Table 3-79
Arizona Personal Income and Earnings (2021)

Income/Earnings	Coconino County	Gila County	La Paz County	Maricopa County	Mohave County	Pima County	Pinal County	Yuma County	Arizona
Personal income ($1,000s)	$8,255,426	$2,612,568	$819,303	$268,713,717	$8,997,444	$55,696,681	$19,687,597	$9,169,548	$403,739,312
Per capita personal income	$56,914	$48,752	$49,933	$59,759	$41,331	$52,942	$43,793	$44,299	$55,487
Earnings by place of work	$4,633,046	$1,050,392	$365,268	$192,958,723	$3,807,031	$31,731,662	$5,182,726	$5,472,861	$258,941,005
Wages and salaries	$3,154,528	$763,967	$281,717	$146,954,704	$2,626,349	$22,652,731	$3,512,696	$3,732,656	$193,197,269
Supplements to wages and salaries	$810,341	$194,781	$72,577	$27,989,246	$591,791	$5,328,512	$870,907	$1,013,969	$39,417,203
Proprietors' income	$668,177	$91,644	$10,974	$18,014,773	$588,891	$3,750,419	$799,123	$726,236	$26,326,533

Source: Bureau of Economic Analysis 2023b

Among the eight counties, average per capita income ranged from a low of approximately $41,331 per year in La Paz County to a high of $59,759 per year in Maricopa County. Only Maricopa and Coconino Counties had per capita income above the state of Arizona average ($55,487). The total personal income generated in the eight counties represented around 93 percent of the state total (Bureau of Economic Analysis 2023b).

Agriculture

Approximately 36 percent of Arizona's land area in 2018 was used for agricultural purposes (either crop or livestock production). According to an agricultural economic profile on Arizona counties for 2017 (Duval et al. 2020)[20], the total market value of agricultural production in Arizona contributed $23.3 billion to Arizona's economy. Direct contributions from the sale of farm products; the manufacture of crop inputs; and crop processing, marketing, and distribution accounted for $14.8 billion, with an additional $8.5 billion coming indirectly from economic activity generated as a result of agricultural income (Lahmers and Edan 2018). The types of crops, amount of water used for agriculture, and the role of agriculture in county economics vary across the state. The top agricultural industries by employment include citrus, hay farming, cotton farming, and crop harvesting (Lahmers and Edan 2018).

Central and southwestern Arizona have long been the center of agricultural production in Arizona; central and southwestern Arizona farms contribute the largest share of agricultural production in terms of sales values. In 2017, the market value of agricultural production occurring within the Arizona study area accounted for nearly 62 percent of the statewide on-farm agricultural production value and 0.41 percent of Arizona total gross domestic product (GDP). In 2017, production values ranged from a low of approximately $17.1 million in La Paz County to a high of $1.2 billion in Yuma County (Duval et al. 2020). **Table 3-80** presents a summary of the market value of on-farm agricultural production with respect to county and state GDP.

In the western US, while agriculture represents a relatively small share of the US production, it requires large amounts of irrigation water. The most water-intensive crops include crops for food, feed, and fiber production. In Arizona, irrigated agriculture accounts for about 75 percent of the state's water use; more than 50 percent of this is from surface waters. According to the 2007 FEIS, urbanization of agricultural lands and heavy investment by the irrigated agricultural industry in conservation measures both on farms and in the delivery system have resulted in a reduction in the percentage (from as high as 90 percent) of water used by agricultural irrigation. Improvements in irrigation technology; voluntary fallowing programs that compensate farmers who reduce water consumption; and utilization of more effective irrigation strategies, such as changes to irrigation timing, have resulted in a reduction in agriculture's share of water consumption (Lahmers and Edan 2018).

[20] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.

Table 3-80
Market Value of On-Farm Agricultural Production in Arizona Study Area (2017)[1]

Area	Market Value of Production ($1,000,000)	Percentage of County GDP	Percentage of Arizona GDP
Maricopa County	89.4	0.04	0.03
Pima County	64.5	0.14	0.02
Pinal County	28.1	0.37	0.01
Total within CAP Counties	**182.0**	**0.06**	**0.05**
La Paz County	17.1	2.55	0.00
Mohave County	27	0.47	0.01
Yuma County	1,200	14.46	0.34
Total within Arizona Study Area[2]	**1,426.1**	**0.45**	**0.41**

Source: Duval et al. 2020

Note: CAP values are aggregated values of Maricopa, Pima, and Pinal Counties.

[1] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.

[2] Coconino County is included in the Arizona study area due to the potential for recreation-related impacts, but it currently does not receive Colorado River irrigation water and is excluded from this table.

Agricultural lands receiving water for irrigation from the CAP are generally within Pinal, Maricopa, and Pima Counties. The three counties account for approximately 50 percent of statewide irrigated and harvested cropland (USDA 2019a). These three counties also account for approximately 70 percent of Arizona's harvested cotton acreage, 50 percent of the state's hay crops, and approximately 44 percent of irrigated wheat cultivation (USDA 2019a).

Agricultural resources in western Arizona are primarily along the Colorado River in Mohave, La Paz, and Yuma Counties and along the Gila River Valley in Yuma County. These three western Arizona counties account for approximately 54 percent of statewide irrigated wheat cultivation, 76 percent of vegetable crops, and 36 percent of hay crops (USDA 2019a). Yuma County alone produces 75 percent of the state's total vegetable crops. **Table 3-81** provides a summary of county-wide irrigated agricultural lands within the Arizona study area.

Table 3-82 shows changes between 2012 and 2017 in acres of irrigated cropland compared with changes to acres of total cropland in each county. In general, there is a correlation between the percent change in irrigated cropland and the percent change in total cropland within the CAP counties. Changes can be due to changing cropping patterns or technological and farming strategy modifications that contribute to expansion of nonirrigated agriculture in Arizona, where irrigation would otherwise be essential. For example, an increase in total Yuma County cropland between 2012 and 2017 was due to expansion of nonirrigated cropland (USDA 2019a).

Table 3-81
Irrigated Acres of Harvested Agriculture in the Arizona Study Area (2017)[1]

Area	Irrigated Cropland (Acres)	Total Cropland (Acres)	Percent Irrigated Cropland
Maricopa County	177,975	187,467	95
Pima County	29,154	29,192	100*
Pinal County	231,092	235,185	98
Total within CAP Counties	**438,221**	**451,844**	**97**
La Paz County	(D)	96,204	(D)
Mohave County	20,713	22,002	94
Yuma County	181,244	193,823	94
Total Arizona[2]	**876,272**	**915,647**	**96**

Source: USDA 2019a
Note: CAP values are aggregated values of Maricopa, Pima, and Pinal Counties. Totals for the Arizona study area are not presented due to a lack of data for some counties.
* Percent irrigated cropland is 99.9 percent of total cropland in Pima County.
(D) = data determined too sensitive to disclose.
[1] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.
[2] Coconino County is included in the Arizona study area due to the potential for recreation-related impacts, but it does not receive Colorado River irrigation water and is excluded from this table.

Table 3-82
Irrigation Trend for Harvested Agriculture in the Arizona Study Area (2012–2017)[1]

Area	Percent Change in Irrigated Cropland	Percent Change in Total Cropland
Maricopa County	-6.6	-4.9
Pima County	1.7	1.6
Pinal County	4.1	3.6
Total within CAP Counties	**-0.7**	**-0.2**
La Paz County	(D)	-7.6
Mohave County	(D)	(D)
Yuma County	0.0	5.1
Total Arizona[2]	**2.6**	**2.9**

Source: USDA 2019a
Note: CAP values are aggregated values of Maricopa, Pima, and Pinal Counties. Totals for the Arizona study area are not presented due to a lack of data for some counties.
(D) = data withheld in USDA 2019a source document to avoid disclosing data for individual farms.
[1] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.
[2] Coconino County is included in the Arizona study area due to the potential for recreation-related impacts, but it does not receive Colorado River irrigation water and is excluded from this table.

Table 3-83 shows the proportion of irrigation water that comes from all surface water resources in each county. In general, there is a correlation between the trend in the change of the percentage of irrigation water that comes from surface waters and the trend in total acre-feet of surface water used for irrigating croplands. However, all or part of the change in the volume of irrigation water from surface water resources may be due to changes in contributions from groundwater. In Mohave County, although the percentage of irrigated cropland sourced from surface waters decreased from 75 percent in 2010 to 56 percent by 2015, the total acres of irrigated cropland receiving surface water increased by 14 percent. Between 2010 and 2015, Mohave County's total water usage, which includes groundwater sources in addition to surface waters, increased more rapidly than the increase in acre-feet of water from surface waters alone. The proportion from surface water's contribution decreased.

Table 3-83
Percent Irrigated Water from Surface Water Sources

Area	Percent Agricultural Water from Surface Waters (2010)	Percent Agricultural Water from Surface Waters (2015)[1]	Percent Change in Acre-Feet of Irrigation Water from Surface Waters (2010–2015)
Maricopa County	27	21	-22
Pima County	33	39	18
Pinal County	76	62	-18
Total within CAP Counties	**51**	**39**	-24
La Paz County	92	87	-5
Mohave County	75	56	-25
Yuma County	85	90	6
Total within Arizona Study Area[2]	**70**	**61**	-13
Total Arizona	**64**	**57**	**-11**

Source: USGS 2015
Note: CAP values are aggregated values of Maricopa, Pima, and Pinal Counties. Surface water sources include all sources; they are not exclusive to the Colorado River.
[1] The 2015 USGS water use (for specific purposes, such as irrigation) data by source (surface water or groundwater, etc.) are the most recent available county-level data.
[2] Coconino County is included in the Arizona study area due to the potential for recreation-related impacts, but it does not receive Colorado River irrigation water and is excluded from this table.

Industrial and Municipal Water Uses

In models of water yield and demand in the western US to 2070, data indicate that demands for municipal water are increasing across the SEIS socioeconomic study area, while projected water availability is decreasing (see, for example, Warziniack and Brown 2019). While this trend is seen throughout the western US, the Colorado River region has the largest percentage increases in projected domestic water use as well as the greatest percentage decreases in projected water yield from all sources, including Colorado River water (Warziniack and Brown 2019).

As described in the 2007 FEIS, municipalities potentially affected by the proposed alternatives include Phoenix, Tucson, Scottsdale, and other Arizona towns and cities served by the CAP, as well as Arizona municipalities along the Colorado River that have post-1968 Colorado River water delivery contracts, such as Lake Havasu City. In Arizona, industrial land uses on the Colorado River include the major power facilities of Glen Canyon Dam in Coconino County, Hoover and Davis Dams on the Arizona-Nevada border in Mohave County (and Clark County, Nevada) and Parker Dam in La Paz County (and San Bernardino County, California).

California

Population

In California, the population has increased by approximately 7.7 percent in the past decade. With the exception of Los Angeles, the study area counties' growth all surpassed that of the state. The largest increase in population was in Riverside County (14.2 percent; see **Table 3-84**).

Table 3-84
California Population 2010–2021

Population	Imperial County	Los Angeles County	Orange County	Riverside County	San Bernardino County	San Diego County	California
Population 2010	168,052	9,758,256	2,965,525	2,109,464	2,005,287	3,022,468	36,637,290
Population 2021	180,051	10,019,635	3,182,923	2,409,331	2,171,071	3,296,317	39,455,353
Percent change 2010–2021	7.1	2.7	7.3	14.2	8.3	9.1	7.7

Source: Headwaters Economics Economic Profile System 2023

Employment

Full- and part-time employment in California totaled 23.9 million jobs in 2021, an increase of approximately 3.9 million jobs from 2004 levels. Full- and part-time employment in the six-county study area totaled 13 million jobs in 2021, representing 55 percent of total California employment. Farm employment was higher in Imperial County (5.2 percent) than in California overall (1.0 percent) and lower in all other counties (see **Table 3-85**).

