survey, the Flood Insurance Administration, and Corps of Engineers data and experience. Note that the 2001 residential curves developed by the Institute of Water Resources (IWR) were used; thus, the residential content damages are a direct relationship to structure value.

Value of Property**—**A survey of structures within the floodplain was conducted to evaluate the flood threat to each damage center**. Table N-3.3** indicates the date of that survey. Property categories surveyed include residential, commercial, public buildings, vehicles, transportation facilities, utilities, and outbuildings (*e.g.*, sheds and detached garages).

Depreciated, replacement residential structure values were computed using local experts such as realtors, appraisers, and builders. The properties were then compared to actual sales data in the area and field inspected for consistency and first floor elevations.

Content values were estimated from several sources. Residential content values were fixed at 50 percent of the structure value. Generally, property insurers estimate content values at greater than 55 percent of structure value. Commercial and public content values were estimated primarily from surveys of similar establishments and interviews.

Vehicle estimates were be determined using in-house data and published surveys. It is assumed that all business-related vehicles would have been evacuated from the floodplain. Therefore, the vehicles that would remain in the floodplain would be associated with residential structures and apartments. Census data or locally available information was used to determine the per capita vehicles per household. It was assumed that 1 of these vehicles was driven out of the floodplain. The remaining vehicles will be distributed among the residential structures located within the 0.2 percent chance exceedance floodplain.

3.5 Impact of Future Development

Future development would change potential damages from any flood event. While future population estimates in the planning area are important, the quantity of that development that occurs within the floodplain is the relevant aspect and is a rough estimate at best. Note that any future development that occurs should follow FEMA requirements and be elevated to the 100-year flood event.

3.6 Analysis of Alternatives

URGWOM daily stream gage flow projections were retrieved to estimate at locations near damage centers identified above for the No Action alternative as well as each alternative that was evaluated. Each damage center has a flow-damage relationship, and has a maximum flow that can pass without creating damages to the damageable property, called the start of damages. Each day over the analysis time frame that a stream gage flow was equal to or greater than the start of damages flow for a given damage center can be identified for each alternative considered. Alternatives that create more days over the project life where flows exceed the start of damages can be said to be increasing damages, and would be less desirable than those with equal or fewer total days where flooding exceeds the start of damages. In the following tables, this measurement was termed “Days Flooded.”

Another measure of alternative impacts is an estimate of the dollar damages over the project life cycle, generated by interpolating the flows for each day to the flow-damage relationships available, and then generating a grand total over the project life cycle. No estimates of growth within the floodplain are available, and the flow-damage relationships used are current as of their stated price level. No discounting of future benefits was performed to bring the price levels across damage centers in line, and the damages represent nominal damages, in thousands of dollars, at the price level indicated on the flow damage relationship for that damage center.

The “Days Flooded and Marginal Flows” metric was developed to answer the question “Are there days over the project life where flows exceed the start of damages AND are greater than the flows for that day in the No Action alternative?” The number of days and the total damages associated with those particular days was computed, using methods previously described.

The final analysis parameter asks the question “Does the alternative increase damaging flows relative to the No Action alternative?” The answer to that question, yes or no, is the difference of the life cycle damages between each alternative and the No Action alternative. A positive result is “yes.”

3.6.1 Example calculation:

The following provides a sample of the calculations used to generate the following tables (**Tables N-3.2, N-3.3, N-3.4)**:

URGWOM daily stream gage flow projects were retrieved to estimate at locations near damage centers identified above for the No Action alternative as well as each alternative that was evaluated over each alternative’s life cycle. Corps data used to generate the annual report to Congress of the benefits attributed to completed works uses flow-damage relationships where flows are measured at stream gages. Those daily flows were then used to estimate damages for the damage centers, interpolating between points on the flow-damage relationships. For flows exceeding the zero damage point on the flow-damage relationships, a tally is included in “Days Flooded,” indicated that there was flooding that day and the “Interpolated Flood Damages” column is populated with an estimate of damages based on the flow-damage relationship. The “Marginal Flows” column subtracts flows from an alternative from the same daily flow in the No Action condition, and puts a tally in the “Daily Induced Days” column if the project flows exceed the No Action flows for that day, and takes the “Interpolated Flood Damages” for the project condition for every day that project flows are a) exceeding the start of damages condition and b) is greater than the equivalent than the flow in the No Action alternative. The “Days Flooded,” “Daily Induced Damages” and “Daily Induced Days” columns are then summed over the project life to get an estimate of cumulative flood impacts over the live of each alternative considered. The final measure of the impact of each alternative is “Induced?” which answers the question, “Do the alternatives generate more total days of flooding over the project life than the No Action alternative?”

Clearly, there are some assumptions that may or may not make sense mathematically. For one, the dollar damages associated with induced flooding is presented here as TOTAL damages, rather than the difference between damages associated with the alternative and the No Action alternative. The public will generally perceive induced flooding as “flooding where there was none before” rather than “flooding where there was none before or a marginal increase in existing flooding.” In the sample calculation (**Table N-3.2**), the project has one day of induced flooding, though it is clear that the alternative lessens existing flood events, and the one day where with project flows are greater than No Action flows, the marginal increase in flow is minimal. The with-project flood damages are substantially less than the No Action flood damages, and a significant percentage of those damages are from one “Induced Day.”

Table N-3.2 Sample Calculation

Reach 8 - Using Otowi gage		
	Base	Alt. B
Days flooded	5	4
Damages	$8,795.59	$8,734.64
Days flooded AND	N/A	1
Marginal flows >		
		$1,729.73
Induced?		No

3.6.2 Impacts of Alternatives

Each alternative had the desirable impact of reducing flood damages in damage centers. Residual flooding is caused by unregulated drainages flowing into the Rio Grande downstream of existing reservoirs. Generally, and across all damage centers, the number of days that flows exceeded start of damages dropped dramatically from the No Action alternative (**Table N-3.2**), signifying that each alternative considered had substantial flood control benefits. No significant impact occurred in which there were more days of flooding or flood damages greater than the No Action condition.

There were some exceptions to the benefits described above. Along, Belen, NM, Alternatives B-3 and E-3 had increasing damages over the No Action Alternative. The total number of days was small, and varied depending upon which data point was used for the analysis. Flood duration study data was not current for this reach. The Corps is currently studying flood control alternatives for this reach of the Rio Grande.

3.6.3 Impacts of the EIS Alternatives

Under the No Action Alternative, operations of the reservoirs continue as before, and the Upper Rio Grande would be subjected to periodic flood and inundation damages. This flooding would be due to unregulated drainages flowing into the Rio Grande downstream of existing reservoirs. The following tables summarize the calculated impacts of flooding in each section under each alternative (**Table N-3.3 and N-3.4**).

Table N-3.3 Impacts of No Action Alternatives

Using Otowi gage			**Days Flooded**	**Interpolated Flood Damages**	**Using Otowi gage**				**Marginal Flows**	**Interpolated Flood Damages**	**Daily Induced Damages**	**Daily Induced Days**
Base Conditions			5	$8,795.59	**Alternative B-3**					$7,024.85	$1,729.73	1
Date	**Otowi. Gage Outflow (units—cfs)**				**Date**	**Otowi. Gage Outflow (units—cfs)**						
5/9/2031	10246.65	Yes	1	$1,770.44	5/9/2031	10242.86	Yes		(3.79)	$1,769.14	0	0
5/10/2031	10228.17	Yes	1	1,764.08	5/10/2031	10228.11	Yes		(0.06)	1,764.06	0	0
5/8/2031	10261.27	Yes	1	1,775.47	5/8/2031	10221.88	Yes		(39.39)	1,761.92	0	0
5/11/2031	10128.28	Yes	1	1,729.72	5/11/2031	10128.31	Yes		0.03	1,729.73	$1,729.73	1
5/7/2031	10204.33	Yes	1	1,755.88	5/7/2031	5049.64	No		(5,154.69)	0	0	0

Table N-3.4 Calculated Impacts of Flooding

Northern Section								
Reach 4 - Velarde and Lyden, NM								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		20	20	20	20	20	20	20
Damages		$1,711.70	$1,711.70	$1,711.70	$1,711.70	$1,711.70	$1,711.70	$1,711.70
Days flooded AND		N/A	0	0	0	0	20	20
Marginal flows >								
	Damages		$0.00	$0.00	$0.00	$0.00	$1,711.70	$1,711.70
Increased over No Action?			No	No	No	No	No	No

Damages in thousands of dollars

Rio Chama Section								
Reach 7 - Abiquiu to Española, NM								
Agricultural damages >1800 cfs (no flows > 4200 cfs start of damages)								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		1006	341	711	613	987	766	619
Damages		$4,970.61	$1,280.40	$4,090.96	$2,810.05	$4,775.13	$3,560.30	$2,835.59
Days flooded AND		N/A	6	614	34	957	738	602
Marginal flows >								
	Damages		$14.74	$3,686.38	$108.17	$4,718.21	$3,472.53	$2,782.23
Increased over No Action?			No	No	No	No	No	No
Española								
Reach 7 - Using Chamita gage - no damage								
Reach 8 - Using Otowi gage								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		313	261	279	272	301	283	272
Damages		$202,656.50	$151,776.45	$175,294.00	$162,659.60	$200,740.35	$183,190.41	$166,405.30
Days flooded AND		N/A	27	169	23	20	21	272
Marginal flows >								

Rio Chama Section								
	Damages		$14,379.31	$117,795.11	$12,452.09	$10,504.31	$10,142.50	$166,405.30
Increased over No Action?			No	No	No	No	No	No

Damages in thousands of dollars

San Acacia Section								
Reach 14 - San Acacia to Elephant Butte								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		208	56	6	64	188	139	6
Damages		$4,269,804.74	$1,054,421.02	$53,728.59	$1,462,438.71	$3,228,307.55	$1,431,151.31	$52,707.99
Days flooded AND		N/A	21	0	25	2	139	6
Marginal flows >			0	0	0	0	0	0
	Damages		$535,364.17	$0.00	$1,003,512.35	$13,626.17	$1,431,151.31	$52,707.99
Increased over No Action?			No	No	No	No	No	No

Damages in thousands of dollars

Central Section								
Reach 12 - Corrales, NM								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		121	88	103	102	119	106	97
Damages		$3,111.43	$6,493.30	$690.19	$8,178.36	$784.95	$696.44	$653.63
Days flooded AND		N/A	83	24	99	58	106	97
Marginal flows >								
	Damages		$6,483.88	$208.74	$8,168.59	$365.22	$696.44	$653.63
Increased over No Action?			No	No	No	No	No	No
Reach 12 - Albuquerque, NM - No damages								
Reach 12 - Belen, NM								
Below Isleta Wastewater Reach								
		No Action	Alt. B-3	Alt. D-3	Alt. E-3	Alt. I-1	Alt. I-2	Alt. I-3

Central Section								
Days flooded		0	46	0	52	0	0	0
Damages		$0.00	$35,980.04	$0.00	$53,111.70	$0.00	$0.00	$0.00
Days flooded AND		N/A	46	0	52	0	0	0
Marginal flows >								
	Damages		$35,980.04	$0.00	$53,111.70	$0.00	$0.00	$0.00
Increased over No Action?			Yes	No	Yes	No	No	No
Below Isleta Diversion Reach								
		Base	Alt. B	Alt. D	Alt. E	Alt. I-1	Alt. I-2	Alt. I-3
Days flooded		0	26	0	26	0	0	0
Damages		$0.00	$8,940.83	$0.00	$23,367.13	$0.00	$0.00	$0.00
Days flooded AND		N/A	26	0	26	0	0	0
Marginal flows >								
	Damages		$8,940.83	$0.00	$23,367.13	$0.00	$0.00	$0.00
Increased over No Action?			Yes	No	Yes	No	No	No

Damages in thousands of dollars

Southern Section
Reach 17 - Hudspeth County, TX - No damages or induced damages
Damages in thousands of dollars
Days flooded - Number of days over the scenario where daily flow exceeds the start of damages flow.
Damages - Sum of damages computed where flow exceeds start of damages flow over scenario
Days flooded and marginal flows greater - Number of days and damages where the alternative flow exceeds
start of damages AND is greater than equivalent day in No Action condition.
Increased over No Action? Yes/No. Value where Yes — Project damages >Base damages; No — Project damages <— Base damages

4.0 HYDROPOWER

4.1 Introduction

This section of the EIS examines the hydropower production, which is impacted by storage regulation and allocation at various reservoirs in the Rio Grande Basin. These areas are at the Middle Rio Grande Conservancy District's El Vado Reservoir; the Bureau of Reclamation's Elephant Butte Reservoir; and the U.S. Army Corps of Engineers' Abiquiu 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. Changes in operation will affect the total generation of these plants.

4.2 Historical Power Provision

A net generation of 164,291,220 kilowatt hours (kwh) was recorded at the Elephant Butte Powerplant during 1987. This was an increase of 252% over the 47 year average from 1940 through 1986 of 65,231,128 kwh. The net power generated during 1987 was the second highest amount recorded in any one year during the powerplant's 48 years of operation. The 1986 net generation of 166,340,400 kwh was the record setting net power generation. These resulted from the record reservoir releases occurring in this time period.

El Vado and Abiquiu data has not currently been obtained.

4.3 Potential Impacts

There are two components to hydropower benefits. The first, the capacity benefit is associated with investment costs that would be displaced by the additional hydro generation. The capacity benefits are based on the dependable capacity of the hydro plant and a unit capacity value based on the fixed costs of the most likely thermal alternative. A significant impact would be a material increase or decrease in the capacity benefit.

The second component is the energy benefit. This measures the displaced variable costs and is the cost of energy that would be produced from other generation sources if the hydropower is not available; specifically, the cost of generation from the area powerplants that would most likely provide the replacement generation (or would be displaced by additional hydro generation). These energy costs are primarily fuel costs, along with some variable O&M and transmission costs. Energy benefits are computed as the product of the average annual energy and unit energy value which represents the average cost of replacement generation. A significant impact would be a substantial increase or decrease in the energy benefits provided by an alternative considered.

The hydropower values derived will be used in conjunction with other groups EIS analysis to estimate benefits of each operating plan, including the without project condition. The kilowatts estimated for each operating plan will be multiplied by the value of a hydropower kilowatt. The difference between plans will be measured on the basis of a 5 5/8 percent interest level, current prices, and standard discounting procedures.

Hydropower values on the dams will be computed differently. A previous analysis (1991), which is currently being updated, provides the following information: The El Vado and Abiquiu plants are used primarily to displace thermal energy and are not considered to have dependable capacity. Hence, there will not be any gain or loss in capacity benefits at these projects as a result of changes in reservoir operation. The value of energy from these plants can be estimated by examining the generation resources available to this system and how they will be used to meet loads during 1991 and subsequent years. Following is a list of generation resources at that time. This analysis will be updated to include a more recent list:

- A 32-megawatt share of Public Service of New Mexico's San Juan coal-fired steam plant, which has a total variable cost of 23.5 mill/kwh.
- 10 megawatts from Basin Electric's Laramie River coal-fired steam plant in Wyoming (15 mills/kwh) if San Juan is fully utilized.
- 18 megawatts of gas-fired steam capacity belonging to the Department of Energy-Los Alamos Utilities at 30 mills/kwh.
- 21 megawatts from the Western Area Power Administration (WAPA), which has an annual capacity of 58% and can be load shaped down to a minimum of 6 megawatts (18 mills/kwh).
- 15 megawatts of WAPA peaking capacity at prices of 17 to 30 mills/kwh.
- 8 megawatts of hydroelectric capacity at El Vado and 15 megawatts at Abiquiu with transmission costs of 7.8 mills/kwh and 5.2 mills/kwh for El Vado and Abiquiu respectively.

During the winter months, generation replacing hydropower would be from the San Juan plant, so the value of hydro energy during the November-March period is about 23.5 mills/kwh. During the summer months, San Juan plant electric generation would replace hydroelectric generation also, but as a result of high loads, sometimes more expensive sources must be used, such as WAPA peaking (#5) capacity. This does not occur often, so it is estimated that the weighted average of San Juan and the other generation sources is about 25 mills/kwh during the months of April through September in 1991. An average yearly figure of 25 mills/kwh was used for 1991.

At Elephant Butte, power generation is no longer marketed directly to individual utilities. It is marketed instead as a part of a system which also includes the Bureau of Reclamation's Colorado River projects. Since WAPA contracts the power with Plains Electric and other users for delivery of a portion of the combined system output, the individual utilities would not be directly impacted by changes in the output of Elephant Butte. WAPA would be the entity that would feel these impacts. They would have to purchase replacement power to make up any shortfalls or market for any excess. The value of any hydropower losses could vary, depending upon what type of operationally change is proposed at Elephant Butte. The value of energy might change if operational adjustments require that the daily generating pattern be shifted to more of a base load or to more of a peaking operation than is presently followed.

Elephant Butte has value as a plant providing dependable capacity. This is a measure of its ability to carry peak load and is used to determine how much thermal generating capacity would be required in the power system if the hydro capacity were not available. The dependable capacity accounts for the periodic unavailability of part of the hydro plant's generating capacity due to the variability of hydrologic factors such as streamflow and reservoir elevation. For a hydro project in a thermal based power system such as the Arizona-New Mexico system, dependable capacity would normally be computed as the average capacity available in the peak demand months. An alternative method would be to base it on the capacity available for some specified percentage of the time during the peak demand months. The latter method is used by WAPA in estimating the marketable capacity of the hydro projects in their system. Elephant Butte does contribute 27 megawatts of marketable capacity to the WAPA system, and marketable capacity will be used in this case as a measure of dependable capacity. WAPA bases marketable capacity on the capacity that is available 90 percent of the time during the peak demand months (which in this system are December and January in the winter and July and August in the summer). Some of the proposed reservoir operation plans could result in lower average pool elevations during these periods and hence a loss in dependable capacity. As an interim energy value for the 1991 study, subsequent to discussions with a WAPA representative and local utilities, market prices were used to the next 5 to 10 years (28.83 mills/kwh). After that period, WAPA customers would likely purchase replacement power from a new power plant (51.5 kwh) much of the time. An average of market price and the cost of new combined cycle plant is 40.2 mills/kwh.

4.4 Impact of Future Development

Changes since the 1991 study will have to be quantified and applied to the existing condition analysis as well as each alternative. Future development in this context includes both demand within the region and the resulting impact upon prices. Additionally, future development incorporated competing demands (e.g. Albuquerque's use of San Juan Chama water) which will impact the existing condition as well as each of the alternatives.

4.5 Analysis of Alternatives

The energy benefit of hydro production was computed with flow-energy output relationships pulled directly from the URGWOM model, for Abiquiu, Elephant Butte, and El Vado reservoirs. Annual unit energy values were computed for each of the twenty-five simulated load years. **Table N-4.1** summarizes the unit energy values in $/MWh for each year in the period of analysis, using the FY 2002 interest rate. The values for the future years after 2030 that were not simulated with the model were assumed to be the same as the year 2030 value.

To obtain one levelized unit energy value for use over the period of analysis, the unit energy values for each year were time valued with present worth methods to the year 2005 (the midpoint of the unit Power-On-Line dates for the project). A levelized unit energy value was computed by applying an amortization factor of 6.125 percent (the FY 2002 Federal interest rate for water resources projects) over the assumed 35-year economic project life. **Table N-4.1** also shows the resulting levelized value of 28.40$/MWh.

Table N-4.1 Present Worth and Energy Values

Interest Rate	6.125	Current Year	2002
Power-Online-date (Midpoint)	**2005**	**Economic Life**	**35**
Year	**Present-Worth Factor**	**Earned Value ($/Mwh)**	**Present-Worth Values Energy Value ($/Mwh)**
2002	1.0000	-----	-----
2003	1.0000	-----	-----
2004	1.0000	-----	-----
2005	0.9423	28.20	26.57
2006	0.8879	28.09	24.94
2007	0.8367	27.98	23.41
2008	0.7884	27.86	21.97
2009	0.7429	27.75	20.62
2010	0.7000	27.64	19.35
2011	0.6596	27.65	18.24
2012	0.6215	27.66	17.19
2013	0.5857	27.66	16.20
2014	0.5519	27.67	15.27
2015	0.5200	27.68	14.69
2016	0.4900	27.89	13.66
2017	0.4617	28.09	12.97
2018	0.4351	28.30	12.31
2019	0.4100	28.5	11.69
2020	0.3863	28.71	11.09
2021	0.3640	28.87	10.51
2022	0.3430	29.04	9.96
2023	0.3232	29.20	9.44
2024	0.3045	29.37	8.94
2025	0.2870	29.53	8.47
2026	0.2704	29.53	7.98
2027	0.2548	29.53	7.52
2028	0.2401	29.53	7.09
2029	0.2262	29.53	6.68
2030	0.2132	29.53	6.30
2031	0.2009	29.53	5.93
2032	0.1893	29.53	5.59
2033	0.1784	29.53	5.27
2034	0.1681	29.53	4.96
2035	0.1584	29.53	4.68
2036	0.1492	29.53	4.41
2037	0.1406	29.53	4.15
2038	0.1325	29.53	3.91
2039	0.1248	29.53	3.69
		TOTAL	**405.35**
	Annualizing Factor @ 6.125, 35 years		**35**
		Annualized Value	**28.37**

4.6 Capacity Value Computation

The Corps' Hydropower Analysis Center (HAC) utilizes a methodology developed by the Federal Energy Regulatory Commission (FERC) to compute capacity values. The capacity value includes allowances for transmission costs, and incorporate capacity value adjustments to account for differences in reliability and operating flexibility between hydropower projects an its thermal alternative.

Hydropower benefits are based on the cost of the most likely thermal alternative that would carry the same increment of load as the proposed hydro project or hydro project modification. Capacity benefits are intended to measure the investment cost of thermal plant capacity that would be deferred by implementation of the hydro plan. Capacity benefits are computed as the product of the dependable capacity of the hydro project and a capacity value, which is based on the unit cost of constructing the most likely thermal alternative.

Utilizing the FERC methodology, unit capacity values for coal, combustion turbine and combined cycle thermal generation was developed for the state of New Mexico. The resulting values were:

Coal	$231.78/kw-yr
Combustion turbine	$ 60.96/kw-yr
Combined Cycle	$111.19/kw-yr

4.6.1 Dependable Capacity

The El Vado and Abiquiu hydropower plants are used to generate power from reservoir releases for irrigation. These releases do not follow any electrical demand pattern and are made as needed for irrigation purposes. On occasion, WAPA will request releases during peak demand periods to displace thermal generation. The generation at these power plants is distributed directly to the City of Los Alamos. Dependable capacity or firm sustain peaking capability is not a factor at these projects.

Elephant Butte has value as a plant providing dependable capacity. This is a measure of its ability to carry peak load and is used to determine how much thermal generating capacity would be required in the power system if the hydro capacity were not available. The dependable capacity accounts for the periodic unavailability of part of the hydro plant's generating capacity due to the variability of hydrologic factors such as streamflow and reservoir elevation. For a hydro project in a thermal-based power system such as the Arizona-New Mexico-Southern Nevada system, dependable capacity would normally be computed as the average capacity available in the peak demand months. An alternative method would be to base it on the capacity available for some specified percentage of the time during the peak demand months. The latter method is used by WAPA in estimating the marketable capacity of the hydro projects in their system. Elephant Butte does contribute 28 MW of marketable capacity to the WAPA system. Therefore marketable capacity will be used in this analysis as a measure of dependable capacity for the Elephant Butte project. WAPA bases marketable capacity on the capacity that is available ninety percent (90%) of the time during the peak demand months, which in the AZ-NM-SNV power system are December and January in the winter and July and August in the summer. Some of the proposed reservoir operation plans could result in lower average pool elevations during these periods and hence a loss in dependable capacity at Elephant Butte.

4.6.2 Impacts Of Alternatives

Generally speaking, each alternative produced additional output at Abiquiu and Elephant Butte reservoirs, and was only differentiated by the amount of additional output produced at each reservoir. The following (**Table N-4.2**) lists the marginal output and dollar value of that output (using the methodology described above) over the alternative's life cycle.