Table 3-85
California Employment by Industry (2021)

Employment	Imperial County	Los Angeles County	Orange County	Riverside County	San Bernardino County	San Diego County	California
Total employment	82,115	6,428,159	2,253,070	1,127,161	1,122,017	2,131,117	23,906,353
Wage and salary employment	67,229	4,597,519	1,675,102	813,146	858,597	1,619,417	17,891,462
Proprietors' employment	14,886	1,830,640	577,968	314,015	263,420	511,700	6,014,891
Farm employment (number and percentage of total employment)	4,229	4,110	1,363	7,293	2,467	10,820	229,419
	5.2%	0.1%	0.1%	0.6%	0.2%	0.5%	1.0%

Employment	Imperial County	Los Angeles County	Orange County	Riverside County	San Bernardino County	San Diego County	California
Non-farm employment (number and percentage of total employment)	77,886	6,424,049	2,251,707	1,119,868	1,119,550	2,120,297	23,676,934
	94.8%	99.9%	99.9%	99.4%	99.8%	99.5%	99.0%
Forestry, fishing, and related	6,934	2,747	1,327	6,950	1,153	3,030	250,669
	8.4%	<0.0%	0.1%	0.6%	0.1%	0.1%	1.0%
Mining, quarrying, and oil and gas extraction	395	5,738	2,436	1,689	1,351	1,810	33,528
	0.5%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Utilities	525	13,326	3,403	1,903	3,898	5,465	65,390
	0.6%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%
Construction	2,501	252,952	132,853	98,788	60,656	113,440	1,253,884
	3.0%	3.9%	5.9%	8.8%	5.4%	5.3%	20.8%
Manufacturing	2,532	341,233	158,005	49,600	56,632	123,412	1,375,410
	3.1%	5.3%	7.0%	4.4%	5.0%	5.8%	5.8%
Wholesale trade	2,222	242,952	90,733	32,519	48,346	51,850	731,178
	2.7%	3.8%	4.0%	2.9%	4.3%	2.4%	3.1%
Retail trade	9,604	520,666	185,913	120,232	112,569	176,273	2,031,941
	11.7%	8.1%	8.3%	10.7%	10.0%	8.3%	8.5%
Transportation and warehousing	3,686	398,305	73,131	104,835	163,147	83,983	1,371,207
	4.5%	6.2%	3.2%	9.3%	14.5%	3.9%	5.7%
Information	D	252,429	30,588	8,228	6,621	28,470	643,367
	D	3.9%	1.4%	0.7%	0.6%	1.3%	2.7%
Finance and insurance	1,896	320,290	166,014	42,930	37,784	106,550	1,191,722
	2.3%	5.0%	7.4%	3.8%	3.4%	5.0%	5.0%
Real estate rental and leasing	1,962	393,202	157,319	53,359	42,016	115,531	1,250,434
	2.4%	6.1%	7.0%	4.7%	3.7%	5.4%	5.2%
Professional, scientific, and technical services	2,021	520,666	220,542	52,231	46,030	232,087	2093532
	2.5%	8.1%	9.8%	4.6%	4.1%	10.9%	8.8%
Management of companies and enterprises	178	77,980	42,667	4,674	5,587	27,703	277,998
	0.2%	1.2%	1.9%	0.4%	0.5%	1.3%	1.1%
Administrative, support, and waste management	3,459	406,452	198,480	85,653	89,927	132,174	1,526,406
	4.2%	6.3%	8.8%	7.6%	8.0%	6.2%	6.4%
Educational services	387	172,964	53,545	14,692	16,275	46,095	543,623
	0.5%	2.7%	2.4%	1.3%	1.5%	2.2%	2.3%
Health care and social assistance	11,023	855,509	159,818	129,950	134,728	218,439	2,822,918
	13.4%	13.3%	7.1%	11.5%	12.0%	10.2%	11.8%
Arts, entertainment, and recreation	348	223,083	56,418	22,842	14,023	47,031	566,938
	0.4%	3.5%	2.5%	2.0%	1.2%	2.2%	2.4%
Accommodation and food services	4,452	408,321	159,818	86,805	14,023	152,988	1,575,223
	5.4%	6.4%	7.1%	7.7%	1.2%	7.2%	6.6%
Other services	D	414,016	123,440	72,847	73,055	115,935	1,346,871
	D	6.4%	5.5%	6.5%	6.5%	5.4%	5.6%
Government and government enterprises	19,271	600,175	160,559	129,141	65,928	338,030	2,724,695
	23.5%	9.3%	7.1%	11.5%	5.9%	15.9%	11.4%

Source: Bureau of Economic Analysis 2023a

D = not shown to avoid disclosure of confidential information; estimates are included in higher-level totals.

Personal Income

Total personal income in California totaled $3 trillion in 2021, compared with $1.84 trillion in 2004 (when adjusted for inflation). Statewide per capita income also increased from approximately $49,435 in 2004 (adjusted for inflation) to approximately $76,614 in 2021 (Bureau of Economic Analysis 2023b; see **Table 3-86**).

In 2004, total personal income ranged from a low of approximately $8.6 billion in Imperial County to a high of $728.8 billion in Los Angeles County. When combined, the total personal income of the six counties represents 48.8 percent of the state total. Per capita income ranged from a low of approximately $47,653 in Imperial County to a high of approximately $81,034 in Orange County.

Table 3-86
California Personal Income and Earnings (2021)

Income/ Earnings	Imperial County	Los Angeles County	Orange County	Riverside County	San Bernardino County	San Diego County	California
Personal income ($1,000s)	$8,570,390	$728,772,915	$256,700,438	$125,820,553	$108,623,799	$238,691,713	$3,006,183,929
Per capita personal income	$47,653	$74,141	$81,034	$51,180	$49,493	$72,637	$76,614
Earnings by place of work	$5,137,777	$510,862,232	$181,016,988	$64,353,758	$69,548,586	$167,563,948	$2,102,644,661
Wages and salaries	$3,249,301	$359,122,730	$128,811,520	$45,029,294	$49,466,149	$123,893,955	$1,533,988,242
Supplements to wages and salaries	$1,122,878	$78,557,777	$26,652,410	$11,516,385	$12,705,654	$29,637,025	$314,285,006
Proprietors' income	$765,598	$73,181,725	$25,553,058	$7,808,079	$7,376,783	$14,032,968	$254,371,413

Source: Bureau of Economic Analysis 2023b.

Agriculture

The percentage of cropland that is irrigated in the California study area, with an average of 94 percent—which is the same as the percentage of irrigated cropland for all of California—varies across the different counties. The percentage of irrigated cropland ranges from a low of 68 percent in Orange County to a high of 98 percent in Imperial County. The proportion of irrigated croplands within the California study area represents approximately 12 percent of total irrigated croplands in the state. **Table 3-87** shows acres of irrigated and total cropland within the California study area.

Table 3-87
Irrigated Acres of Harvested Agriculture in the California Study Area (2017)[1]

Area	Irrigated Cropland (Acres)	Total Cropland (Acres)	Percent Irrigated Cropland
Imperial County	455,768	467,445	98
Los Angeles County	10,104	12,806	79
Orange County	3,946	5,803	68
Riverside County	125,363	143,628	87

Area	Irrigated Cropland (Acres)	Total Cropland (Acres)	Percent Irrigated Cropland
San Bernardino County	21,487	22,145	97
San Diego County	41,607	49,080	85
Total California Study Area	**876,272**	**915,647**	**94**
California	**7,348,690**	**7,857,512**	**94**

Source: USDA 2019b

[1] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.

Industrial and Municipal Water Uses

As noted in the 2007 FEIS, municipalities potentially affected by the proposed alternatives include 88 cities in Los Angeles County, 34 cities in Orange County, 24 cities in Riverside County, 31 cities in San Bernardino County, and 18 cities in San Diego County.

Nevada

Population

Following trends seen in other study area states, the population of Nevada grew by over 16 percent from 2010 through2021. Clark County's population change (17.7 percent) was higher than that of the state overall (see **Table 3-88**).

Table 3-88
Nevada Population 2010–2021

Population	Clark County	Nevada
Population 2010	1,895,521	2,633,331
Population 2021	2,231,147	3,059,238
Percent Change 2010–2021	17.7	16.2

Source: Headwaters Economics Economic Profile System 2023

Employment

Full- and part-time employment in Nevada totaled 1,875,709 jobs in 2021, an increase of approximately 472,402 jobs from 2004 levels. In 2021, employment in the arts, entertainment, and recreation sector totaled 55,322 jobs, or approximately 3 percent of total employment in the state. Farm employment represented only 0.3 percent of total employment.

Full- and part-time employment in Clark County totaled 1,368,492 jobs in 2021, an increase of approximately 370,492 jobs from 2004. Total employment in Clark County represented almost 70 percent of total employment in Nevada. In 2021, employment in the arts, entertainment, and recreation sector totaled 41,400 jobs, or approximately 3 percent of total employment in the county. Similar to statewide totals, farm employment represented only 0.03 percent of total employment. See **Table 3-89**.

Table 3-89
Nevada Employment by Industry (2021)

Employment	Clark County	Nevada
Total employment	1,368,492	1,875,709
Wage and salary employment	1,019,149	1,409,465
Proprietors' employment	349,343	466,244
Farm employment (number and percentage of total employment)	409	5,028
	0.03%	0.3%
Non-farm employment (number and percentage of total employment)	1,368,083	1,870,681
	>99.9%	99.7%
Forestry, fishing, and related	457	1,937
	<0.0%	0.1%
Mining, quarrying, and oil and gas extraction	1,577	4,526
	0.1%	0.2%
Utilities	86,255	4,526
	6.3%	0.2%
Construction	86,255	120,249
	6.3%	6.4%
Manufacturing	29,758	66,978
	2.2%	3.6%
Wholesale trade	29,275	43,982
	2.1%	2.3%
Retail trade	136,244	185,306
	10.0%	9.9%
Transportation and warehousing	104,271	137,427
	7.6%	7.3%
Information	15,961	21,137
	1.2%	1.1%
Finance and insurance	80,765	103,909
	5.9%	5.5%
Real estate rental and leasing	79,184	110,419
	5.8%	5.9%
Professional, scientific, and technical services	79,184	109,638
	5.8%	5.8%
Management of companies and enterprises	79,597	32,573
	5.8%	1.7%
Administrative, support, and waste management	26,541	132,423
	1.9%	7.1%
Educational services	16,473	21,845
	1.2%	1.2%
Health care and social assistance	118,625	160,792
	8.7%	8.6%
Arts, entertainment, and recreation	41,400	55,322
	3.0%	2.9%

Employment	Clark County	Nevada
Accommodation and food services	229,369	276,961
	16.8%	14.8%
Other services	67,012	89,948
	4.9%	4.8%
Government and government enterprises	119,106	177,141
	8.7%	9.4%

Source: Bureau of Economic Analysis 2023a

Personal Income

Total personal income in Nevada totaled $189.3 billion in 2021, an 89 percent increase over 2004 levels (when adjusted for inflation). Statewide per capita income increased from approximately $23,800 in 1994 (inflation-adjusted levels) to approximately $33,800 in 2004. See **Table 3-90.**

In 2021, per capita income in Clark County was $58,276, which was slightly lower than the state average. The total personal income of Clark County represents more than 70 percent of the state total. See **Table 3-90**.

Table 3-90
Nevada Personal Income and Earnings (2021)

Income/Earnings	Clark County	Nevada
Personal income ($1,000s)	$133,596,955	$189,308,244
Per capita personal income	$58,276	$ 60,213
Earnings by place of work	$83,182,161	$117,154,278
Wages and salaries	$60,447,133	$ 84,993,156
Supplements to wages and salaries	$13,352,162	$ 19,168,471
Proprietors' income	$9,382,866	$ 12,992,651

Source: Bureau of Economic Analysis 2023b
(D) = Not shown to avoid disclosure of confidential information; estimates are included in higher-level totals.

Agriculture

Agriculture in the Nevada study area was relatively small (2,722 acres, which are less than 0.01 percent of the agricultural study area) compared with the agricultural areas in Arizona and California study areas. The Nevada agricultural study area was also relatively small (0.5 percent) compared with total agricultural cropland in the state. Of the total harvested agricultural lands in Clark County, which makes up the Nevada study area, 100 percent were irrigated cropland, which is comparable with the percentage of irrigated cropland in Nevada (99 percent). **Table 3-91** shows the acres of irrigated and total cropland within the Nevada study area.

Table 3-91
Irrigated Acres of Harvested Agriculture in the Nevada Study Area (2017)[1]

Area	Irrigated Cropland (Acres)	Total Cropland (Acres)	Percent Irrigated Cropland
Clark County	2,722	2,722	100
Total Nevada	**567,978**	**573,785**	**99**

Source: USDA 2019c

[1] The 2017 agricultural census from the National Agricultural Statistics Service (used in reports developed by Duval et al. 2020) provides the most recent available data on the market value of agricultural production at the county level. The next agricultural census data release is due in the spring/summer 2024.