Table N-4.2 Marginal Output and Dollar Value

	Alternative	Total Marginal Output (MW)	Total Marginal Output (dollars)
Abiquiu	B-3	15,262.68	$445,951.47
	D-3	67,597.33	$1,958,741.32
	E-3	68,824.25	$1,994,402.03
	I-1	63,306.15	$1,833,104.49
	I-2	67,265.65	$1,948,949.33
	I-3	68,884.21	$1,996,196.82
El Vado	B-3	-643.74	$18,693.58
	D-3	-487.65	$14,390.40
	E-3	-379.25	$10,956.43
	I-1	-160.27	$4,601.55
	I-2	-228.83	$6,686.12
	I-3	-271.69	$7,877.05
Elephant Butte	B-3	34,752.41	$1,007,851.48
	D-3	34,897.37	$1,012,102.72
	E-3	34,695.28	$1,006,125.50
	I-1	11,443.08	$324,831.39
	I-2	27,493.37	$794,979.49
	I-3	34,914.73	$1,012,586.43

Each alternative had the effect of lowering energy production at El Vado reservoir, but the additional output at Abiquiu and Elephant Butte more than made up for this loss. Thus, we have a significant, though positive, impact even considering the negative impact of lower power output at El Vado reservoir. On an annual basis, El Vado's losses are somewhere around $300-$1,000 per year, which falls well within the measurement tolerances such that it's possible that there is no impact to El Vado's hydroelectric output from implementing any of the alternatives.

As previously stated, Elephant Butte Reservoir contains the only hydroelectric power plant that provides dependable power. Alternatives that decrease the amount of hydro output at Elephant Butte could make it necessary for power consumers to seek other, more expensive sources of energy, and incurring an opportunity cost for the loss of hydroelectric capacity. Of the alternatives considered, only Alternative I-1 impact's Elephant Butte's dependable power capacity, where the losses are roughly $100 per year ($4,300 over the alternative's life cycle), which falls within measurement tolerances.

4.6.3 Impacts of No Action Alternative

Under the No Action Alternative, operations of the reservoirs continue as before, and the hydroelectric plants at Abiquiu, El Vado, and Elephant Butte Reservoirs continue to provide hydroelectric power. Moreover, Elephant Butte continues to provide dependable power as projected by WAPA.

5.0 River and Reservoir Recreation

5.1 Introduction

Recreation throughout the upper Rio Grande Basin is supported by both reservoirs and rivers. Reservoir recreation occurs as a byproduct of dams built to control floodwaters and sedimentation and to store irrigation waters. Due to congressional action, certain reservoirs along the Rio Grande Corridor also serve wildlife enhancement purposes. The users of these facilities enjoy activities in the water and along the shorelines. Riverside recreation occurs both at developed facilities and in a more dispersed manner along the river banks where there is public access.

Subsequent sections describe recreation opportunities at reservoirs and along the upper Rio Grande and Rio Chama. For each setting, the following conditions are described: the range of recreational activities; the recreational facilities within the area of interest; and visitation to or estimated level of use for specific recreational facilities or locales.

5.2 River Recreation

Several discrete facilities along the river concentrate recreation and a number of activities occur dispersed along the river. **Table N-5.1** summarizes the activities and amenities at developed site or special areas for each reach in the project area.

Table N-5.1 Recreation Sites and Areas along Upper Rio Grande and Rio Chama by Reach[1,]

Reach	Managing entity	Recreation Site/area	Activities										
			Camping	Hiking	Fishing	Rafting	Kayaking	Canoeing	Picnicking	Swimming	Wildlife	Winter sport	Hunting
1	USFS	Rio Grande NF	√	√	√	√	√	√	√		√	√	√
1	USFWS	Alamosa NWR		√							√		√
2	USFS	San Juan NF	√	√	√	√	√	√	√		√	√	√
3	BLM	Wild Rivers RA	√	√	√	√	√	√	√		√	√	√
3	BLM/ USFS	Rio Grande NW&SR	√	√	√	√	√	√	√		√		√
3	USFS	Carson NF	√	√	√	√	√	√	√		√	√	√
3	BLM	Taos Box (rafting)				√	√	√					
4	BLM	Racecourse (rafting)				√	√	√					
4	BLM	Orilla Verde RA	√	√	√	√	√	√	√		√	√	√
5	USFS	Santa Fe NF	√	√	√	√	√	√	√		√	√	√
5	NM	Heron Lake SP	√	√	√		√	√	√				√
5	BLM/ USFS	Rio Chama NW&SR	√	√	√	√	√	√	√		√	√	√
6	USFS	Santa Fe NF	√	√	√	√	√	√	√		√	√	√
6	NM	El Vado SP, SWA	√	√	√	√	√	√	√		√	√	√
6	USFS	Santa Fe NF	√	√	√	√	√	√	√		√	√	√
7	USFS	Chama River Canyon Wilderness	√	√	√	√					√	√	√
7	COE	Abiquiu Lake	√	√	√		√	√	√	√	√	√	√

Reach	Managing entity	Recreation Site/area	Activities										
			Camping	Hiking	Fishing	Rafting	Kayaking	Canoeing	Picnicking	Swimming	Wildlife	Winter sport	Hunting
7	USFS	Santa Fe NF	√	√	√	√	√	√	√		√	√	√
7	USFS	Carson NF	√	√	√	√	√	√	√		√	√	√
9	USFS	Santa Fe NF	√	√	√	√	√	√	√		√	√	√
9	NPS	Bandalier NM	√	√					√		√		
9	NPS	Bandalier Wilderness	√	√					√		√		
9	COE	Cochiti Reservoir	√	√	√		√	√	√	√	√	√	√
10	NM	Coronado State Monument			√				√		√		
12	NM	RG Nature Center (SP)		√							√		
13	NM	La Joya Wildlife refuge									√		√
13	NM	Bernardo Wildlife Refuge									√		√
13	NM	Casa Colorada Wildlife Refuge									√		√
13	USFWS	Sevilleta NWR									√		√
14	USFWS	Bosque del Apache NWR/Wilderness		√					√		√		√
14	NM	Elephant Butte SP	√	√	√		√	√	√	√	√	√	√
15		Caballo Lake SP	√	√	√		√	√	√	√	√	√	√
16	NM	Leasburg SP	√	√	√				√		√		
16	NM	Percha Dam SP	√	√	√				√		√		

Notes: 1. Does not include facilities on tribal and pueblo lands.

2. Includes facilities and public recreational areas directly alongside river or reservoirs.

5.2.1 Northern Section–Colorado/Northern New Mexico (River Reach 1 through 4)

General Recreation.—Spanning seven counties, two States, and several tributaries, the northern section of the Rio Grande, reaches 1 through 4, offers pristine and unrestricted territories. The waters of the northern section harbor local and nationally desired recreational opportunities. Water activities such as rafting, kayaking, and canoeing (known generically as "float boating") dominate the river usage of this area. Swimming and fishing also occur along this section of the river at various locations. Adjacent to the river, recreation includes camping at more than 20 public and private campgrounds, hiking along miles of scenic trails, and wildlife viewing from numerous locations such as the Alamosa National Wildlife Refuge (NWR).

In Reach 3, 64 miles of the Rio Grande have Wild and Scenic River designation for both wild values (along 48 miles) and scenic value along 12 miles. This stretch provides outstanding opportunities for pristine river experiences (BLM 2000).

Several developed recreational facilities in along Reach 4 (**Table N-5.1**) provide amenities for camping, hiking, and picnicking. Also, the wildlife and fisheries resources provide recreational experiences such as wildlife viewing, hunting, and fishing.

Rafting—River rafting and kayaking provide the bulk of water-based recreation use during the spring and summer when there are sufficient flows. High flow rates for the northern section typically fluctuate, occurring in the spring when the winter snow pack melts. When flows are high, the rafting season tends to extend longer into the early summer. Low flow rates in spring and summer in the northern basin (below 200 cfs) hinder river recreation and affect local businesses related to this market (Sundin 2002 a,b).

About 50,000 people use the Rio Grande for kayaking and rafting per year (mostly in reach 4). Popular rafting segments include the Taos Box and the Race Course. The Taos Box (16 miles north of Taos) receives about 10,000 visitors annually, typically from May through June. A minimum flow of 500 cfs is needed for float boating; when the flow exceeds 800 cfs, people flock to the area (Sundin 2002 a,b).

In the Race Course (5 mile south of Pilar), the rapids are less steep so boaters can run on lower water levels such as 150 cfs; however, this is not the optimum float level. This section is less challenging and attracts a higher number of vacationers, families and inexperienced rafters. About 30,000 visitors use this area annually. At low water (150 cfs), the river is floated for its scenic value. May through June is usually the best time for floating this segment of the river. However, depending on the water levels, visitor use will also go into July and August. The remaining 10,000 visitors use stretches of the Rio Grande farther south.

BLM controls the number of boaters using the river, to maintain the river corridor's primitive character in conformance with its Wild designation (Taos Box) and Scenic designation (Race course portion). Float boating usage is based on reports from commercial outfitters and BLM records. Outfitters pay a per person fee to BLM for the use of the river. Approximately 80 percent of rafters/kayakers use a commercial outfitter. Approximately 20 percent are private parties that register at put-in points. In addition, BLM staff count visitors on various days. Due to drought conditions during the summer of 2001 river flows plunged to flow rates below 200 cfs. In 2002, fires in the surrounding forests were the cause for closure and lack of access for rafting (Sundin 2002a).

River Fishing—Fishing on the northern section of the Rio Grande occurs year round but the best months for the upper Rio Grande are generally September through November. Above the confluence of the Red River, fishing is of high quality, and generally for advanced skill-level anglers. Cutbow, rainbow, and brown trout are the primary catch. Upstream from Pilar, in the vicinity of Pilar State Park and Red River (Taos Junction bridge), 15,000 anglers and 35,000 angler days were recorded for 2000/2001 (Hansen 2003a), down somewhat from 34,000 angler days recorded above Pilar in 1998/1999 surveys (NMDGF 2000). Catchable-sized rainbow trout are stocked in the river below Pilar. About 15,000 angler days were recorded in 1998/1999 for the portion south of Pilar to Cochiti (Hansen 2003a). Most portions of the river below Pilar flow through pueblos in this section, and angler days are not recorded for this stretch of the river, so the total number of angler days is likely higher. Several lakes in the pueblos are popular for fishing. Tribal areas define their own fishing regulations. Favored access points are Pilar State Park and trails leading down to Red River and the Rio Grand Wild and Scenic River, and Taos Junction Bridge (Hansen 2003b).

5.2.2 Rio Chama Section—(Reaches 5 through 9)

General Recreation.—Reaches 5 through 9 occur along the Rio Chama from El Vado Reservoir to the confluence with the Rio Grande at Española and along the main stem down to Cochiti Reservoir in north central New Mexico. Fishing, rafting, hunting and preservation of wild and scenic qualities constitute the dominant use of the northern portion of the Rio Chama. Miles of hiking trails, several camping facilities, good wildlife viewing, swimming, and scenic quality support river recreation.

On the upstream side of El Vado Lake, the Rio Chama Wildlife and Fishing area has trails and campsites (NMDGF 2004). The portion of the Rio Chama between El Vado and Abiquiu is co-managed by the Forest Service and BLM. This 32-mile stretch is designated Wild and Scenic and allows for multiple day trips, unlike the stretches on the Rio Grande that are primarily day trips. The primary put-in is at Cooper's

Ranch just below El Vado dam. In the surrounding area, designated as Wilderness by the Forest Service, visitors are able to experience primitive wilderness where no motorized vehicles (e.g., ATVs, OHVs) are allowed. The last 8 miles of river above Abiquiu Reservoir is not designated Wild and Scenic and can be run as day trip. For this stretch, Chavez canyon put-in point, located south of the Christ in the Desert Monastery, is popular and has developed camping. Only 2,000 to 3,000 people per year float the Wild and Scenic River section of the Rio Chama. The Chavez canyon day use area receives another 2,000 to 3,000 visitors/rafters each year (Sundin 2002a).

Below the confluence, Bandalier National Monument has hiking trails through scenic canyons down to the river. Float boating is popular from the bridge at the Otowi gage down to Cochiti reservoir during the spring runoff and summer.

Rafting.—The BLM has a lottery system for rafting permits and there are only 250 launch permits for the Rio Chama each year. BLM receives over 10 times that number of applications (Sundin 2002a), attesting to the popularity and demand for rafting opportunities. There are two "float" seasons on the River Chama: the runoff season from May 1 through mid-June and the irrigation season from mid-July through August. The slack time in between the seasons usually allows a predictable flow (through informal agreements between operators and contractors) of 1,000 cfs from Friday through Sunday and 500 cfs Sunday evening through Thursday. Visitors cannot raft the Rio Chama at 100 cfs—the minimum required is 250 cfs. At this water level, kayakers and canoes can float the rivers, but rafters cannot because a minimum of 500 cfs is required for rafting, and 1,000 cfs is better (Sundin 2002).

Fishing.—Total angler days recorded for the Rio Chama above El Vado in 1998/1999 were 36,000, about 24,000 between El Vado and Abiquiu Reservoir and 14,000 below Abiquiu to the confluence with the Rio Grande (NMDGF 2000). There was an increase during the 2000/2001 season with 36,000 angler days recorded between El Vado and Abiquiu (Hansen 2003a). The primary fish are rainbow trout (stocked) and brown trout (wild), and spring and summer are the main fishing seasons. Fishing conditions are impaired when flows fall below 150 cfs and rise above 800 cfs. Below Abiquiu, the quality of fishing declines with high flows and improves with lower flows, with the best conditions when the flow is less than 300 cfs. Good spring flows helps scour habitat (mimicking the natural hydrograph) and are best for wild species (Hansen 2003a). Popular access points are the tailwater area around Abiquiu dam and along the river near Christ in the Desert Monastery above Abiquiu Lake (Hansen 2003b).

5.2.3 Middle Section–Cochiti to Elephant Butte (Reaches 10 through 14)

The middle section of the Rio Grande includes reaches 10 through 14. This diverse portion of the river has natural, urban, and agricultural areas. River recreation in this region competes with reservoirs, municipalities, and agriculture use of adjacent land. River flows in the middle section are controlled through seasonal demands for irrigation, municipal and industrial use, as well as demands to meet State, national, and international policies.

General Recreation.—Recreational use in the middle section concentrates around the reservoirs and New Mexico State parks that receive approximately 5 million visitors annually. More than 37 percent of these visitors recreate at Cochiti and Elephant Butte Reservoirs (NMEMNRD 2001). Water sports such as fishing, swimming, and motorized watercraft recreation are the main attractions at reservoirs. River recreation is limited to activities such as relaxed floats down the river, wildlife viewing, and hiking the miles of trails adjacent to the rivers of the Middle Basin, particularly in the Rio Grande Valley State Park and Nature Center that extends along the river in Albuquerque (reach 12). The river is also an essential feature for several wildlife refuges in the middle section (see Appendix N2 and **Table N-5.1**). The Bosque del Apache is particularly popular and valued by both in-State and out-of-State visitors, and renowned for the daily spectacle of geese and waterfowl leaving and returning to roost each day. The BDA has averaged almost 150,000 visits annually, mostly between October and March (USFWS 2004). Other managed refuges along the river have more emphasis on wildlife programs, with recreational access for wildlife viewing, some duck hunting, and fishing, being secondary. Waterfowl hunting is also popular at Bosque del Apache, La Joya and Bernardo Wildlife Areas, and along the LFCC.

Fishing.—Fishing is popular just below the Cochiti outfall. Angler days recorded during the 1998/1999 season were about 22,000 between Cochiti and I-40 in Albuquerque, and 40,000 in 2000/2001. South of I-40 to Elephant Butte, 32,000 angler days were recorded for during 1998/1999 season. In general, high quantity releases from the reservoir affect fishing downstream in a beneficial manner, low-quantity releases from the reservoir do not enhance fishing quality. Fishing conditions are best when flows below Cochiti are between 500 and 2,000 cfs (NMDGF 2000, Hansen 2003a). Fishing is optimal in Fall, winter and spring. The primary species are rainbow trout (stocked below the dam, but not in summer), largemouth bass, and channel catfish. A popular fishing location below the Cochiti outfall is being closed and the location for a new site at the reservoir is being considered by the COE. Some fishing takes place along the larger drains and ditches running through Bernalillo and Albuquerue, at Coronado State Monument, at Conservancy Park (Hansen 2003b). While convenient, these waters do not provide the high quality fishing opportunities found further north. Fishing is less prominent in Reaches 13 and 14 below Los Lunas (Hansen 2003b).

5.2.4 Southern Section─Southern New Mexico/Texas (Reaches 15 through 17)

This section follows the Rio Grande through southern New Mexico and into northwestern Texas. The river supports numerous types of wildlife, miles of hiking trail, and several camping facilities, but agricultural and municipal use is dominant. Flow rates in the Southern Basin are generally lower than in the Northern Basin due to local irrigation demands that deplete the river for water. Waters of the southern basin are generally more turbid than in the faster flowing waters of the Northern and Middle Basin.

Fishing in the Rio Grande south of Elephant Butte to Caballo is popular, with 51,000 angler days recorded for 1998/1999. South of Caballo Lake, 35,000 angler days were recorded. It should be noted that the majority of fishing takes place at the lakes themselves, with about 400,000 angler days counted for these lakes (combined). State Park facilities are located at Leasburg Dam and Caballo reservoir. In Texas, most of the riverside land is privately owned. Therefore public access for fishing is limited.

5.2.5 Fishing Statewide

Overall, fishing is one of the main recreational opportunities afforded by the Rio Grande. New Mexico is primarily a trout-fishing State. Other popular fish include bass, kokanee salmon, lake trout, walleye, and pike. Conditions sought for quality fishing include lack of fishing pressure (from other anglers), scenery, solitude, accessibility, size, and abundance of fish. The upper reaches provide cold-water fishing, and the lower reaches provide warm-water fishing. NMDGF recorded a total of almost 3.7 million-angler days during 1998/1999 for the entire State of New Mexico, of which almost 1 million (26 percent) were in the project area. The trend over the last decade shows a general increase in fishing.

5.2.6 River Recreation and the Economy

River recreation is important for the economy and many small businesses in Northern Basin area, particularly complementing the off-ski season. The economy of surrounding communities relies heavily on recreation-related income, employment, and other factors (Sundin 2002b). According to a study prepared in 1994 on the economic impact of river recreation in northern New Mexico, about 85 percent of rafters come from out-of-State (U of AZ 1994). In terms of local business, the spring/summer season for rafting complements the ski industry business that takes over during the winter months.

5.2.7 Reservoir Recreation

This section describes recreation at eight reservoirs (**Table N-5.2 and N-5.3**) within the area of interest. **Tables N-5.2 and N-5.3** provide information about activities and physical amenities at reservoirs and **Table N-5.4** summarizes visitation between 1997 and 2001.

Table N-5.2 Reservoir Recreation Resources of the Upper Rio Grande Basin

Reservoir site	Owner	Recreation Operator	Recreational Activities									
			Camping	Picnicking	Hiking	Wildlife viewing	Biking	Hunting	Fishing	Swimming	Boating[1]	Winter sports[2]
Platoro	USBR	State of NM	X	X	X	X	X	X	X	X	X	X
Heron Lake	USBR	State of NM	X	X	X	X			X		X	X
El Vado	MRGCD	State of NM	X	X	X	X			X		X	
Abiquiu	COE	COE	X	X	X	X			X		X	
Cochiti	COE	COE	X	X	X	X		X	X	X	X	
Jemez	COE	Jemez pueblo		X		X						
Elephan t Butte	USBR	State of NM	X	X	X	X	X		X	X	X	X
Caballo Dam	USBR	State of NM	X	X	X	X			X	X	X	X

Sources: Casados 2001, Dunlap 2001, USCOE 2001

Notes:

[1]Boating includes rafting, kayaking, canoeing, and motor boating.

[2] Winter sports include snowmobiling, skiing, sledding, etc.

Table N-5.3 Reservoir Recreation Facilities and Key Elevations for the Upper Rio Grande Basin

Reservoir site	Recreational water levels[1] (low/optimal/high (feet)	Visitor center	Camp sites	Restrooms	Showers	Parking lots	Shelters	Trails	Boat ramps	Marinas
Platoro	Unk/10,034/10,042	N	N	N	N	Y	N	Y	1	N
Heron Lake	7,145/7,186/7,191	Y	284	Y	Y	Y	1	Y	2	Y
El Vado	6,902/6,909	Y	54	Y	Y	Y	2	N	1	N
Abiquiu	6,202/6,222/	Y	66	Y	Y	Y	1	Y	1	N

Reservoir site	Recreational water levels[1] (low/optimal/high (feet)	Visitor center	Camp sites	Restrooms	Showers	Parking lots	Shelters	Trails	Boat ramps	Marinas
Cochiti	5,317/5,340/5,370	Y	146	Y	Y	Y	Y	Y	2	Y
Jemez	/5,271/	N	N	Y	N	Y	1	N	N	N
Elephant Butte	4,400//4,700	Y	111	Y	Y	Y	10	Y	3	3
Caballo Dam	4,161//4,182	Y	200	Y	Y	Y	3	Y	2	N

Sources: Casados 2001, Dunlap 2001, USCOE 2001
Notes:

Table N-5.4 Visitation to Reservoir Facilities

Reservoir site	Annual visitation				
	1997	1998	1999	2000	2001
Heron[1]	153,841	166,787	179,266		
El Vado[1]	45,367	46,998	43,478		
Heron/El Vado [2]	169,962	227,227	213,785	241,996	221,590
Abiquiu[1]	76,491	97,426	87,142	121,833	Incomplete
Cochiti Reservoir[1]	315,717	319,249	269,629	322,781[3]	336,878[3]
Elephant Butte Reservoir[1]	1,754,055	1,804,833	1,620,716	1,759,813	1,466,021
Caballo Reservoir[1]	411,034	345,457	326,791	247,731	211,350
NM State Parks	5,206,397	4,953,418	4,677,205	4,195,149	3,982,097
NM National Parks/ Monuments	2,253,186	2,076,080	2,015,613	1,766,079	1,843,650

Sources: Casados 2001, NMEMNRD 2001, USCOE 2001
Notes:

5.2.8 Platoro Reservoir

Platoro Dam and Reservoir are located on the Conejos River approximately 1 mile north of the town of Platoro, in Costilla County, Colorado. The facility is owned by Reclamation and operated by the Conejos Water Conservancy District for the purpose of flood control, irrigation storage, recreation, and fish and wildlife enhancement.

Recreational usage at Platoro is limited due to difficult access and the quality of facilities. Despite the challenges, visitors enjoy picnicking, hiking, wildlife viewing, fishing, and other activities (**Tables N-5.2 and N-5.3**).

Water levels at Platoro Reservoir create minor concern in terms of recreational management (Hong 2001). Only one boat launch is available at the reservoir. Under low-water conditions, boat ramp access becomes more difficult than it already is. Below the reservoir, high quantity water releases reduce fishing quality due to the increase in turbidity. On the other extreme, low-water flows during the wintering months create conditions below the threshold level for fish life; winter fish kills have resulted in recent years.

Fishing is the main attraction at Platoro. Therefore, maintaining fishing quality is the primary concern for the Platoro staff. Fish stocking efforts have historically supplemented the cold water fishery that Platoro harbors. Modern outbreaks of whirling disease have resulted in the reduction of stocking efforts. With the decline in fishing quality there has been a decline in visitation and usage. Peak season for recreation at Platoro is June 1 through October 1. Visitation at Platoro Reservoir is not monitored.

5.2.9 Heron Reservoir

Heron Dam and Reservoir (Heron Lake) is located on the Rio Chama in Rio Arriba County, about 180 miles north of Albuquerque. Recreational activities at Heron Lake State Park include camping, picnicking, fishing, boating (limited to no-wake speeds), sailing, hiking, wildlife viewing, and winter activities (non-motorized). These activities are supported by a variety of structures such as campsites, boat docks, and visitor center distributed throughout the complex (**Tables N-5.2 and N-5.3**).

Heron Lake has two boat docks. Recent low-water elevations of 7,136 feet have created access problems to these boat docks. One boat dock becomes inoperable at 7,145 (and is currently not in operation). The other remains open throughout the year. To accommodate dynamic water levels, park personnel routinely move equipment such as boat docks (Casados 2001). Although lower water levels expose hazards, fishing, boating, and other water activities continue.

The facility operates year-round. However, certain campgrounds close in the winter when visitation is low (around December 1). The higher-use campgrounds remain open throughout the year. Highest-use season is between Memorial and Labor days.

The primary recreational activities on the lake are fishing and sailing. Since El Vado and Heron Lake are close geographically, visitation data is counted together. However, the two facilities provide different types of recreation opportunities. Sailboat use is quite heavy at Heron. No jet skis or speedboats are allowed there. At El Vado Dam, power boating is allowed. Visitors often spend time at each reservoir during a weekend to participate in different activities.

In 2000/2001, 27,000 anglers and 110,000 angler days were recorded for Heron Lake (Hansen 2003a). The primary species are kokonee salmon and rainbow trout (both stocked), and lake trout. Fall drawdowns are detrimental for natural reproduction of lake trout and spawning of stocked kokonee salmon (Hansen 2003a). Water levels during November and December 2002 limited access. Drawdowns lower than the boat ramp affect fishing access.