Municipal and Industrial Water Use

As noted in the 2007 FEIS, municipalities potentially affected by the proposed alternatives include Boulder City, Henderson, Las Vegas, and North Las Vegas due to their reliance on Colorado River water supplied by SNWA.

Utah

Reclamation does not anticipate that the counties in the Utah study area would be affected by agricultural, industrial, or municipal water shortages as a result of proposed management. As a result, no detailed information is included for the population, employment, and income, or the agriculture, municipal, or industrial uses in the study area.

Economic Contributions from Recreation

As discussed in **Section 3.14**, Recreation, recreational activities with the potential to be affected by proposed management include recreation (boating, camping, hiking, etc.) on and adjacent to reservoirs at Lake Powell and Lake Mead, as well as river-based recreation downstream in Glen Canyon and Grand Canyon. Information is also included on wildlife refuges on the Colorado River; these refuges may be affected by the Proposed Action.

Economic benefits result when visitors spend dollars on recreation. Those benefits include increased sales, income, and jobs. Direct economic benefits occur when businesses sell goods and services to area visitors. Additional jobs and economic activity are supported when businesses purchase supplies and services from other local businesses, thus creating indirect effects from visitor spending. In addition, employees use their income to purchase goods and services in the local economy, generating further induced effects from visitor spending.

Table 3-92, below, displays the total economic contributions from recreation occurring in the GCNRA, LMNRA, and GCNP. Information is included in **Table 3-92** related to economic contributions from wildlife refuges. Economic contributions are estimated by multiplying total visitor spending by regional economic multipliers. Total visitor spending includes spending by both local visitors who live in gateway regions and nonlocal visitors who travel to NPS sites from outside gateway regions. Spending by nonlocal visitors represents an influx of dollars from outside the local economy. In addition, nonlocal visitors typically have higher levels of spending on food, lodging, and other activities on a per-trip basis.

Table 3-92
Summary of Economic Contributions for NPS-Based Recreation (2021)

NPS Unit	Total Recreation Visits	Visitor Spending (1,000s of 2021$)	Jobs	Labor Income (1,000s of 2021$)	Value Added (1,000s of 2021$)	Economic Output (1,000s of 2021$)	% of Spending from Nonlocals
GCNRA	3,144,318	$332,150	3,839	$139,418	$234,458	$409,546	96
GCNP	4,352,667	$710,256	9,390	$324,318	$539,433	$944,693	99
LMNRA	7,603,474	$373,668	4,054	$167,550	$281,033	$457,279	88

Source: NPS 2022d

Note: Jobs measure annualized full- and part-time jobs that are supported by NPS visitor spending. Labor income includes employee wages, salaries, and payroll benefits, as well as proprietors' incomes that are supported by NPS visitor spending. Value added measures the contribution of NPS visitor spending to the GDP of a regional economy. Value added is equal to the difference between the amount an industry sells a product for and the production cost of the product. Economic output is a measure of the total estimated value of the production of goods and services supported by NPS visitor spending. Economic output is the sum of all intermediate sales (business to business) and final demand (sales to consumers and exports).

The GCNRA, LMNRA, and GCNP had 96 percent, 88 percent, and 99 percent of spending from nonlocal visitors, respectively. A discussion of recreation-related economic activity occurring on the Colorado River downstream of Lake Powell and Lake Mead was not included; this is because no change in recreation and resulting changes in economic activity are expected under the proposed alternatives. For additional details on recreation and levels of use, see **Section 3.14**, Recreation.

As shown in **Table 3-93**, below, recreational visits to the GCNRA and GCNP correspond with a wide array of job sectors within local (predominately small town and rural) economies. In 2021, GCNRA recreation supported 3,839 jobs, including 921 indirect and induced jobs. GCNP recreation supported 9,390 jobs, including 2,243 indirect and induced jobs (NPS 2022d). LMNRA recreation supported 4,054 total jobs in 2021 (specific job data unavailable).

Table 3-93
Jobs by Sector Supported by Economic Contributions from NPS-Based Recreation (2021)

Jobs	GCNRA	GCNP
Direct Jobs by Sector		
Camping	76	143
Gas	73	94
Groceries	98	127
Hotels	1,200	2,400
Recreation industries	610	1,880
Restaurants	580	1,500
Retail	155	439
Transportation	126	564
Indirect and Induced Jobs	**921**	**2,243**
Total Jobs	**3,839**	**9,390**

Source: NPS 2022d

In addition to general recreation sector contributions, visitor use supports concessionaires, including those associated with water-based recreation. Contributions from GCNRA concessioners and small business permittees are estimated at $130 million annually in gross receipts (NPS 2022e). This spending represents an important contribution to local communities in Coconino County in Arizona and Garfield, San Juan, Wayne, and Kane Counties in Utah. Based on communication with the NPS, the State of Utah believes recreational access to Lake Powell contributes up to $8 million to the state's economy.

In terms of river-based recreation, it is estimated that Grand Canyon river outfitters retain roughly 1,100 employees, not including the contracted transportation and training services and numerous food, sundries, and river supply vendors required to support the operations.[21]

In addition to the direct economic impact on GCNP and the NPS, it is estimated that the regional economic impact of commercial river trips sustains hundreds of additional jobs and generates millions more of additional revenue throughout the mostly rural communities and small businesses of northern Arizona and southern Utah each season. All river recreation in GCNP is regulated through the NPS CRMP (to protect the resource and the visitor experience). River trips are closely regulated, and this experience is generally reserved an average of 12–18 months in advance. River trips include approximately 22,000 visitors annually, generating more than $50 million in revenues to the region (NPS 2006a).

In terms of wildlife refuges, economic contributions are associated with recreational visitors paying for recreation through entrance fees, lodging near the refuges, and purchases from local businesses for items to pursue their recreational experience. This spending supports economic activity throughout the local economy (Caudill and Carver 2019). **Table 3-94** displays the estimated contributions from the two refuges receiving Colorado River water, Imperial NWR and Bill Williams River NWR.

Table 3-94
Economic Contributions from National Wildlife Refuges (2017 Data)

NWR	Total Recreation Visits	Total Economic Output ($1,000)	Total Employment Income ($1,000)	Total Jobs
Bill Williams River NWR (Arizona)	326,344	$11,345.3	$2,944.2	113
Imperial NWR (Arizona and California)	274,159	$11,069.8	$3,228.6	100

Source: Service 2019a, 2019b

[21] Laurie Dyer, NPS supervisory concessions management specialist in the Commercial Services Division at GCNP, personal communication provided on March 15, 2023.

3.16.2 Environmental Consequences

Methodology

Agriculture

The purpose of the agricultural impact assessment is to estimate the change in agricultural production as a result of a reduction of irrigation water. The change in the value of agricultural production is directly related to the acres of cropland chosen to be fallowed and the estimated revenue per acre of the fallowed crop. In addition to revenue loss from agricultural products, agricultural jobs and wages would potentially be lost.

As described in **Section 3.3**, Reclamation used CRMMS to analyze water deliveries across alternatives. Modeling details for each alternative are described in **Section 3.3.4** and **Appendix D**, CRMMS Model Documentation. Additionally, as described in **Section 3.3**, Reclamation used a Shortage Allocation Model in addition to CRMMS to analyze the potential impacts of the alternatives on individual agricultural water users within each Lower Division State under different shortage scenarios.

Reclamation then applied the 2007 agricultural modeling framework, using crops' profitability in each county to determine which crops farmers are most likely to fallow in times of reduced water availability. In this analysis, water shortages are assumed to result in temporary acres of fallowed cropland during the period in which shortages would occur. While farmers may use groundwater and other surface water resources to mitigate impacts from allocated shortages, it is difficult to project exactly how individual farmers, irrigation districts, or each Lower Division State may mitigate potential future agricultural impacts from shortages. Therefore, similar to the assumption made in the 2007 FEIS, the projected change in agricultural production was based on the conservative assumption that other sources of water would not replace the estimated water shortage.

The decision to fallow lands is based on the farmer's ability to cover the variable cost of production of a given crop. If the cost of water exceeds the maximum amount a farmer can pay or if water is not available, a crop is taken out of production and the land is fallowed during the year shortages would occur. Considering crop profitability gives an indication of crops that face larger reductions compared with other crops (Dale and Dixon 1998; Frisvold et al. 2012). The least profitable crop would be fallowed first. Crops would continue to be fallowed in the order of least profitable crop, until the full volume of water shortage is offset or until the crop is completely fallowed within the county.

Irrigated crops in the analysis area include field crops, vegetables and melons, and trees and vines. Field crops have lower earnings per acre-foot of water than other crops; therefore, they are more vulnerable to changes in water costs and shortages. Studies on fallowing patterns in the southwestern US show that field crops account for 98 to 100 percent of fallowed crops (Frisvold et al. 2012; Dale and Dixon 1998). Fallowed crops for the No Action Alternative were limited to cotton, wheat, and alfalfa. Crops considered in this analysis included irrigated crops for which data were available; farmers may choose to fallow other crops, such as corn or other forage and grain crops, for which data were unavailable or unreliable.

Calculation of crop profitability per acre-foot of water followed the method outlined in Appendix H of the 2007 FEIS, which used the difference between revenue and the variable costs per acre of land required to grow a given crop. In the Arizona and Nevada analy, calculations were updated with the most recent available data from the US Department of Agriculture[22] (USDA 2019a). County-level revenue for each crop was based on 5-year (2014 to 2018) averages of yield[23] and prices. The US Department of Agriculture does not provide recent county-level data for California; yield, acreage, and price data for the California study area between 2014 and 2018 were obtained from reports produced by each county's agricultural commissioner/weight and measures departments (Imperial County 2014, 2015, 2016, 2017, 2018b; Riverside County 2014, 2015, 2016, 2017, 2018; San Bernardino County 2014, 2015, 2016, 2017, 2018).

County-level production cost data for each crop, including the difference in irrigation cost, are not updated frequently. To capture the difference in the irrigation cost for each crop in different counties in Arizona, variable costs-of-production estimates were based on historical crop and livestock budgets developed by the University of Arizona for 1999 (University of Arizona 2001); these were the same cost-of-production data used in the 2007 analysis. For the California counties, estimates were based on budgets developed by the University of California Davis (UC Davis 2023) for a range of years (from 1970 to 2004, depending on the type of crop and the county for which it was developed). All dollar values were converted to 2022 dollars. The purpose of using the cost estimates was only to determine the order in which crops would be fallowed; the estimates are not considered an accurate measure of the current cost and return estimates.

To determine how much a farmer would be willing to pay for water before a choice is made to fallow a crop, the irrigation cost of growing each crop was added back to the calculated revenue over the variable production cost. To account for each crop's required amount of water (different for each crop), the estimated return plus irrigation cost was divided by the amount of water per acre[24] needed to grow that crop (University of Arizona 2001; UC Davis 2023). Based on this method, the order in which crops would be fallowed varied across the counties in the study area. In Arizona and Nevada, cotton is most likely to be fallowed first. In California, wheat and alfalfa would be fallowed before cotton; vegetables would be expected to be fallowed last in the entire study area.

As in the 2007 FEIS, the socioeconomic effects of changes in agricultural production in Arizona were analyzed using the IMPLAN input-output economic model. IMPLAN is a regional economic model that describes the flows from producers to intermediate and final consumers using a series of economic multipliers. The IMPLAN model describes for each county the transfers of money between all industries and institutions. This model of county-level economic interactions is used to project total changes to regional economic activity based on the direct change estimated in agricultural production. In addition to the direct loss in agricultural output, reduced expenditures

[22] The most recent available yield and price data for alfalfa hay were from 2018. More recent cotton and wheat data (2019 to 2022) were available; however, for consistency across the different crops, 2018 data were the latest data used in this analysis.
[23] The cottonseed revenue estimates that were included in the 2007 model were excluded from current revenue estimates due to a lack of county-level yield data for cottonseed in Arizona.
[24] Water (per acre) required by a particular crop is assumed to be relatively constant over time.

occur from a drop in business-to-business purchases and in reduced household expenditures. These changes, known as indirect and induced economic effects, were also estimated using IMPLAN.