Visitation at Heron Lake is monitored through staff observations and visitor receipts. Table N-5-3 shows the visitor use of Heron and El Vado Reservoirs compared to that of New Mexico State Parks, National Monuments, and Parks. Over the last three years Heron and El Vado reservoirs received an average of 225,790 visitors annually with the primary focus of visits being camping. This year visitation use is down by 20 to 25 percent. This is attributed to low water levels and fire restrictions (Casados 2001). An estimated 60 percent of visitors come from within New Mexico and 40 percent come from out of State (primarily Oklahoma and Texas). Most in-State visitors come from Albuquerque (Casados 2001).

5.2.10 El Vado Reservoir

Recreation at El Vado reservoir is managed by the New Mexico State Parks Divison. Recreation at El Vado Lake consists of, but is not limited to, camping, fishing, picnicking, boating, and wildlife viewing. El Vado has campgrounds, boat launching facilities, and other structures to support recreation (**Tables N-5.2 and N-5.3**). Visitation numbers at El Vado are combined with those of Heron Lake (**Table N-5.4**). Because power boating and motorized recreation activities are permitted here, this lake is popular. Most visitors camp during their visit.

5.2.11 Abiquiu Reservoir

Abiquiu Dam and Reservoir are located in Rio Arriba County, New Mexico, on the Rio Chama, 32 river miles above the confluence with the Rio Grande. The storage of SJ-C water has maintained the reservoir at higher elevations that favor recreation. Abiquiu Reservoir provides boating, fishing, camping, picnicking, hiking, and wildlife viewing. These activities occur at developed recreation areas along the lake (**Tables N-5.2 and N-5.3**). The popularity of the lake is augmented by the presence of other points of interest in the area, including the Georgia O'Keefe House, Echo Amphitheater, Monastery of Christ in the Desert, Dar al Islam (a Muslim Mosque), and Poshuouinge Ruins. Visitation for Abiquiu was determined through the use of vehicle counters and the Visitation Estimation and Reporting System (VERS). **Table N-5.4** shows visitation use of Abiquiu Reservoir compared to that of New Mexico State Parks, National Parks, and Monuments. Over the four years from 1997 through 2000, the average annual visitation was 95,723. The primary recreation activities were fishing, camping, and boating.

Water levels at Abiquiu Reservoir fluctuate seasonally. These changes affect the overall facility operations. Dynamic water levels at the reservoir are known to create increased costs related to the erosion of roads and parking lots, as well as the need for riprap, base coarse, gravel, and dock extensions. Releases from the reservoir that create flows greater than 600 cfs hinder fishing below the dam (Dunlap 2001).

At Abiquiu Reservoir, the optimal water level for lake and facility usage is 6,222 mean sea level (msl). If the water level falls below 6,217 msl, the high-water boat ramp becomes inaccessible. At 6,202 msl, the low-water boat ramp is off the concrete, which makes access difficult. The low-water parking lot floods at water levels at or above 6,225 msl (Dunlap 2001).

Fishing at Abiquiu and the Rio Chama River below the dam is very popular and fairly productive any month of the year. Several years ago Abiquiu Reservoir was considered a warm water fishery with crappie being the most often-caught species. Over the last decade, however, the lake has gone through a transformation as more water is being stored at Abiquiu than in years past. Water at Abiquiu is now much deeper and therefore much colder. This has changed the reservoir from a warm-water fishery into a predominantly cold-water fishery, although some warm-water species are still caught (Corps 1999).

In 2000/2001, 15,000 anglers and 37,000 angler days were recorded. Kokonee salmon, walleye, and rainbow trout are stocked. Smallmouth bass and white crappie occur naturally, and are negatively affected by late May-June drawdowns (Hansen 2003a).

5.2.12 Cochiti Reservoir

Cochiti Dam and Reservoir are located in Sandoval County, New Mexico on the Pueblo de Cochiti lands, approximately 50 miles north of Albuquerque, New Mexico. Recreation at Cochiti Reservoir is supported by the Cochiti Recreation Area on the west side of the reservoir, Tetilla Peak Recreation Area on the east side of the reservoir, the Al Black Recreation Area and the Visitor Center. Visitors participate in an array of activities throughout the complex (**Tables N-5.2 and N-5.3**). Fishing and sailing are the main recreational activities of Cochiti Reservoir.

Visitation at Cochiti Reservoir is monitored by traffic counters and the VERS program. **Table N-5.4** shows visitation use of Cochiti Reservoir compared to New Mexico State Parks, National Parks, and Monuments. Over the 4 years from 1997 through 2000, the average annual visitation was 387,539. The primary recreation activities were fishing and boating.

The high-water mark at Cochiti Reservoir is 5,370 msl. Water levels of this magnitude inundate project boat ramps, parking lots, beaches, and the day-use area. The low-water mark for Cochiti is 5,317 msl. This elevation occurs at the very end of the Cochiti boat ramp. Levels below the low-water mark make use of the boat ramp difficult. The optimal water level for most recreational activities at Cochiti is 5,340 msl (USCOE 2001).

Dynamic water levels are common at Cochiti due to seasonal demands for the storage of water and water releases. High-quantity releases from the reservoir affect fishing downstream in a beneficial manner, low-quantity releases from the reservoir do not enhance fishing quality. Operating costs for Cochiti increase with extreme water level fluctuations due to repairs, increased labor requirements, and clean-up activities.

In 2000/2001, 23,000 anglers and 80,000 angler days were logged for Cochiti reservoir. Cochiti is not considered a great spot for fishing (Hansen 2003a). Primary species in the lake are largemouth bass, northern pike, white crappie, and channel catfish, with spring and fall the heaviest fishing seasons. The hydrology of the reservoir has little effect on fishery.

5.2.13 Jemez Reservoir

Jemez Canyon Dam and Reservoir are located in Sandoval County, New Mexico within the confines of Santa Ana Pueblo. The dam and storage space are owned and operated by the Corps for flood and sediment control. However, the use of the lake and surrounding land is owned and controlled by the Pueblo.

Recreational use of the facilities at Jemez Reservoir is limited due to the surrounding land ownership. Currently, no water is being stored in the reservoir; therefore, no water-based activities take place there. In the past, use of the water has been limited to Tribal members. Public recreational use consists of day picnicking only with no access to the water. An overlook facility (**Tables N-5.2 and N-5.3**) is popular for viewing the scenic lake. Without access to the water, general public visitation is low compared to other reservoirs. Tribal visitation numbers are not known.

5.2.14 Elephant Butte Reservoir

Elephant Butte Dam and Reservoir are located 125 miles north of El Paso, TX in Sierra County, New Mexico (at the end of reach 14). Elephant Butte Reservoir is the largest and most-visited recreation area administered by Nm State Parks Divison. Combined with Caballo Reservoir, it offers a wide range of year-round recreational opportunities and draws visitors from New Mexico and surrounding States. During winter, the mild climate provides a haven for campers and anglers from the colder northern climates. In spring, summer, and fall, Elephant Butte and Caballo Reservoirs teem with recreational activities including fishing, developed, and dispersed camping, boating, swimming, use of personal water craft, hiking, biking, wildlife viewing, and hunting. Recreation opportunities and facilities that support these activities are shown in **Tables N-5.2 and N-5.3**.

Visitation for Elephant Butte was determined through the use of vehicle counters and the VERS. Approximately 75 percent of the 1.5 million-plus visits occur between April and September. New Mexico State Park personnel estimate that on peak weekends, such as Memorial Day, between 80,000 and 100,000 persons visit the park (USDOI, BLM 1999). As **Table N-5.4** shows, Elephant Butte provides over a third of the total visitor use to New Mexico State Parks. Average annual visitor use from 1997 through 2000 was about 1,735,000 visitors.

Elephant Butte Reservoir is full at 2.1 million acre-feet of water, with 1.6 million acre-feet the optimal water level, according to reservoir officials. Dynamic water levels affect recreational management of the facilities and increase operational costs. High-water levels reduce the area of land usable by visitors. As a result, consolidation problems arise, and Park officials have noted increased incidents of conflict among visitors due to crowding. Also, portable facilities have to be relocated to accommodate the higher water levels. During low-water conditions, accessibility becomes challenging and park officials are forced to move portable facilities. Lower water levels increase debris exposure in the lake (which can be unsafe for boaters and skiers). Also, lower levels expose debris along the shoreline, which needs to be cleaned up for aesthetic reasons.

Fishing is also a main recreation activity, offering the opportunity to catch striped bass, white bass, crappie, largemouth bass, walleye, and catfish. In 2000/2001, 40,000 to 80,000 anglers and 250,000 to 350,000 angler days were estimated at the reservoir. There are mostly wild fish in the lake (Hansen 2003a). White bass is the primary catch, followed by smallmouth bass, and catfish. Striped bass are stocked. Spring and fall are the primary seasons. Drawdowns in April through June (for irrigators in the south valley) are detrimental for fish reproduction. As the lake goes down, there has been a steady decline in fishing, due both to poorer access and less reproduction.

5.2.15 Caballo Reservoir

Caballo Dam and Reservoir are located 17 miles south of Truth or Consequences in Sierra County, New Mexico, 25 miles downstream from Elephant Butte Dam. The reservoir supports numerous activities such as camping, fishing, hiking, swimming, sailing, water-skiing, picnicking, and wildlife viewing. Caballo Reservoir accommodates these activities through multiple facilities located on site (**Tables N-5.2 and N-5.3**). Combined with Elephant Butte, Caballo offers year-round recreation opportunities. Water fluctuations at Caballo Reservoir make camping difficult to manage. At high-water levels, some of the existing dispersed camping areas are flooded. Often people do not know where the water will be and what camping areas will be accessible from one week to the next (USDOI, BLM 1999). Fishing, motor boating, and swimming are the most popular recreation activities at Caballo Reservoir (USDOI, BLM 1999).

Visitation for Caballo was determined through the use of vehicle counters and the VERS. **Table N-5.4** shows reservoir visitor use compared to that of New Mexico State Parks and National Monuments and Parks. The average annual visitor use from 1997 through 2000 was 332,753 visits. According to the Elephant Butte and Caballo Resource Management Plan EIS (1999), the fluctuation in visitor use can be correlated directly with water level fluctuations in the reservoirs, which have a direct effect on access to the shoreline and shoreline camping (USDOI, BLM 1999).

Reservoir levels are operated at 25,000-80,000 acre-feet in accordance with the Caballo management plan. If the water level drops below 15,000 acre-feet, then boat ramp access becomes impaired. The highest water level recorded at Caballo Reservoir is 200,088 acre-feet. At high-water levels, parking lots and other facilities become inundated. Dynamic water levels due to seasonal demands affect recreational management of Caballo Reservoir. Reservoir staff have documented difficulty accessing boat launching sites and fluctuations in fishing quality due to the alternating water levels.

If the water level drops below 15,000 acre-feet, then boat ramp access becomes impaired. The highest water level recorded at Caballo Reservoir is 200,088 acre-feet. At high-water levels, parking lots and other facilities become inundated. Dynamic water levels due to seasonal demands affect recreational management of Caballo Reservoir. Reservoir staff has documented difficulty accessing boat launching sites and fluctuations in fishing quality due to the alternating water levels.

5.3 Recreation Impacts

Many factors affect recreational opportunities and experiences. A key measure of impacts on recreation is changes in visitation. However, it is difficult to estimate changes in visitation because it is influenced by so many factors. For example, weather on holiday weekends, availability of alternate sites and preferable sites for similar activities, gas prices, fire hazard restrictions and forest closures, previous experiences, population growth, method of counting, and accuracy, and staffing and condition of facilities are some factors that may affect visitation levels. It is difficult to attribute changes in visitation levels or trends specifically to water operation-driven factors such as reservoir elevations and in-stream flows. However, this analysis uses selected measurable criteria to provide comparisons between the alternatives. These criteria are indicators of conditions that may favor or inhibit recreation at reservoirs or along the river.

The analysis of water-related recreation considered the following key issues and concerns:

- Maintaining flows for rafting/kayaking;
- Maintaining conditions for quality fishing;
- Inundation of developed recreation sites;

- Reservoir elevations allow access for boating;
- Inundation of facilities or muddy shorelines;
- Affects of reservoir drawdowns on sport and native fishery; and
- Reservoir water levels that are safe for navigation and water-based activities.