This analysis of economic impacts from fallowed crops is based on a uncompensated reduction in agricultural production associated with modeled levels of shortage. System conservation included in the No Action Alternative and Proposed Action would result in a voluntary reduction of water use for agricultural purposes, for which entities would receive compensation per the details of existing agreements (under the No Action Alternative) and the states' proposed alternative (for the Proposed Action). The regional economic impacts from system conservation are discussed qualitatively.

Impact Analysis Area

Potential changes in agricultural production within the study area due to estimated shortages were quantitatively assessed for the counties expected to experience impacts; these include La Paz, Maricopa, Mohave, Pima, Pinal, and Yuma Counties in Arizona; Imperial, Riverside, and San Bernardino Counties in California; and Clark County in Nevada.

Assumptions

- Farmers would fallow irrigated crops in response to water shortages or an increased cost of irrigation.
- Farmers would fallow crops that generate the lowest returns per acre-foot of water.
- Crops have a constant profitability per acre of land and per acre-foot of water.
- Changes in the amount of irrigated crops would be the result of changes in water deliveries from the Colorado River sources; they do not involve changes to allocations or to irrigation water from groundwater or other surface water sources.
- Estimated shortages in the agricultural sector are based on the Shortage Allocation Model (**Appendix E**, Shortage Allocation Model Documentation).
- DCP contributions and ICS assumptions are consistent with the official June 2023 CRMMS simulation, as detailed in **Appendix D**.
- The Shortage Allocation Model does not account for the use or conversion of ICS to meet DCP contributions, and it models DCP contributions as shortages to Lower Division States and users.
- Shortages and required DCP contributions are distributed between Nevada and Arizona, and between California parties, as described in the 2007 Interim Guidelines and the 2019 DCPs.
- For all alternatives, available water is distributed within the CAP based on the CAP priority system, and shortage volumes are calculated relative to scheduled 2024–2026 use. Non-Indian CAP agricultural districts currently do not hold long-term CAP contacts, but they are shown as absorbing significant shortage based on their historical use of CAP excess water.
- In most cases, the contractor, subcontractor, or recipient of an allocation is shown as the entity bearing shortage, by sector. In some cases, water allocated to one contractor, subcontractor, or recipient (for example, a Tribal CAP contractor) may lease its allocation to other users (for example, to a non-Indian municipality). The Shortage Allocation Model does not replicate those arrangements, and it only provides approximate estimates at the contract or subcontract allocation level. The CAP contractor, subcontractor, and/or parties to those

arrangements would have specific decisions to make during shortage conditions to administer those arrangements that Reclamation cannot predict with sufficient certainty to analyze in this SEIS.

Impact Indicators

- Acres of fallowed cropland
- Crop profitability per acre-foot of water
- Jobs and income associated with agriculture

Recreation

A qualitative discussion is provided related to social and economic impacts from changes in recreational access and experiences as a result of changes in reservoir elevations and river flows, as discussed in **Section 3.14**, Recreation.

In addition, a discussion of net economic value changes is provided for a subset of recreational activities, including for anglers and whitewater rafters in Glen and Grand Canyons. This analysis is provided following the approach used in the recreation economic analysis for the LTEMP SEIS (Gaston et al. 2015). Models were informed from past survey research and were used to project the change in net economic value for angling in Glen Canyon and whitewater rafting in Grand Canyon; these were compared with the Proposed Action and No Action Alternative scenarios. The analysis was based on whitewater boater and angler surveys that examined different river flow scenarios to estimate the net economic value of an individual trip as a function of river flow. The function used to estimate the net economic value is for conditions where within-day fluctuations are less than 10,000 cfs, consistent with the Proposed Action and No Action Alternative.

Impact Analysis Area

The impact analysis area consists of the counties adjacent to the Colorado River from Lake Powell to the SIB.

Assumptions

Recreation spending per trip for anglers and whitewater rafting (adjusted for inflation) would follow results from willingness-to-pay surveys (Gaston et al. 2015) with variation based on river flows.

Impact Indicators

- Recreation’s economic contributions

Municipal and Industrial Uses

Impacts on municipal and industrial uses of water are discussed qualitatively based on anticipated water shortages of various magnitudes, as determined under the Shortage Allocation Model. The analysis then examines whether a particular shortage event would affect the M&I sector as compared with the No Action Alternative. For example, a shortage in Arizona would affect parts of the agricultural sector first before affecting M&I uses. In contrast, a shortage in Nevada would primarily affect M&I users, because Nevada has a small agricultural sector that uses high-priority Colorado River water.

For situations likely to have an effect on the M&I sector, each state's ability to manage shortages to the M&I sector is analyzed. The M&I shortages allocated to each state are compared with the drought plans or actions that state or local agencies could institute during a shortage. The analysis then qualitatively discusses whether such drought-planning mechanisms are adequate to address shortages to the M&I sector and the existing and estimated conservation measures to be applied under the No Action Alternative and Proposed Action.

Impact Analysis Area
The analysis area for M&I water shortages is the same as the overall analysis area for socioeconomics, as described in **Section 3.15.1**.

Assumptions
The analysis is based on shortage levels as modeled in the Shortage Allocation Model, and the frequency and magnitude of shortages based on modeled CRMMS output.

Impact Indicators

- The potential for economic impacts due to shortages and depletions among and within the Lower Division States

Issue 1: How would anticipated water shortages affect economic contributions from agriculture?

Summary
Anticipated water shortages would result in a temporary increase in acres of fallowed cropland and agricultural production loss under both alternatives. The modeled agricultural production loss would in turn result in short-term impacts on the associated jobs, income, and tax revenue . The No Action Alternative has the potential to result in up to $116 million in agricultural revenue loss, $112 million in income loss from jobs lost, and $25 million in tax revenue loss. Impacts also have the potential to occur in California and Arizona under this alternative.

Under the Proposed Action, the total range of agricultural sector losses and the associated impacts on jobs, income, and tax revenue, prior to consideration of compensated SEIS conservation, would be the same as modeled under the No Action Alternative. Increased SEIS conservation would result in more compensated conservation than under the No Action Alternative (**Table 3-95**). This would offset, to some degree, the level of economic impacts associated with reduced agricultural production. There are insufficient data, however, on the degree to which this compensation would offset the regional economic impacts in the agricultural sector, due to the loss of indirect and induced jobs and income that may not be fully compensated.

In addition, the long-term preservation of reservoir levels above a critical value (dead pool) due to proposed system conservation would help limit the potential for higher levels of shortage modeled. This is anticipated to lessen the long-term (potentially permanent) economic impacts.

Table 3-95
State-Level Comparison of Modeled Conservation for Irrigation Water Users (2023–2026 af Totals)

State		No Action Alternative	Proposed Action
		System Conservation	System Conservation
Arizona	Tribal	383,700	550,000
	Non-Tribal	36,200	138,400
California	Tribal	—	52,000
	Non-Tribal	98,200	1,582,000
Nevada	—	—	—

Source: Based on Shortage Allocation Model allocations for the type of use and CRMMS model assumptions for modeled conservation. ICS is not included due to no identified ISC for irrigated water users.

In addition, the Proposed Action would result in higher elevations at Lake Mead, with fewer traces at higher shortage tiers, as compared with the No Action Alternative, in 2025 and 2026. As a result, the potential to reach higher-tier shortage levels for domestic water users (for example, those shortages as modeled at 967,000 to 1,100,000 af) would be reduced. This would, in turn, result in a decreased potential to reach higher levels of economic impacts on the regional economy compared with the modeled impacts under the No Action Alternative.

No Action Alternative

Temporary impacts (during periods of lower water elevations) from allocated shortages under the No Action Alternative (200,000 af to 1.100 maf of water) would result in up to 98,485 acres of fallowed cropland and up to $120 million in loss of agricultural production. The impacts would be restricted to the Arizona analysis area and would be limited to field crops. Under the No Action Alternative, cotton, wheat, and hay were analyzed in detail, and impacts did not extend to additional crops. **Table 3-96** shows the total estimated acres of fallowed cropland and the reduction in the dollar value of agricultural production for different shortage volumes under the No Action Alternative.

While non-Indian agriculture is expected to experience short-term impacts for every allocated shortage amount, lower shortage volumes (between 200,000 and 533,000 af) would not result in impacts on Indian agriculture. However, for shortages greater than 617,000 af, up to $13 million in agricultural production loss would be due to fallowed Indian agricultural lands, which account for up to 11 percent of total agricultural production loss in the study area.

In the long term, if the current guidelines of the No Action Alternative remained in effect, the water levels would be expected to decline below a critical level in Lake Mead; if water levels decline below this threshold, farmers across the analysis areas in Arizona, California, and Nevada would experience long-term (potentially permanent) production loss from fallowed crops.

Table 3-96
Acres of Fallowed Cropland and the Loss of Market Value of Agricultural Production in Arizona and California – No Action Alternative

Shortage Amount (1,000 af)	Non-Indian Agriculture – Arizona		Non-Indian Agriculture – California		Indian Agriculture		Total Agriculture in the Study Area	
	Fallowed Cropland (Acres)	Change in Production Value	Fallowed Cropland (Acres)	Change in Production Value	Fallowed Cropland (Acres)	Change in Production Value	Fallowed Cropland (Acres)	Change in Production Value
200	50,067	$57,566,506	0	$0	0	$0	50,067	$57,566,506
533	74,269	$89,980,128	0	$0	0	$0	74,269	$89,980,128
617	82,482	$98,932,404	0	$0	2,456	$3,052,073	84,938	$101,984,477
867	83,065	$99,797,208	2,154	$3,367,803	5,387	$6,693,991	90,606	$109,859,002
917	83,065	$99,797,208	2,692	$4,209,854	5,387	$6,693,991	91,144	$110,701,053
967	83,065	$99,797,208	3,231	$5,051,825	5,387	$6,693,991	91,683	$111,543,024
1,017	83,065	$99,797,208	3,769	$5,893,795	5,387	$6,693,991	92,221	$112,384,994
1,100	83,895	$101,374,907	3,769	$5,893,795	10,821	$12,967,706	98,485	$120,236,408

Source: Values were calculated using input from the Shortage Allocation Model and crop profitability, according to the methodology described above.

Note: Modeling results should only be used to compare the relative magnitude of impacts that are reasonably expected to occur under the alternatives. The results are not a substitute for agricultural production loss estimates in the analysis area; the results are subject to uncertainties from built-in assumptions and data limitations.

For those Tribes identified by Reclamation to use the full or a substantial amount of their water entitlement for agricultural operations, this analysis assumed 100 percent of consumptive-use water, as well as allocated shortages, were used for irrigation; the exact proportion of water used for agricultural operations for these Tribes was not known.

Due to data limitations for Indian agriculture, such as those involving privacy concerns, particularly for Tribes where three or fewer farms for a given crop exist, estimates did not account for the full allocated shortage volumes. Therefore, economic impacts may be larger than the estimated values.

Table 3-97 provides an overview of the jobs, income, and total economic output associated with the estimated change in agricultural production value due to fallowed crops under each shortage level for the No Action Alternative. This analysis covers anticipated shortages for operating years 2024 through 2026. **Table 3-98** provides an overview of the change to tax revenue from agricultural production losses over the same period. Under the No Action Alternative, shortages and related economic impacts have the potential to occur in Arizona and California agriculture.

The estimates provided above do not account for compensated conservation. Under the No Action Alternative, existing agreements would be in place for approximately 518,100 af of irrigation user-associated water (see **Table 3-95**). Of this amount, California system conservation agreements are associated with the Palo Verde Irrigation District in Riverside and Imperial Counties (98,200 af), and Arizona conservation agreements with Tribal entities are associated with 383,700 af of water allocation. Non-Tribal system conservation agreements include approximately 36,200 af in Mohave, Yuma, and La Paz Counties.

Table 3-97
Estimated Jobs and Income under the No Action Alternative

Shortage Amount (1,000 af)	Non-Indian Agriculture – Arizona		Non-Indian Agriculture – California		Indian Agriculture		Total	
	Total Jobs	Total Income	Total Jobs	Total Income	Total Jobs	Total Income	Total Jobs	Total Income
200	657	$67,037,544	0	$0	0	$0	657	$60,442,632
533	1,082	$86,934,411	0	$0	0	$0	1,082	$86,934,411
617	1,506	$97,623,780	0	$0	31	$2,780,000	1,537	$100,403,780
867	1,539	$98,418,089	43	$1,860,665	68	$6,097,798	1,650	$106,376,552
917	1,539	$98,418,089	54	$2,325,831	68	$6,097,798	1,661	$106,841,718
967	1,539	$98,418,089	65	$2,790,997	68	$6,097,798	1,672	$107,306,884
1,017	1,539	$98,418,089	75	$3,256,163	68	$6,097,798	1,682	$107,772,050
1,100	1,525	$100,082,619	75	$3,256,163	88	$8,368,185	1,688	$111,706,967

Source: Agricultural model output and IMPLAN 2021 software and data
Note: Total jobs include direct, indirect, and induced jobs. Due to model limitations and market uncertainties, modeling results should only be used to compare the relative magnitude of impacts that are reasonably expected to occur under the alternative.

Table 3-98
Estimated Tax Revenue Change under the No Action Alternative

Shortage Amount (1,000 af)	Non-Indian Agriculture – Arizona ($)	Non-Indian Agriculture – California ($)	Indian Agriculture ($)
200	10,465,107	0	0
533	14,395,033	0	0
617	16,646,755	0	2,087,855
867	16,814,136	646,886	4,579,323
917	16,814,136	808,608	4,579,323
967	16,814,136	970,329	4,579,323
1,017	16,814,136	1,132,051	4,579,323
1,100	17,211,487	1,132,051	6,404,036

Source: Agricultural model output and IMPLAN 2021 software and data
Note: Includes local, state, and federal tax revenue. Tax amounts are affected by agricultural subsidies. The agricultural sectors in IMPLAN have significant amounts of government subsidies. Because tax revenue is net of subsidies, it can be negative for a given industry in a given year, if that industry receives more subsidies from the government than it pays out in these specific taxes in that year. Due to model limitations and market uncertainties, modeling results should only be used to compare the relative magnitude of impacts that are reasonably expected to occur under the alternative.

Existing system conservation agreements would offset, to some degree, the level of economic impacts associated with reduced agricultural production. There are insufficient data, however, on the degree to which this compensation would offset the regional economic impacts in the agricultural sector, due to the loss of indirect and induced jobs and income that may not be fully compensated. For example, compensation agreement funds may not be distributed to the agricultural workers who may, therefore, still experience a loss of labor income. Similarly, funds may not be distributed to regional retail stores, restaurants, and other businesses that would typically be beneficiaries of the induced spending of labor income.

Proposed Action

Under the Proposed Action, the range of agricultural sector losses prior to consideration of compensation would be the same as modeled under the No Action Alternative. Increased system conservation would result in a higher level of compensated conservation than under the No Action Alternative. Estimated system conservation agreements include a total of 2,312,700 af of irrigation user-associated water (see **Table 3-95**). Of this amount, additional system conservation agreements modeled in California are associated with the Bard Water District and Imperial Irrigation District in Imperial County, and the Coachella Valley Water District in Riverside County. Tribal system conservation modeled in California includes the Quechan Indian Tribe in Imperial County.

In Arizona, system conservation agreements modeled with Tribal entities are associated with 550,000 af of water allocation for Tribes in Maricopa, Pinal, and Gila Counties. Additional Non-Tribal system conservation agreements include approximately 138,400 af in Mohave, Yuma, and La Paz Counties

As noted in the No Action Alternative, system conservation agreements would offset, to some degree, the level of economic impacts associated with reduced agricultural production. There are insufficient data, however, on the degree to which this compensation would offset the regional economic impacts in the agricultural sector, due to the loss of indirect and induced jobs and income that may not be fully compensated.

In addition, the Proposed Action would result in higher elevations at Lake Mead, with fewer traces at higher shortage tiers, as compared with the No Action Alternative, in 2025 and 2026. As a result, the potential to reach higher-tier shortage levels for agricultural water users (for example, those shortages as modeled at 967,000 to 1,100,000 af) would be reduced. This would, in turn, result in a decreased potential to reach higher levels of economic impacts on jobs, income, and tax revenue for the regional economy compared with those modeled under the No Action Alternative.

Cumulative Effects

The potential operational changes included in the LTEMP SEIS flow options would not result in changes to water diversion amounts, water available for agriculture, or associated economic contributions.

No cumulative effects would occur on economic contributions from agriculture due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

Issue 2: How would changes to reservoir levels as a result of water shortages impact economic activity associated with recreation?

Summary

Under both alternatives, economic contributions from recreation in Lake Powell; Lake Mead; and other reservoirs, including Lake Havasu; river-based recreation; and adjacent land-based recreation would continue. Contributions from recreation at national wildlife refuges would also continue. Due to anticipated reservoir levels, there is the potential for reduced contributions from reservoir-based recreation due to inaccessibility of boat launches in Lakes Powell and Mead as well as navigational issues. These issues would be present under both alternatives, but slightly reduced under the Proposed Action.

For river-based recreation, activities and the associated economic contributions and nonmarket values would be supported under both alternatives due to minimum flow requirements. The net economic value for whitewater rafting and anglers as a function of river flow would be similar across both alternatives, as would impacts on recreation and the associated visitor spending in the Salton Sea region. No impact on recreation contributions associated with Lake Havasu is anticipated due to a lack of anticipated changes to reservoir levels. For national wildlife refuges, no data are available to support a change in water-based recreation levels and the associated economic contributions as a result of the Proposed Action.

No Action Alternative

Under the No Action Alternative, water levels in Lake Powell would remain below thresholds for boat launching, as discussed in **Section 3.1.4**; this would impact the visitor experience for recreational boating in the reservoir. At LMNRA and GCNRA, the No Action Alternative would make boat ramps and marina services partially or completely unavailable, limiting recreation and the associated contributions and representing costs associated with maintaining access. Concessioners have spent $6 million in the last 3 years on projects directly tied to mitigating the impacts of low Lake Powell elevations (NPS 2022e).

The degree to which water levels would result in a reduction in economic contributions would depend on the impact on total visitation and related spending; these are difficult to predict given that water-based recreation is only one source of recreation-related economic contributions. Water-based recreation does, however, represent a large portion of visitor activity. Based on the most recent GCNRA visitor survey, 46 percent of visitors to the GCNRA participated in some form of motorized boating activity (NPS 2018). Water-based recreation is likely to be affected by lake volume.

Nehr et al. (2013) found lake volume in Lake Powell to be predictor of visitation levels in the summer season. This model projected that a 100,000-af increase in Lake Powell volume over a year was associated with 5,280 additional recreational visits to Lake Powell and $374,000 in additional visitor spending in tourism-related sectors in Coconino County, Arizona. The Lake Powell volume-visitation and volume-spending models imply the average visitor to Lake Powell spends $71 in the lodging, restaurant and bar, and amusement/recreation sectors in Coconino County. This estimate is generally consistent with independent estimates of visitor spending derived from prior NPS visitor surveys (Nehr 2013). Based on correlation in Nehr 2013, it was estimated that lake elevation reductions from 3,675 to 3,625 feet would result in a more than 25 percent reduction in visitation (Johnson et al. 2016). As discussed in **Section 3.14.2**, the importance of land-based recreation may be increasing with decreasing lake elevations, which could influence total reductions in economic contributions when water levels decrease.

For Lake Mead, a similar potential for a reduction in economic contributions associated with water-based recreation is possible; this is because all but one boat launch would be inaccessible under modeled reservoir levels under this alternative. Navigational hazards would also be present, further impacting the visitor experience and potentially the level of spending ($327 million in 2021, as detailed in the affected environment section).

The availability of camping near the lakeshore during the shoulder seasons increases revenue for gateway businesses and LMNRA since the fall and spring months are the best times of year for fishing. This effectively extends the season for visitation at LMNRA, which makes revenue streams more stable for tourist-dependent businesses over a greater part of the year. As access to the shoreline changes, campers attracted for fishing opportunities may be discouraged from visiting, thus reducing income to LMNRA and local businesses.

The loss of visitation and the associated visitor spending due to low lake levels could have significant impacts on the revenue associated with LMNRA and GCNRA, including declines in entry and camping fees, as well as impacts on concessioners due to declining visitation and commercial-use fees. If operations are no longer economically viable, some concessionaires and small businesses may no longer be able to operate. This, in turn, could result in a loss of visitor services provided by concessionaries, including, but not limited to, lodging, food and beverage facilities, fuel boat tours, and a medical clinic. A loss of these services can impact the visitor experience in opportunities available, as well as travel time and visitor safety. The economies of gateway communities could be significantly affected from a loss of direct visitor spending and the associated indirect and induced spending.

No impact on recreation's contributions associated with other reservoirs, including Lake Havasu, is anticipated due to a lack of anticipated changes to reservoir levels.

For river-based recreation, commercial recreation upstream of Lake Powell may continue at present levels under the No Action Alternative and the Proposed Action. High variability of flows has and will continue to make this section of the river less popular for commercial operation.

For whitewater rafting from Glen Canyon to Lake Mead, including GCNP, it is anticipated that minimum flow requirements for Glen Canyon Dam would result in continued commercial operations. As a result, it is anticipated that economic contributions would continue to be supported under the No Action Alternative; however, the variation in flow may impact the recreational experience and the related value that users obtain from this experience.

The net economic value supported for whitewater rafting and anglers in Glen and Grand Canyons is shown in **Table 3-99**. It should be noted that the modeling estimates are based on flow and do not account for other factors that may impact boating or anglers. For example, in terms of fishing opportunities, under the No Action Alternative there is the potential for seasonal impacts on rainbow trout from temperatures at lower lake elevations in Lake Powell (see **Section 3.14.2** for additional details). Impacts on the visitor experience and level of visitation for commercial whitewater rafting have the potential to impact the associated economic contributions, which are important for rural communities and small business in northern Arizona and southern Utah, as discussed in the affected environment section.

Table 3-99
Mean Low to High Annual Net Economic Value for River-Based Recreation in Glen and Grand Canyons (Millions of $2022)

Activity	
Whitewater rafting	24.57 to 38.37
Angling	1.30 to 1.71

Note: Use values are based on methods in Gaston et al. 2015. Mean annual high and low values are based on high and low values by month from 90 ESP traces, with values provided for a 60-month simulation period. Estimated individual whitewater trips per month (NPS 2006a) are multiplied by the net economic value per trip to obtain the aggregate net economic value for whitewater rafting. The analysis does not include reservoir use, water-based day use in Glen Canyon, and recreational rafting in the lower Grand Canyon below Diamond Creek. Net economic value is indexed to 2022 dollars using the consumer price index (US Bureau of Labor Statistics 2023). The information in the table represents estimates based on best available data and should be used for the purpose of alternative comparison only.

For national wildlife refuges, no data are available to support a change in water-based recreation levels and the associated economic contributions as a result of the No Action Alternative.

In addition to potential impacts on river and reservoir recreation, there is also the potential for impacts on recreation on the Salton Sea and the surrounding region. As noted in **Section 3.14**, Recreation, the Salton Sea's shoreline would be anticipated to continue to decrease at current rates, which would increase the potential for impacts on local air quality (see **Section 3.9**, Air quality). Decreased air quality has been correlated with decreased visitor satisfaction and spending levels not only adjacent to the Salton Sea, but in the greater Palm Springs region (Tourism Economics 2014).

Proposed Action

As described for the No Action Alternative, under the Proposed Action, projected Lake Powell elevations would be below the critical thresholds for most boat launch facilities and safely navigating Castle Rock and Gregory Butte. This would result in lower visitor satisfaction and may impact visitation numbers and economic contributions. Recreation impacts at Lake Powell would be slightly reduced under the Proposed Action because the Proposed Action would preserve more water in Lake Powell and reduce overall variability in water surface elevations; this would result in a slight potential for reduced impacts on recreation visitation and related spending. Similarly, the slight rebound in Lake Mead pool elevations under the Proposed Action could marginally help limit the closure or relocation of boat launch facilities at Lake Mead in year 2026, compared with the No Action Alternative. This could result in a slight decrease in the potential for related impacts on recreation visitation and spending.

Impacts on whitewater boating would be the same as those described under the No Action Alternative.

As described in **Section 3.7.2**, Issue 6, under the Proposed Action, there is the possibility that IID and CVWD could enter into additional system conservation agreements; thus, there could be reduced deliveries, resulting in potentially less inflow to the Salton Sea from irrigation drainage. Therefore, the Proposed Action could result in expedited (but not additional) lake bed exposure, compared with the No Action Alternative, due to less possible available agricultural runoff. As described in **Section 3.9**, lake bed exposure can result in air quality impacts. This could result in impacts occurring on regional recreation and the associated spending in an expedited fashion compared with the No Action Alternative.