The analyses use the following measurable criteria:

- Flows suitable for rafting (preferred minimum flow is >500 cfs in Reach 6)
- Flows suitable quality fishing: for anglers and fish reproduction
- Inundation of key access and recreation sites along the river
- Inundation of key facilities at reservoirs
- Low water levels at reservoirs that limit boat access

Assumptions and Limitations:

- Northern Section not evaluated as no operational effects
- Below Elephant Butte not evaluated as not modeled; therefore, comparative effects data
- Reach 11 not evaluated as there would be no operational effects above Jemez Canyon, and agricultural lands area below the dam overlap with Reach 12 below Cochiti (and are therefore represented in the analysis).
- Under the No Action, reservoir and river-related recreation would continue throughout the Basin. Water-based recreation will continue to provide an important opportunity in an environment where water and moisture is limited. These activities will continue to respond to direct factors, such as reservoir levels and river flows, but other dominating factors such as trends in preferred recreational activities, population growth, weather on holidays, availability of alternate places to recreate, gas prices, adequacy of facilities, and forest fires. These factors may either promote or lower visitation in any given season, year, or decade. Because of this variability, the analysis focuses of qualitative effects rather than estimating changes in visitation or use.

Tables in the following section summarize data for several criteria to indicate the relative performance of the alternatives in providing suitable conditions for specific recreational activities. Criteria selected are representative and generally only apply to some reaches or facilities. These measures are comparative indicators to assess the degree to which the alternatives may promote suitable conditions for recreation.

5.4 Reservoir Recreation

Table N-5.5 summarizes number of days over 40 years when water levels are unsuitable for access to facilities based on indicative elevations provided by reservoir personnel. Current management of facilities The No Action is somewhat less beneficial than the other alternatives. Current operations and visitation reflects the challenges from recent lower lake levels. For example, at Elephant Butte, the most visited lake in the Basin, new boat ramps have been added to provide access for boats as lake levels change.

Table N-5.5 Access for Water-Based Activities at Reservoirs

Alternative	% days lake elevation impairs access			
	Heron Lake[1]	Abiquiu[1]	Cochiti[1]	Elephant Butte[1]
No Action	29%	88%	1%	12%
B-3	31%	65%	<1%	0%
D-3	29%	70%	<1%	0%

E-3	29%	69%	<1%	0%
I-1	29%	86%	<1%	6%
I-2	29%	78%	<1%	<1%
I-3	29%	69%	<1%	0%

Source: derived from URGWOM (40-year, daily reservoir elevation)
Best
Worst
Notes:

1. The following critical (unsuitable) elevations are used:
   Heron Lake: <7,136 feet (Casados 2002)
   Abiquiu reservoir: <6,202 feet (Dunlap 2001)
   Cochiti Lake: <5,317 >5,370 (USCOE 2001)
   Elephant Butte: < 4300 and >4,410 feet (Kirkpatrick 2001)

Safety for boaters and navigation is a key concern amongst public users, although most issues revolve around boater behavior and knowledge of protocols. However, reservoir facility managers consider "safe boating capacity" of the lake or reservoir in terms of surface area per boat. At Elephant Butte, where boating and visitor numbers are by far the greatest of any reservoir in the project area, the possible number of boats at the reservoir is limited by the number of mooring slots and tie-up points for boats. Based on average reservoir water levels (and surface areas) and maximum boat numbers, the ratio of acres per boat is well above generally accepted safe boating standards (USDOI, BLM 1999). While this is not an issue presently, setting standards at each reservoir, based on the type of boating allowed and the experience desired, would be a beneficial safeguard for maintaining safe and high quality boating opportunities.

Rapid change in elevation at reservoirs can cause muddy shoreline conditions or require additional effort by reservoir personnel to move or adjust equipment and mobile facilities. Fishing is one of the popular activities at reservoirs, and angler satisfaction is partially dependent on the quality of the fishery. Water operations can affect the reproduction and maturation of sport fishery in reservoirs. However, stocking of fish at reservoirs somewhat reduces the dependence of reservoir health on recreational fishing and angler satisfaction. If there were significant changes and long-term trends in declining fish populations angler numbers may be affected over time.

5.5 River Recreation

River-based recreation takes place at key locations where facilities have been developed and in areas where the public has access, primarily to publicly-owned land. Most facilities are beyond the zone of inundation, but some trails, picnic areas, and campsites along the river may be subject to occasional flooding. Like reservoir use, visitation to developed recreation sites is heavily influenced by a variety of factors including proximity to urban areas, availability of recreational alternatives, access to river-side facilities and put-in locations, vandalism and sense of safety for visitors, weather, and other restrictions (such as forest closures).

Few, if any, developed recreational facilities are directly within floodplains. During infrequent flood events, however, localized inundation could result in restricted access to riverside areas. This could temporarily disrupt recreational use of public trails and facilities.

Rafting, one of the most popular water-dependent activity on the river, requires certain minimal flows. **Table N-5.8** shows that under the No Action, flows would fall below 500 cfs, the preferred minimum level on the Rio Chama between El Vado and Abiquiu, on 52 percent of days during the rafting season over forty years. Through informal agreements, water operators currently time the release of water to meet desired flows of 1,000 cfs on weekends during the rafting season. Rafting would benefit from formalizing agreements to the extent that this does not conflict with meeting other priorities or contract obligations. It should be noted, that during some years, rafting operations have ceased when access to put-ins on public land were restricted due to fire hazard conditions.

Table N-5.8 Suitability for Rafting on Rio Chama Between El Vado and Abiquiu

Alternative	Number <500 cfs over 40-year project life (days)[1,2]	% days
No Action	3,435	52
B-3	3,344	51
D-3	3,356	51
E-3	3,444	53
I-1	3,428	52
I-2	3,433	52
I-3	3,444	53

Source: derived from URGWOM, 40-year daily flows at gauge below El Vado, Sundin 2002a

Best

Worst

Notes:

1. Based on rafting season from April 1 through September 15 (168 days per year)
2. Estimated for gauge below El Vado, reach 6

Fishing on the Rio Chama and Rio Grande depends on suitable conditions for high quality fisheries, and for flows that are conducive to safe fishing, particularly for in-stream anglers. Angler activities have been increasing in New Mexico, due partially to population growth and increasing popularity of fishing as a recreational activity. This trend should continue under the No Action, until other pressures, such as overcrowding at favorite fishing spots or significant declines in fish populations due to a variety of threats, seriously impinge on the quality of the experience. In general, fish stocking practices by the NMDGF will continue to maintain a reasonable supply of fish for recreational purposes. **Table N-5.9** shows the relative frequency of days with flows that are suitable for fishing at selected popular fishing locations. There is little difference between alternatives on conditions along Reach 6. Reach 7, below Abiquiu has the most variation with the No Action being the least favorable. Below Cochiti, the No Action provides marginally less suitable flow conditions for anglers in Reach 10.

As reported in the Aquatic section, habitat for brown trout, the primary sport fish on the Rio Chama, and for channel catfish in the Rio Grande, would not change measurably between alternatives. This criterion is not expected to have any discernible impact on recreational fishing.

Table N-5.9 Suitability for Anglers at Selected Locations on Rio Chama and Rio Grande

Alternative	% days with suitable fishing flows (May 1 - October 1)		
	Reach 6	Reach 7	Reach 10
No Action	71	21	69
B-3	71	38	72
D-3	72	38	74
E-3	70	38	73
I-1	69	26	69
I-2	69	33	71
I-3	70	38	73

Alternative	% days with suitable fishing flows (May 1 - October 1)		
	Reach 6	Reach 7	Reach 10

Source: derived from URGWOM, 40-year daily flows at gauge below El Vado, Abiquiu and Cochiti, Hansen 2003a
Best
Worst
Notes:

1. Suitable defined as >190cfs and<830 cfs at gauge below El Vado between May 1 and October 1
2. Suitable defined as >150 cfs at gauge below Abiquiu between May 1 and October 1
3. Suitable defined as >500 cfs and <2,000 cfs at gauge below Cochiti between May 1 and October 1

5.5.1 Additional Technical Output Tables:

5.5.1.1 Reach 7

Table N-5.10: Number of Days (in 40 Year Period) Over 50 cfs and Less Than 300 cfs by Alternative Below Abiquiu Outfall

Alternative	# Days >50 & <300 cfs
Alt B	6,969
Alt D	7,368
Alt E	7,283
Alt I	6,662
Alt I-2	6,961
Alt I-3	7,291
Baserun	6,665

Table N-5.11: Number of Days (in 40 Year Period) Over 50 cfs and Less Than 300 cfs By Alternative During the Fishing Season (May 1 – October 1) Below Abiquiu Outfall

Alternative	# Days >50 & <300 cfs
Alt B	2,347
Alt D	2,312
Alt E	2,333
Alt I-1	1,578
Alt I-2	2,013
Alt I-3	2,332
Baserun	1,292

5.5.1.2 Reach 10, 12

Table N-5.12: Number of Days (in 40 Year Period) Over 500 cfs and Less Than 2000 cfs By Alternative Below Cochiti Outfall

Alternative	# Days >500 & <2000 cfs
Alt B	10,253
Alt D	10,379
Alt E	10,372
Alt I-1	10,183
Alt I-2	10,299
Alt I-3	10,341
Baserun	10,146

Table N-5.13: Number of Days (in 40 Year Period) Over 500 cfs and Less Than 2000 cfs By Alternative During the Fishing Season (May 1 – October 1) Below Cochiti Outfall

Alternative	# Days >500 & <2000 cfs
Alt B	4,450
Alt D	4,534
Alt E	4,520
Alt I-1	4,223
Alt I-2	4,370
Alt I-3	4,504
Baserun	4,237

5.5.1.3 Reach 6

Table N-5.14: Number of Days (in 40 Year Period) Over 190 cfs and Less Than 840 cfs By Alternative Below El Vado Outfall

Alternative	# Days >190 & <840 cfs
Alt B	8,622
Alt D	8,635
Alt E	8,382
Alt I-1	8,324
Alt I-2	8,310
Alt I-3	8,382
Baserun	8,396

Table N-5.15: Number of Days (in 40 Year Period) Over 190 cfs and Less Than 840 cfs By Alternative During the Fishing Season (May 1 – October 1) Below El Vado Outfall

Alternative	# Days >190 & <840 cfs
Alt B	4,371
Alt D	4,410
Alt E	4,305
Alt I-1	4,269
Alt I-2	4,271
Alt I-3	4,308
Baserun	4,346

Table N-5.16 Fishing Flows Analysis

During Fishing Season May 1 Through October 1			
Days Per Season	154		
Seasons	40		
Total Season Days	6160		
Suitable Criteria Met	>190<840	# Days >50 & <300 cfs	
	Reach 6	Reach 7	Reach 10
No Action	4,346	1,292	4,237
Alt B	4,371	2,347	4,450
Alt D	4,410	2,312	4,534
Alt E	4,305	2,333	4,520
Alt I-1	4,269	1,578	4,223
Alt I-2	4,271	2,013	4,370
Alt I-3	4,308	2,332	4,504
Score for preferred angler flows			
No Action	71%	21%	69%
Alt B	71%	38%	72%
Alt D	72%	38%	74%
Alt E	70%	38%	73%
Alt I-1	69%	26%	69%
Alt I-2	69%	33%	71%
Alt I-3	70%	38%	73%

Table N-5.17 Reservoir Visitation Levels in 2000

Heron/El Vado	244,996
Abiquiu	121,833
Cochiti	322,781
Elephant Butte	1,759,813
Caballo	247,731

Table N-5.18 Riverside Recreational Facility Impacts

Total Acres Affected									
	Reach 7	**Reach 8**	**Reach 9**	**RC section**	**Reach 10**	**Reach 12**	**Reach 13**	**Central Sec**	**Reach 14**
No Action	1,384	2,364	34	**3,782**	1,911	4,821	8,494	**15,225.37**	**86,708**
ALT B	4,721	3,161	52	**7,934**	1,733	4,528	7,811	**14,071.85**	**43,274**
ALT D	4,681	2,553	34	**7,269**	3,735	8,907	14,308	**26,949.91**	**26,412**
ALT E	3,385	2,456	34	**5,875**	1,922	5,297	9,177	**16,396.14**	**23,422**
ALT I-1	4,736	3,132	52	**7,921**	4,395	9,590	14,979	**28,964.19**	**25,712**
ALT I-2	3,930	2,760	40	**6,730**	2,433	5,377	9,940	**17,750.47**	**81,371**
ALT I-3	3,300	2,519	34	**5,853**	1,957	4,930	8,896	**15,782.06**	**78,421**
	26,138	18,944	281	45,363	18,086	43,449	73,604	135,140.00	365,320

Score for total affected acres Suitable for river-side recreation (i.e. less inundation has higher score)									
	Reach 7	**Reach 8**	**Reach 9**	**RC section**	**Reach 10**	**Reach 12**	**Reach 13**	**Central Sec**	**Reach 14**
No Action	95%	88%	88%	92%	89%	89%	88%	89%	76%
ALT B	82%	83%	82%	83%	90%	90%	89%	90%	88%
ALT D	82%	87%	88%	84%	79%	80%	81%	80%	93%
ALT E	87%	87%	88%	87%	89%	88%	88%	88%	94%
ALT I-1	82%	83%	82%	83%	76%	78%	80%	79%	93%
ALT I-2	85%	85%	86%	85%	87%	88%	86%	87%	78%
ALT I-3	87%	87%	88%	87%	89%	89%	88%	88%	79%

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6.0 Land Use and Related Factors (Demographics, Regional Economics, Agriculture, Recreation, and Environmental Justice)

6.1 Existing Environment

6.1.1 Introduction

The discussion in this section includes 14 counties adjacent to the Rio Grande River and 2 additional counties linked through economic or social ties. There are two major urban centers located in the three-state study region, Albuquerque, New Mexico and El Paso, Texas. Together these two cities account for about 73 percent of the total study area population. There are several smaller municipalities located throughout the study area that make important contributions to the regional economy. Agriculture, recreation, tourism, and manufacturing are important sectors in the regional economy.