Cumulative Effects

As discussed above, this SEIS's alternatives would result in relatively minor changes in use values and economic activity associated with reservoir and river recreation. The LTEMP SEIS flow options would have the potential for cumulative impacts on economic contributions associated with sport fisheries within the Glen Canyon Dam to Lake Mead reach of the Colorado River due to changes in the water temperature released from Glen Canyon Dam, as detailed in **Section 3.14.2**.

No cumulative effects would occur on economic activity associated with recreation due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

Issue 3: How would water shortages impact M&I uses of water?

Summary

Under both alternatives, allocated water shortages for different elevations in Lake Mead would result in domestic (e.g., M&I) water shortages compared with 2021 use levels, the last non-shortage year in the Lower Basin. The economic impacts from domestic and industrial water shortages are unknown due to the variety of approaches the municipalities and other entitlement holders use in shortage scenarios, including supply-side actions (such as groundwater recharge, water purchase agreements, and alternative water supplies) and demand-side strategies (such as water conservation measures). One study estimated that if all Colorado water were lost for 1 year, this would result in impacts on 16 million job years and $871 billion in labor income in $2014 for the Upper and Lower Basin regions (James et al. 2014).

Under the No Action Alternative, impacts would be realized at lower shortage scenarios for Arizona entitlement holders (533,000-af scenario) and Nevada entitlement holders (200,000-af scenario) compared with California; this is due to the modeled effects of the 2007 Interim Guidelines and 2019 DCPs. Impacts on California entitlement holders would be realized at the 867,000-af shortage scenario. At a 1.100-maf shortage scenario, maximum levels of shortage would result in domestic water shortages of 179,364 af in Arizona, 30,000 af in Nevada, and 325,500 af in California (based on California's DCP contribution).

Conservation measures applied under both alternatives would reduce the potential to reach higher levels of shortage, by increasing the potential that Lake Mead levels would remain above critical levels. **Table 3-100** shows a comparison of conservation measures by alternative for users with primarily domestic use.

Table 3-100
Comparison of Modeled Conservation for Domestic Water Users (2023–2026 af totals)

State	No Action Alternative		Proposed Action	
	System Conservation	ICS	System Conservation	ICS
Arizona	209,000	—	402,400	41,800
California	146,000	—	—	216,000
Nevada	—	65,000	—	285,000

Source: Based on Shortage Allocation Model designations for the type of use and CRMMS assumptions for modeled conservation.

Modeled shortage scenarios under the Proposed Action would be the same as those under the No Action Alternative; however, the increased level of system conservation and ICS would result in higher elevations at Lake Mead, with fewer traces at higher shortage tiers as compared with the No Action Alternative in 2025 and 2026. As a result, the potential to reach higher-tier shortage levels for domestic waters users (such as those shortages modeled at 967,000 to 1,100,000 af) would be reduced.

No Action Alternative

The driest region of the country—the Census Bureau's Mountain division, comprising Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming—is expected to grow by approximately 45 percent between 2010 and 2040 (Kearney et al. 2014). Population growth combined with precipitation decreases is leading to increasing demand for municipal water throughout the study area.

As discussed in the 2007 FEIS, shortages to the Arizona M&I sector would be addressed through the state's and each local jurisdiction's drought responses and plans. These responses include supply-side and demand-side actions. Supply-side actions may include groundwater recharge, water purchase agreements, and alternative water supplies, such as brackish water and reclaimed water. Demand-side strategies focus on implementing different stages of water conservation measures as drought progresses. Existing conservation measures at the state level are shown in **Table 3-100**.

Due to shortages triggered pursuant to the 2007 Interim Guidelines in 2022 and 2023 and contributions that were made under the DCPs and other programs in the Lower Division States, some municipalities are already enacting drought response programs. These programs often include a combination of voluntary and enforced restrictions, depending on the anticipated shortage levels (see, for example, Gilbert, Arizona's Supply Reduction Management Plan 2022). **Table 3-101**, below, shows estimated shortages for domestic use.

In 2024, Arizona M&I shortages would range from approximately 89,525 af during a 533,000-af shortage to 179,364 af during a 1.100-maf shortage (see **Table 3-101**).

Table 3-101
No Action Alternative—Impacts on Arizona Domestic Water Shortages from the Range of Analyzed Volumes of Total Shortages (af)

County	200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
Coconino County	0	0	0	0	0	0	0	0
Gila County	0	0	0	156	156	156	156	390
La Paz County	0	0	0	0	0	0	0	1
Maricopa County	0	78,174	85,482	104,683	104,683	104,683	104,683	134,332
Mohave County	0	0	0	0	0	0	0	3,314
Pima County	0	7,317	7,317	17,986	17,986	17,986	17,986	34,031
Pinal County	0	4,034	4,034	5,337	5,337	5,337	5,337	7,296
Yuma County	0	0	0	0	0	0	0	0
Arizona Domestic Shortages	**0**	**89,525**	**96,833**	**128,162**	**128,162**	**128,162**	**128,162**	**179,364**

An estimated 146,600 af of system conservation measures for domestic uses are associated with existing signed agreements with CAP subcontractors. These may be fulfilled in part by implementing statewide and local demand-side and supply-side strategies, although conservation agreements do not dictate the specifics of how conservation is achieved.

In California, deliveries to MWD are not anticipated to be adversely affected for Lower Basin shortages until 867,000 af under the No Action Alternative; these reductions are associated with California's contributions under the DCPs, which are made notwithstanding the Lower Basin priority system, as modeled in the 2007 FEIS. For the purpose of this analysis, these reductions are assumed to result in reduced water availability to MWD, although Reclamation acknowledges that flexibility exists for how the DCP contributions may be made.

Table 3-102 shows the estimated shortages for domestic use. However, total shortage amounts would be higher than those in Arizona for the higher range of analyzed shortage amounts. The Colorado River supplies approximately 25 percent of MWD water. Drought plans are under development and include storage systems, including groundwater and surface water reservoirs, reverse flow to enhance flexibility of delivery systems, partnership agreements for additional water supply, and in-region programs with member agencies to provide cost-offset opportunities and additional flexibility (MWD 2023). No system conservation measures are in place for domestic users in California under the No Action Alternative. ICS includes 209,000 af associated with the MWD.

Table 3-102
No Action Alternative—Impacts on California Domestic Water Shortages from the Range of Analyzed Volumes of Total Shortages (af)

State	200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
California Domestic Shortages[1]	0	0	0	186,000	232,500	279,000	325,500	325,500

[1] Includes the combined area of Los Angeles, Orange, San Diego, Riverside, and San Bernardino Counties supplied by the MWD

In Nevada, shortages to the M&I sector would mostly be borne by the SNWA, which has prepared a water resources plan (SNWA 2023) and adaptive management techniques to address water shortages. Estimated shortages for domestic use are shown below in **Table 3-103**.

Management includes voluntary and involuntary conservation programs as well as water banking. This includes ICS for domestic uses in Clark County at a level of 65,000 af.

Table 3-103
No Action Alternative—Impacts on Nevada Domestic Water Shortages from the Range of Analyzed Volumes of Total Shortages (af)

State	200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
Nevada Domestic Shortages	8,000	21,000	25,000	27,000	27,000	27,000	27,000	30,000

In the long term, if the current guidelines under the No Action Alternative remain in effect, the water levels would be expected to decline below a critical level in Lake Mead; if water levels decline below this threshold, more severe domestic shortages would be triggered with the potential for additional social and economic impacts.

Proposed Action

Under the Proposed Action, modeled shortages would be the same as outlined in the No Action Alternative. Under this alternative, however, additional system conservation would be applied. **Table 3-100** provides an overview of the additional SEIS system conservation for domestic water users under the Proposed Action, based on Shortage Allocation Model assumptions regarding the primary type of water usage by each entitlement holder. It should be noted that these values of additional SEIS system conservation are based on modeling assumptions; they do not represent mandatory system conservation, and they in no way commit specific water entitlement holders to system conservation.

As shown in **Figure 3-20**, Percent of Traces with Lower Division Shortage and DCP Tiers, due to system conservation measures, the Proposed Action would result in higher elevations at Lake Mead with fewer traces at higher shortage tiers, as compared with the No Action Alternative, in 2025 and 2026. As a result, the potential to reach higher-tier shortage levels for domestic water users (such as those shortages as modeled at 967,000 to 1,100,000 af) would be reduced.

Cumulative Effects

The potential operational changes included in the LTEMP SEIS flow options would not impact water shortage amounts for M&I uses or the associated economic contributions.

No cumulative effects would occur on M&I uses of water due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

3.17 Environmental Justice

3.17.1 Affected Environment

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 *Federal Register* 7629, February 11, 1994; US President 1994b), formally requires federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs them to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations.

Analysis consists of two steps: (1) screening of populations within the study area to identify the presence of communities for further environmental justice consideration, and (2) review of impacts to determine the potential for disproportionate adverse impacts on these communities.

As in the 2007 FEIS, the environmental justice study area is defined by those counties that may be affected by management direction that could result in water shortages or changes to water-based recreation.

While the California, Nevada, and Utah study areas are the same as those described in the 2007 FEIS and detailed in the Socioeconomic section, the Arizona study area for this SEIS has been expanded to include four additional counties: Apache, Gila, Graham, and Navajo. This is because as of 2023, there are Indian water rights settlements involving CAP water and/or non-CAP Colorado River water delivered through the CAP with several Tribes, including White Mountain Apache, which overlaps the aforementioned counties (more information is provided in subsequent paragraphs). The Arizona study area from the 2007 FEIS consisted of Coconino, La Paz, Maricopa, Mohave, Pima, Pinal, Yuma, and Yavapai Counties. The Arizona study area for this SEIS includes 12 counties. Information is provided below on locations within these counties that receive water deliveries and the rationale for the expansion of the study area.

As of 2023, there are Indian water rights settlements involving CAP water and/or non-CAP Colorado River water delivered through the CAP with the Ak-Chin Indian Community, Fort McDowell Yavapai Nation, Gila River Indian Community (GRIC), San Carlos Apache Tribe, Salt River Pima-Maricopa Indian Community, Tohono O'odham Nation, Yavapai-Prescott Indian Tribe, Hualapai Tribe, and White Mountain Apache Tribe. Other Tribes hold CAP contracts (Pascua Yaqui Tribe, Sif Oidak District of the Tohono O'odham Nation, Tonto Apache Tribe, and Yavapai-Apache Tribe). CAP water is also retained for a future water rights settlement agreement approved by an act of Congress that settles the Navajo Nation's claims to water in Arizona. Additional details are included in **Section 3.18**, Indian Trust Assets (ITAs).

The California study area for this SEIS consists of six counties, including Riverside and Imperial Counties, where the Salton Sea is located.

Map 3-2 provides an overview of the environmental justice study area and population centers within it. **Map 3-2** also displays the environmental justice study area counties in relation to the two major storage reservoirs (Lake Powell and Lake Mead) with major fluctuations in the water's surface level.

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Map 3-2
Environmental Justice Study Area

- Environmental justice study area: counties that may be affected by management direction, resulting in water shortages or changes to water-based recreation
- Populated place
- Dam
- Colorado River
- Colorado River tributary
- Colorado River Basin, Upper and Lower Basins
- States in the Colorado River Basin

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While not shown in this map, several other mainstream dams are present. While this analysis presents data and identifies environmental justice communities at the county level, it should be noted that additional environmental justice communities may be present at a smaller geographic scale.

Each county was screened to identify the presence of low-income, minority, and Native American populations that would meet the criteria for identification as populations for further consideration for environmental justice concerns.