6.1.2 Population

According to the 2000 Census, there were nearly 1.7 million people in the three-state study region. Almost 1 million people were located in the New Mexico portion of the study area and most of the remaining 700,000 people were in Texas. A little over one-half of the total study area population were of Hispanic origin and slightly less than 3 percent were of American Indian origin. The percentage of the total population that is of Hispanic origin has increased significantly over the last 10 years, from 52.4% in 1990 to 57.4% in 2000. The highest percentage of Hispanic population is in the Texas portion of the study area, with about 78% of Hispanic origin in 2000. Overall, the percentage of American Indian population is relatively small, except for three counties in north central New Mexico. From 1990 to 2000 the population of the entire study area grew at an annual rate of 1.75% and it is projected to grow at a rate of 1.45% annually from 2000 to 2025.

6.1.3 Economy

The retail trade sector accounts for the largest portion of sales and business receipts in most of the study area counties. The one major exception is El Paso County, where manufacturing accounts for the largest percentage of business receipts. The large impact from retail trade is in part due to the large amount of tourism in the area. Other sectors that consistently account for large percentages of sales and receipts in the study area counties include wholesale trade, health care and social services, professional and technical services, and accommodation and food services. Wholesale trade is particularly important in the counties that include larger cities. The majority of commercial activity in the study area is in Bernalillo, Santa Fe, Sandoval, and El Paso Counties. Business activity and commercial growth over the last decade have been highest in the Albuquerque and El Paso regions.

Agriculture is an important part of the area’s economy. According to the 1997 Census of Agriculture, the total market value of agricultural products in the Colorado portion of the study area was $222 million, the New Mexico portion was $135 million, and the Texas portion was $101 million. Total farm expenses were about $168 million in Colorado, $106 million in New Mexico, and $75.5 million in Texas. A little over 9,000 people were directly employed on farms in the study region in 1999. About 33% of direct agricultural employment in the study area was in Colorado, 53% was in New Mexico, and the remaining 14% was in Texas.

Hay and wheat are the major crops grown in the Colorado portion of the study area. Hay, corn, and wheat are the major crops in the New Mexico portion of the region and cotton is predominant in the Texas portion. Some smaller crop acreages, such as Chiles in Sierra and Socorro Counties, produce important significant farm income. Approximately 40% of the land in farms in the Colorado study area counties is irrigated farmland, compared to 2% or less for the New Mexico and Texas study area counties. Cattle ranching is also an important agricultural activity in the region. In 1999 there were a little more than 200,000 head of cattle in the New Mexico part of the study area and about 100,000 head in the Colorado portion. There were about 64,000 head of cattle in the two Texas counties included in the study region.

6.1.4 Income and Employment

Median household income in the Colorado counties in 1998 ranged from $19,815 in Costilla County to $29,121 in Alamosa County. This compares to a state average of $43,400 for all of Colorado. Median household income in 1998 for the New Mexico study area counties ranged from $22,038 in Sierra County to $81,879 in Los Alamos County. Median household income in Bernalillo County (where Albuquerque is located) was $38,731 and it was $39,899 in Santa Fe County. The New Mexico state average was $31,445. The median household income in the Texas counties was $26,318 for El Paso County and $20,414 for Hudspeth County, compared to a Texas State average of $35,449. The Colorado and Texas portions of the region generally have a lower income than the New Mexico portion. Per capita personal income data show the same pattern, with the more urbanized New Mexico counties (Los Alamos, Bernalillo, and Santa Fe counties) having higher incomes than other portions of the study region. Median household income unadjusted for inflation consistently increased from 1989 to 1998 and this trend is expected to continue in the study area in the future.

Unemployment in the study region averaged 5.4% in 2001. The New Mexico portion of the region had an unemployment rate of 3.8% compared to 7.1% for the Colorado counties and 8.2% for the Texas Counties. The unemployment rate for the New Mexico counties was brought down by lower than average rates in Los Alamos County (1.0%), Santa Fe County (2.6%), and Bernalillo County (3.5%).

6.1.5 Recreation and Tourism

Recreation has a significant impact on the regional economy. Total recreation at reservoirs in the study area included more than 2.2 million visits in 2000, including visits to the following sites: Elephant Butte, 1.6 million; Caballo, 210,000; Heron, 195,000; Cochiti, 97,000; El Vado, 47,000; and Abiquiu, 37,000. 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. Given the level of overall recreation activity in the study region, recreation related spending could exceed $100 million annually.

6.1.6 Regions of Potential Environmental Justice Concerns

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 American population, 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 percentage of the population that is of Hispanic origin in New Mexico is about 42, compared to 32 percent for all of Texas, and 17 percent for Colorado. All of the study area states are well above the average for the entire U.S. of 13 percent. Therefore, the general study area could be considered to have a high percentage Hispanic population. However, the most useful comparison for evaluating the relative percentage of Hispanic population in smaller areas within the study region is to compare the percentage in individual counties and municipalities to all of New Mexico.

The highest percentage of Hispanic population areas from highest to lowest is Sunland Park (New Mexico), Fabens (Texas), the Picuris Pueblo (New Mexico), Española (New Mexico), Questa (New Mexico), Hatch (New Mexico), El Paso (Texas), and the Pueblo of Santa Clara (New Mexico). Each of these municipalities and Pueblos has populations that are 76 percent or more Hispanic.

Counties with Hispanic populations greater than for all of New Mexico (42%) include Conejos County (Colorado), Costilla County (Colorado), Saguache County (Colorado), Dona Ana County (New Mexico), Rio Arriba County (New Mexico), Santa Fe County (New Mexico), Socorro County (New Mexico), Taos County (New Mexico), Valencia County (New Mexico), El Paso County (Texas), and Hudspeth County (Texas). New Mexico Pueblos with a Hispanic population percentage greater than for all of New Mexico, in addition to the two mentioned above, include Sandia, Nambe, Pojoaque, San Ildefonso, and San Juan.

All of the areas in the study region with a high percentage of Native American population are located in New Mexico. Rio Arriba County (14%), Sandoval County (16%), and Socorro County (11%) all have Native American population percentages greater than the average for all of New Mexico (10%). Other counties with a Native American population of 4% or more of the total population include Bernalillo County (4%) and Taos County (7%). Municipalities with a Native American population percentage greater than the New Mexico average include Cuba (27%) and Magdalena (10%).

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 N-6.1**.

Eight counties and municipalities are identified as low income and high poverty rate as define in **Table N-6.2**. These areas include Alamosa County (Colorado), Conejos County (Colorado), Costilla County (Colorado), Saguache County (Colorado), Sunland Park (New Mexico), Cuba (New Mexico), Fabens (Texas), and Hudspeth County (Texas). Several other areas meet two of the three low income and high poverty rate criteria.

Table N-6.1 Median Household Income, Per Capita Income, and Poverty Percentage

Region	Median Household Income	Per Capita Income	Percentage of Population Below Poverty
UNITED STATES	$41,994	$21,587	**12.4%**
COLORADO	$47,203	**$24,049**	**9.3%**
Alamosa County	$29,447	**$15,037**	**21.3%**
Alamosa	$25,453	$15,405	15.0%
Conejos County	**$24,744**	**$12,050**	**23.0%**
Costilla County	**$19,531**	**$10,748**	**26.8%**
Rio Grande County			
Monte Vista	**$31,836**	**$15,650**	**14.5%**
	$28,393	$13,612	15.1%
Saguache County			
	$25,495	$13,121	22.6%
NEW MEXICO			
Bernalillo County	$34,133	$17,261	**18.4%**
Albuquerque	$38,788	$20,790	**13.7%**
Tijeras	$38,272	$20,884	13.5%
	$34,167	$18,836	9.5%
Dona Ana County			
Hatch	$29,808	$13,999	25.4%
Las Cruces	$21,250	$14,619	34.5%
Mesilla	$30,375	$15,704	23.3%
Sunland Park	$42,275	$25,922	9.4%
	$20,164	$6,576	39.0%
Los Alamos County			
Los Alamos	**$78,993**	**$34,646**	**2.9%**
	$71,536	$34,240	3.6%
Rio Arriba County			
Chama			
Espanola	**$29,429**	**$14,263**	**20.3%**
	$30,513	$16,670	17.9%
Sandoval County	$27,144	$14,303	21.6%
Bernalillo			
Cuba	**$44,949**	**$19,174**	**12.1%**
Jemez Springs	$30,864	$13,100	18.2%
San Ysidro	$21,538	$11,192	41.3%
Rio Rancho	$36,818	$19,522	20.8%
	$30,521	$14,787	15.1%
Santa Fe County	$47,169	$20,322	5.1%
Santa Fe			
Edgewood	**$42,207**	**$23,594**	**12.0%**
	$40,392	$25,454	12.3%
	$42,500	$18,146	10.9%

Table N-6.1 (cont) Median household income, per capita income, and poverty percentage

Region	Median Household Income	Per Capita Income	Percentage of Population Below Poverty
	(continued)		
NEW MEXICO			
Sierra County	**$24,152**	**$15,023**	**20.9%**
Elephant Butte	$31,705	$21,345	10.6%
T or C	$20,986	$14,415	23.2%
Williamsburg	$23,750	$15,549	9.6%
Socorro County	**$23,439**	**$12,826**	**31.7%**
Magdalena	$22,917	$13,064	25.1%
Socorro	$22,530	$13,250	32.3%
Taos County	**$26,762**	**$16,103**	**20.9%**
Questa	$23,448	$13,303	24.3%
Red River	$31,667	$17,883	9.7%
Taos	$25,016	$15,983	23.1%
Valencia County	**$30,099**	**$14,747**	**16.8%**
Belen	$26,754	$12,999	24.8%
Los Lunas	$36,240	$14,992	13.5%
TEXAS	**$39,927**	**$19,617**	**15.4%**
El Paso County	**$31,051**	**$13,421**	**23.8%**
El Paso	$32,124	$14,388	22.2%
Fabens	$18,486	$6,647	43.3%
Hudspeth County	**$21,045**	**$9,549**	**35.8%**
New Mexico Pueblos			
Cochiti	$35,500	$15,363	16.7%
Isleta	$29,331	$11,438	18.3%
Jemez	$28,889	$8,045	25.5%
Sandia	$29,896	$12,341	17.7%
San Felipe	$30,991	$9,266	30.8%
Santa Ana	$45,179	$9,857	5.1%
Santo Domingo	$25,664	$5,713	39.0%
Tesuque	$34,886	$16,484	18.8%
Zia	$34,583	$8,689	15.4%
Nambe	$30,452	$16,543	13.4%
Picuris	$21,136	$10,970	25.2%
Pojoaque	$34,256	$17,348	14.3%
San Ildefonso	$30,457	$14,848	12.5%
Santa Clara	$30,946	$15,336	20.0%
San Juan	$28,315	$12,083	22.7%
Taos	$23,039	$14,225	26.7%