This section identifies environmental justice communities in the analysis area based on the following criteria:

- CEQ 1997 guidance states that minority or low-income populations should be identified where either (1) the minority or low-income population of the affected area exceeds 50 percent, or (2) the minority or low-income population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. The total minority populations are defined as the total population minus those who identify as White, of non-Hispanic descent. For the meaningfully greater analysis, Reclamation used 110 percent of the minority percentage of the geographic reference area as the threshold for meaningfully greater. For Arizona, California, Nevada, and Utah, 110 percent of the total minority population is 35.1 percent, 43.5 percent, 32.2 percent, and 15.8 percent, respectively.
- Low-income populations are defined relative to the annual statistical poverty thresholds from the US Census Bureau (CEQ 1997). The guidance does not provide criteria for determining low-income populations as specifically as it does for minority populations. Therefore, for this analysis, low-income populations are defined as people whose income is less than or equal to twice (200 percent of) the federal poverty level. For this analysis, populations are considered low-income populations when (1) 50 percent of the population is classified as low income, or (2) any geographic area of analysis has a low-income percentage of the population equal to or higher than the reference area.
- Federally recognized Tribes are considered environmental justice populations in and of themselves; when possible, they are included in the analysis as separate minority populations. For this analysis, additional screening was utilized to review US Census Bureau data for those who identify as American Indian or Alaska Native alone or in combination with one or more other races. Reclamation also used a threshold analysis and meaningfully greater analysis to identify Indigenous populations that meet the criteria for environmental justice consideration. The 50 percent threshold analysis involves identifying any block groups with a total Indigenous population 50 percent or greater.

Table 3-104 provides an overview of the environmental justice screening results for the study area.

Table 3-104
Study Area Environmental Justice Screening Results (2021)

Geographic Area	Minority Population Percentage of Geographic Area (Meaningfully Greater Percentage)	Indigenous Population Percentage of Geographic Area	Low-income Population Percentage of Geographic Area	Meets Criteria for Environmental Justice Communities of Concern?
Reference Area				
Arizona	31.9 (35.1)	5.8	31.7	—
California	39.5 (43.5)	2.3	28.5	—
Nevada	29.3 (32.2)	2.5	31.2	—
Utah	14.4 (15.8)	2.0	24.7	—
Apache County, Arizona	82.3*	75.0*	59.3*	Yes
Coconino County, Arizona	14.6	28.7*	37.4*	Yes
Gila County, Arizona	38.9*	19.6*	40.9*	Yes
Graham County, Arizona	49.6*	14.6*	42.3*	Yes
La Paz County, Arizona	28.3	18.4*	44.3*	Yes
Maricopa County, Arizona	31.5	3.2	28.6	No
Mohave County, Arizona	24.1	3.6	38.3*	Yes
Navajo County, Arizona	58.7*	46.3*	49.9*	Yes
Pima County, Arizona	38.0*	6.1*	34.4*	Yes
Pinal County, Arizona	30.9	6.5*	31.3	Yes
Yavapai County, Arizona	20.6	3.2	32.0*	Yes
Yuma County, Arizona	64.7*	2.8	44.0*	Yes
Imperial County, California	85.1*	2.3	46.6*	Yes
Los Angeles County, California	48.7*	2.1	32.2*	Yes
Orange County, California	34.0	1.5	23.3	No
Riverside County, California	50.3*	2.2	30.4*	Yes
San Bernardino County, California	54.6*	2.6*	34.4*	Yes
San Diego County, California	34.3	2.0	25.2	No
Clark County, Nevada	31.8*	2.0	32.5*	Yes
Garfield County, Utah	6.2	4.6*	40.2*	Yes
Kane County, Utah	3.2	5.1*	31.5*	Yes
San Juan County, Utah	6.0	49.8*	44.1*	Yes

*Meets the criteria for environmental justice community of concern
Source: US Census Bureau 2021a, 2021b, 2021c

Overall, 19 of the 22 study area counties met at least one environmental justice criterion (11 Arizona counties, 1 Nevada county, 3 Utah counties, and 4 California counties). As such, the study area has 19 environmental justice populations at the county level. In Arizona, Apache, Gila, Graham, Navajo, and Pima Counties had minority, low-income, and Indigenous populations that met the criteria. San Bernadino County, California, also had minority, low-income, and Indigenous populations that met the criteria. See **Table 3-104** for more information; details for each indicator are provided below.

Additional information is also provided below on Tribal populations with the potential to be affected by the proposed management.

Further, of the 12 Arizona study area counties that each contain communities that receive Colorado River water, either through CAP or mainstream diversions, 11 counties are identified as environmental justice communities, based on the criteria described above. The only exception is Maricopa County, which did not have minority, low-income, or Indigenous populations that exceeded the respective thresholds. While Maricopa County did not have an Indigenous or minority population that met the criteria, it is important to note that both the Salt River Pima-Maricopa Indian Community and the Fort McDowell Yavapai Nation, and portions of the GRIC and Tohono O'odham Nation, are within Maricopa County.

Minority Population

In Arizona, 6 of the 11 counties had total minority populations that exceeded the meaningfully greater threshold of 35.1 percent. In addition, Apache, Navajo, and Yuma Counties had total minority populations well above 50 percent, ranging from 58.7 percent to 82.3 percent. The total minority population in Clark County, Nevada, exceeded the meaningfully greater threshold of 32.2 percent and is considered an environmental justice community. In California, all counties, excluding Orange and San Diego Counties, had minority populations that met the meaningfully greater threshold of 43.5 percent. No counties in Utah had minority populations that exceeded the meaningfully greater threshold of 15.8 percent. As such, there were no identified environmental justice communities in Utah. **Map 3-3** displays the minority populations at the county level.

Indigenous Population

In Arizona, all counties, excluding Maricopa, Mohave, and Yavapai Counties, had Indigenous populations exceeding the state average Indigenous population (5.8 percent). In California, only San Bernadino County had an Indigenous population exceeding the state average (2.3 percent). No counties in Nevada had an Indigenous population that exceeded the state average (2.5 percent). In Utah, all three counties had Indigenous populations that exceeded the state average (2.0 percent), and the Indigenous population in San Juan County, Utah, was notably higher than the other study area counties. **Map 3-4** displays the Indigenous populations at the county level.

It should be noted that the information above pertains to those counties that met or exceeded thresholds for total Indigenous population. Additional Tribal populations at the Tribe and reservation levels are identified in the *Tribal Populations* section below.

Low-Income Population

For Arizona, all study area counties, excluding Maricopa County (28.6 percent) and Pinal County (31.3 percent), had low-income populations exceeding the state average (31.7 percent). For California, all study area counties, excluding Orange County (23.3 percent) and San Diego County (25.3 percent), had low-income populations that exceeded the state average (28.5 percent). All three study area counties in Utah and the single study area county in Nevada had low-income populations that exceeded the state averages (24.7 percent and 31.2 percent, respectively). **Map 3-5** displays low-income populations at the county level.

Tribal Populations

Tribal populations with potential to be affected by project management include those with current entitlements to receive Colorado River water in the Lower Basin (**Map 3-6**). The following Tribes were identified:

Tribes with entitlements related to CAP water:

- Ak-Chin Indian Community
- Fort McDowell Yavapai Nation
- Gila River Indian Community
- Pascua Yaqui Tribe
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- Tohono O'odham Nation
- Tonto Apache Tribe
- Yavapai-Apache Nation
- White Mountain Apache Tribe

Tribes with entitlements held in the reservation’s name:

- Cocopah Indian Reservation
- Fort Mojave Indian Reservation
- Fort Yuma Indian Reservation
- Colorado River Indian Reservation
- Chemehuevi Indian Reservation

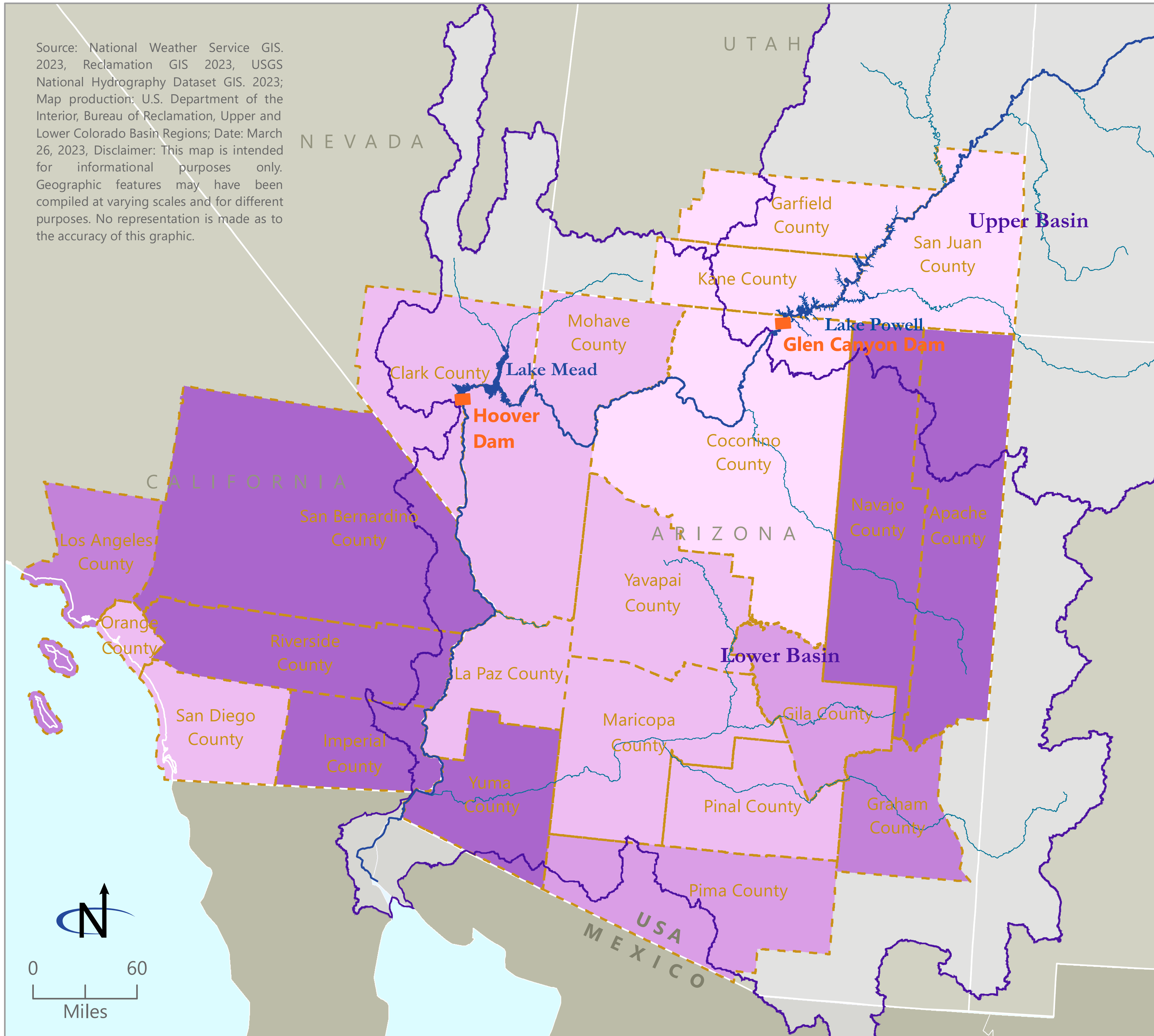
In addition to the list above, the Hopi Tribe holds a contract for delivery of Colorado River water for use along the mainstream river, rather than on reservation lands.

3.17.2 Environmental Consequences

Methodology

This section relies on the analyses in other resource sections to identify whether either alternative would be likely to have adverse human health or environmental impacts. These impacts are discussed in the context of the potential for disproportionate adverse impacts on identified environmental justice communities.

This analysis also relies on modeling assumptions and modeling output from two models: CRMMS (see **Appendix D**, CRMMS Model Documentation) and the Shortage Allocation Model (see **Appendix E**, Shortage Allocation Model Documentation). While more detailed information can be found in **Appendixes D** and **E**, summary information is provided here for context.