Table N-6.2 Municipalities Defined as Low Income and High Poverty Rate

Region	Total population	White	Black or African American	American Indian	Asian	Other race	More than one race	Hispanic Or Latino
UNITED STATES	281,421,906	75.14%	**12.32%**	0.88%	3.64%	5.60%	2.43%	12.55%
COLORADO	4,301,261	**82.77%**	**3.84%**	**1.03%**	**2.21%**	**7.31%**	**2.84%**	**17.10%**
Alamosa County	14,966	**71.16%**	**0.97%**	2.34%	0.82%	20.53%	4.16%	41.41%
Alamosa	7,960	68.53%	1.41%	2.20%	0.95%	22.63%	4.28%	46.80%
Conejos County	**8,400**	**72.76%**	**0.21%**	**1.69%**	**0.15%**	**21.57%**	**3.61%**	**58.92%**
Costilla County	**3,663**	**60.91%**	**0.79%**	**2.48%**	**1.01%**	**29.65%**	**5.16%**	**67.59%**
Rio Grande County	**12,413**	**73.93%**	**0.35%**	**1.26%**	**0.23%**	**21.56%**	**2.67%**	**41.67%**
Monte Vista	4,529	63.08%	0.38%	1.61%	0.29%	31.86%	2.78%	58.20%
Saguache County	**5,917**	**71.29%**	**0.12%**	**2.06%**	**0.46%**	**23.07%**	**3.01%**	**45.26%**
NEW MEXICO	1,819,046	66.75%	1.89%	9.54%	1.06%	17.12%	3.65%	42.08%
Bernalillo County	556,678	70.75%	2.77%	4.16%	1.93%	16.17%	4.22%	41.96%
Albuquerque	448,607	71.59%	3.09%	3.89%	2.24%	14.88%	4.31%	39.92%
Tijeras	474	65.82%	0.00%	1.05%	0.21%	28.06%	4.85%	56.33%
Dona Ana County	**174,682**	**67.82%**	**1.56%**	**1.48%**	**0.76%**	**24.80%**	**3.58%**	**63.35%**
Hatch	1,673	46.03%	0.36%	0.96%	0.00%	2.63%	50.03%	79.20%
Las Cruces	74,267	69.01%	2.34%	1.74%	1.16%	4.17%	21.59%	51.73%
Mesilla	2,180	73.99%	0.23%	1.01%	0.23%	3.85%	20.69%	52.20%
Sunland Park	13,309	69.80%	0.53%	0.81%	0.07%	26.03%	2.76%	96.44%
Los Alamos County	**18,343**	**90.26%**	**0.37%**	**0.58%**	**3.78%**	**2.73%**	**2.28%**	**11.75%**
Los Alamos	11,909	89.13%	0.44%	0.56%	4.47%	3.06%	2.35%	12.21%
Rio Arriba County								
Chama	**41,190**	**56.62**	**0.35%**	**13.88%**	**0.14%**	**25.74%**	**3.28%**	**72.89%**
Espanola	1,199	67.56%	1.58%	2.67%	0.08%	25.10%	3.00%	71.23%
	9,688	67.55%	0.58%	2.86%	0.14%	25.62%	3.25%	84.38%
Sandoval County								
Bernalillo	**89,908**	**65.08%**	**1.71%**	**16.28%**	**0.99%**	**12.47%**	**3.47%**	**29.40%**
Cuba	6,611	60.17%	0.74%	3.92%	0.20%	31.34%	3.63%	74.75%
Jemez Springs	590	44.07%	0.17%	26.78%	0.68%	23.90%	4.41%	60.34%
San Ysidro	375	78.40%	0.0%	2.40%	1.87%	4.53%	12.80%	27.47%
Rio Rancho	238	30.67%	0.84%	7.56%	0.00%	53.78%	7.14%	71.85%
	51,765	78.36%	2.66%	2.37%	1.46%	11.02%	4.12%	27.68%
		73.52%	**0.64%**	**3.08%**	**0.88%**	**17.81%**	**4.07%**	**49.04%**
Santa Fe County	**129,292**	76.30%	0.66%	2.21%	1.27%	15.36%	4.20%	47.82%
Santa Fe	62,203	86.53%	0.32%	2.17%	0.21%	8.40%	2.38%	20.34%
Edgewood	1,893							

Table N-6.2 (continued) Municipalities Defined as Low Income and High Poverty Rate

Region	Total population	White	Black or African American	American Indian	Asian	Other Race	More Than One Race	Hispanic Or Latino
NEW MEXICO **(continued)**								
Sierra County	**13,270**	**86.97%**	**0.48%**	**1.48%**	**0.17%**	**8.35%**	**2.54%**	**26.28%**
Elephant Butte	1,390	91.94%	0.07%	1.58%	0.29%	5.04%	1.08%	13.31%
T or C	7,289	85.35%	0.63%	1.77%	0.16%	9.41%	2.68%	27.36%
Williamsburg	527	91.84%	1.71%	0.76%	0.19%	1.90%	3.61%	13.09%
Socorro County	**18,078**	**62.87%**	**0.64%**	**10.92%**	**1.14%**	**20.16%**	**4.28%**	**48.73%**
Magdalena	913	62.65%	0.55%	9.97%	0.00%	5.04%	21.80%	48.30%
Socorro	8,877	66.16%	0.74%	2.77%	2.24%	23.30%	4.79%	54.50%
Taos County	**29,979**	**63.77%**	**0.35%**	**6.59%**	**0.38%**	**24.96%**	**3.95%**	**57.94%**
Questa	1,864	50.16%	0.11%	0.70%	0.05%	5.58%	43.40%	80.53%
Red River	484	92.56%	0.00%	1.03%	0.00%	2.69%	3.72%	9.30%
Taos	4,700	68.04%	0.53%	4.11%	0.62%	21.77%	4.94%	54.34%
Valencia County	**66,152**	**66.51%**	**1.27%**	**3.30%**	**0.36%**	**24.01%**	**4.55%**	**54.98%**
Belen	6,901	67.50%	1.07%	1.65%	0.17%	25.55%	4.06%	68.61%
Los Lunas	10,034	64.14%	1.16%	2.62%	0.50%	3.96%	27.63%	58.74%
TEXAS	**20,851,820**	**70.97%**	**11.53%**	**0.57%**	**2.70%**	**11.76%**	**2.47%**	**31.99%**
El Paso County	**679,622**	**73.95%**	**3.06%**	**0.82%**	**0.98%**	**18.01%**	**3.19%**	**78.23%**
El Paso	563,662	73.28%	3.12%	0.82%	1.12%	18.26%	3.40%	76.62%
Fabens	8,043	74.01%	0.57%	0.80%	0.02%	21.73%	2.86%	96.16%
Hudspeth County	**3,344**	**87.23%**	**0.33%**	**1.41%**	**0.18%**	**8.76%**	**2.09%**	**75.03%**
New Mexico Pueblos								
Cochiti	1,502	26.96%	0.53%	46.27%	0.13%	23.10%	3.00%	27.36%
Isleta	3,166	4.04%	0.06%	84.49%	0.16%	4.99%	6.25%	13.36%
Jemez	1,958	0.41%	0.00%	99.13%	0.00%	0.31%	0.15%	1.94%
Sandia	4,414	61.64%	0.45%	11.33%	0.25%	23.61%	2.72%	71.77%
San Felipe	3,185	12.53%	0.13%	77.39%	0.03%	9.04%	0.88%	17.11%
Santa Ana	487	1.44%	0.00%	97.13%	0.00%	0.82%	0.62%	2.87%
Santo Domingo	3,166	0.98%	0.00%	97.44%	0.00%	1.26%	0.32%	1.96%
Tesuque	806	28.04%	0.37%	44.04%	0.00%	25.81%	1.74%	36.23%
Zia	646	0.00%	0.00%	99.85%	0.00%	0.00%	0.15%	0.46%
Nambe	1,764	36.22%	0.00%	25.79%	0.62%	31.07%	6.29%	59.24%
Picuris	1,801	16.32%	0.28%	9.22%	0.00%	69.57%	4.61%	85.56%
Pojoaque	2,712	56.19%	0.41%	9.73%	0.22%	29.68%	3.76%	65.78%
San Ildefonso	1,524	53.22%	0.00%	34.65%	0.00%	8.66%	3.48%	45.08%
Santa Clara	6,748	62.23%	0.53%	19.68%	0.15%	14.86%	2.55%	76.22%
San Juan	10,658	64.32%	0.45%	12.47%	0.08%	19.61%	3.08%	73.48%
Taos	4,484	50.60%	0.11%	29.68%	0.29%	15.99%	3.32%	41.88%

Table N-6.2 (continued) Municipalities Defined as Low Income and High Poverty Rate

Region	Total Population	White	Black or African American	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%**	**0%**	**2%**	**0%**	**22%**	**4%**	**59%**
Costilla County	**3,663**	**61%**	**1%**	**2%**	**1%**	**30%**	**5%**	**68%**
Rio Grande County	**12,413**	**74%**	**0%**	**1%**	**0%**	**22%**	**3%**	**42%**
Monte Vista	4,529	63%	0%	2%	0%	32%	3%	58%
Saguache County	**5,917**	**71%**	**0%**	**2%**	**0%**	**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%	0%	28%	5%	56%
Dona Ana County	**174,682**	**68%**	**2%**	**1%**	**1%**	**25%**	**4%**	**63%**
Hatch	1,673	46%	0%	1%	0%	3%	50%	79%
Las Cruces	74,267	69%	2%	2%	1%	4%	22%	52%
Mesilla	2,180	74%	0%	1%	0%	4%	21%	52%
Sunland Park	13,309	70%	1%	1%	0%	26%	3%	96%
Los Alamos County	**18,343**	**90%**	**0%**	**1%**	**4%**	**3%**	**2%**	**12%**
Los Alamos	11,909	89%	0%	1%	4%	3%	2%	12%
Rio Arriba County	**41,190**	**5662%**	**0%**	**14%**	**0%**	**26%**	**3%**	**73%**
Chama	1,199	68%	2%	3%	0%	25%	3%	71%
Espanola	9,688	68%	1%	3%	0%	26%	3%	84%
Sandoval County	**89,908**	**65%**	**2%**	**16%**	**1%**	**12%**	**3%**	**29%**
Bernalillo	6,611	60%	1%	4%	0%	31%	4%	75%

Region	Total Population	White	Black or African American	American Indian	Asian	Other Race	More Than One Race	Hispanic Or Latino
Cuba	590	44%	0%	27%	1%	24%	4%	60%
Jemez Springs	375	78%	0%	2%	2%	5%	13%	27%
San Ysidro	238	31%	1%	8%	0%	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%	0%	2%	0%	8%	2%	20%
Sierra County	**13,270**	**87%**	**0%**	**1%**	**0%**	**8%**	**3%**	**26%**
Elephant Butte	1,390	92%	0%	2%	0%	5%	1%	13%
T or C	7,289	85%	1%	2%	0%	9%	3%	27%
Williamsburg	527	92%	2%	1%	0%	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%**	**0%**	**7%**	**0%**	**25%**	**4%**	**58%**
Questa	1,864	50%	0%	1%	0%	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%**	**0%**	**24%**	**5%**	**55%**
Belen	6,901	68%	1%	2%	0%	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%	0%	22%	3%	96%
Hudspeth County	**3,344**	**87%**	**0%**	**1%**	**0%**	**9%**	**2%**	**75%**
New Mexico								
Pueblos								
Cochiti	1,502	27%	1%	46%	0%	23%	3%	27%
Isleta	3,166	4%	0%	84%	0%	5%	6%	13%
Jemez	1,958	0%	0%	99%	0%	0%	0%	2%
Sandia	4,414	62%	0%	11%	0%	24%	3%	72%

Region	Total Population	White	Black or African American	American Indian	Asian	Other Race	More Than One Race	Hispanic Or Latino
San Felipe	3,185	13%	0%	77%	0%	9%	1%	17%
Santa Ana	487	1%	0%	97%	0%	1%	1%	3%
Santo Domingo	3,166	1%	0%	97%	0%	1%	0%	2%
Tesuque	806	28%	0%	44%	0%	26%	2%	36%
Zia	646	0%	0%	100%	0%	0%	0%	0%
Nambe	1,764	36%	0%	26%	1%	31%	6%	59%
Picuris	1,801	16%	0%	9%	0%	70%	5%	86%
Pojoaque	2,712	56%	0%	10%	0%	30%	4%	66%
San Ildefonso	1,524	53%	0%	35%	0%	9%	3%	45%
Santa Clara	6,748	62%	1%	20%	0%	15%	3%	76%
San Juan	10,658	64%	0%	12%	0%	20%	3%	73%
Taos	4,484	51%	0%	30%	0%	16%	3%	42%

7.0 References

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