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RECLAMATION

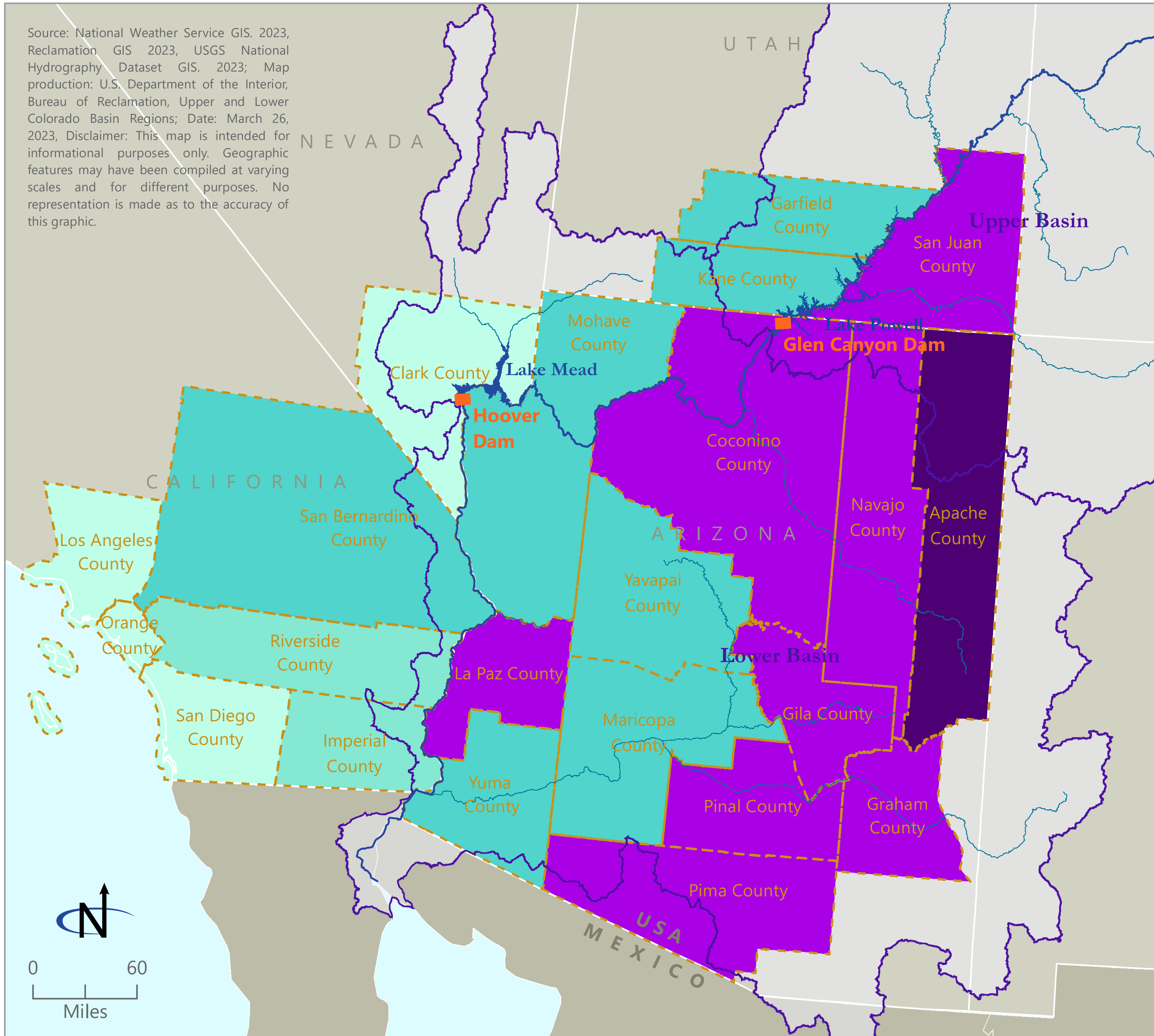
Map 3-3
Minority Populations for Environmental Justice Consideration

Percent of the population identifying as a racial and/or ethnic minority at the county level

- 0-15.0
- 15.1-35.0
- 35.1-45.0
- 45.1-50.0
- 50.1-85.1

State	% minority population meaningfully greater threshold
Arizona	35.1
California	43.5
Nevada	32.2
Utah	15.8

- Environmental justice study area: counties that may be affected by management direction, resulting in water shortages or changes to water-based recreation
- Dam
- Colorado River
- Colorado River tributary
- Colorado River Basin, Upper and Lower Basins
- States in the Colorado River Basin



— BUREAU OF —
RECLAMATION

Map 3-4
Indigenous Populations for Environmental Justice Consideration

Percent of the population identifying as a American Indian or Alaska Native (alone or in combination with one or more other races) at the county level

- 1.5- 2.2
- 2.3- 2.5
- 2.5- 5.7
- 5.8-50.0
- 50.1-75.0

State	% Indigenous population state threshold
Arizona	5.8
California	2.3
Nevada	2.5
Utah	2.0

Environmental justice study area: counties that may be affected by management direction, resulting in water shortages or changes to water-based recreation

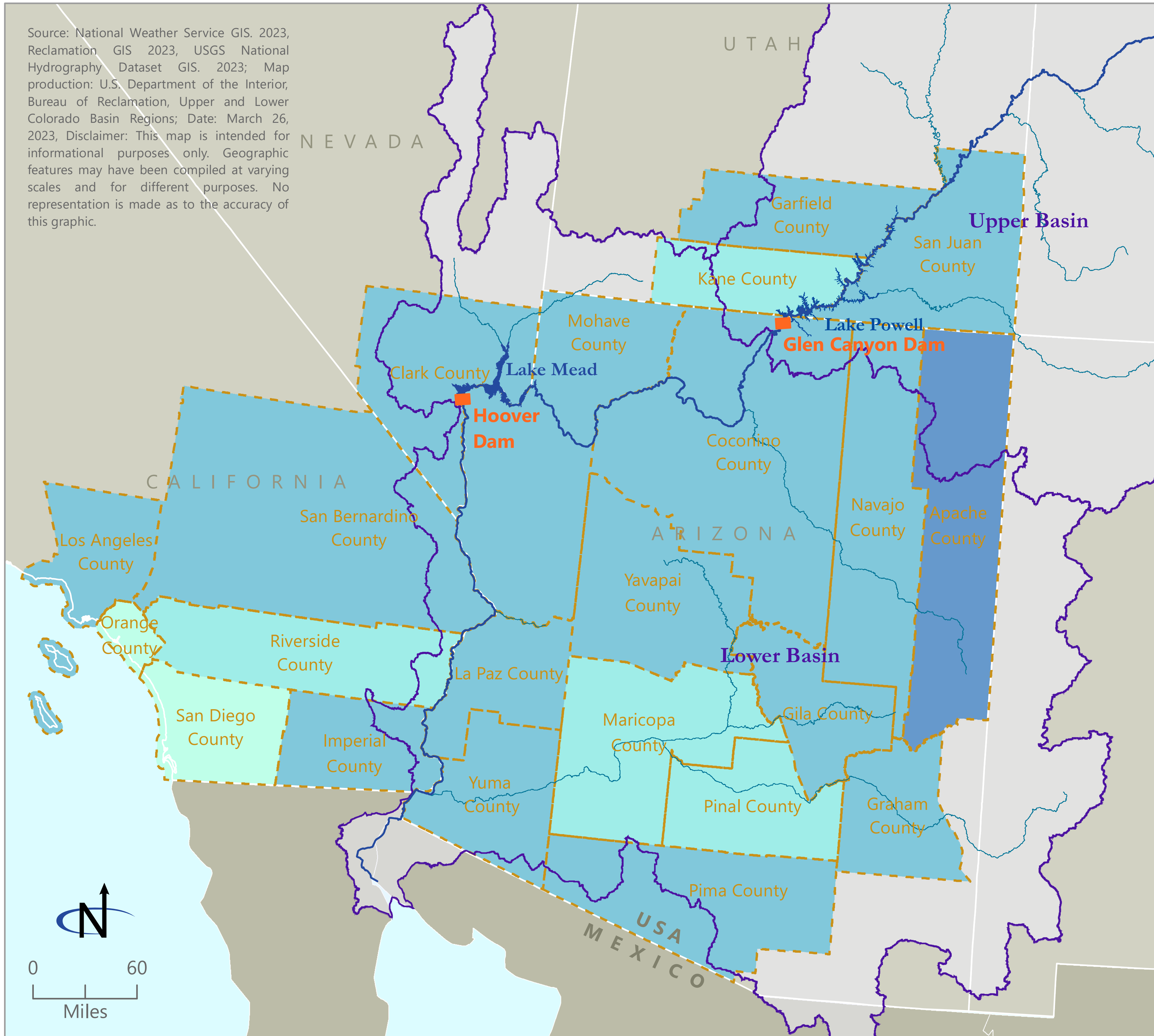
Dam

Colorado River

Colorado River tributary

Colorado River Basin, Upper and Lower Basins

States in the Colorado River Basin



BUREAU OF RECLAMATION

Map 3-5
Low-income Populations for Environmental Justice Consideration

Percent of the population identifying as living at or below 200 percent of the federal poverty level

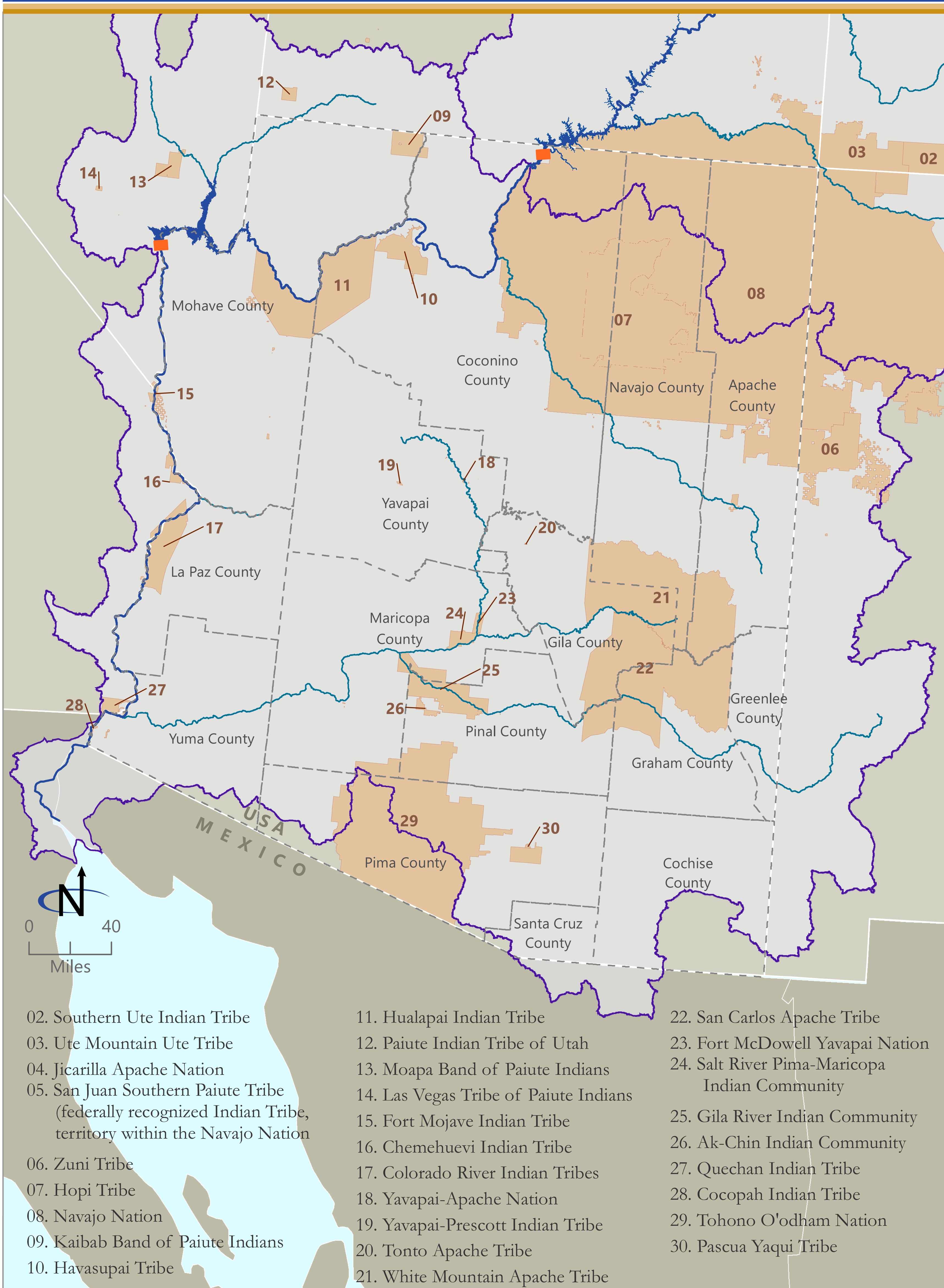
- 23.0-28.4
- 28.5-31.5
- 31.6-50.0
- 50.1-59.3

State	% low-income population state threshold
Arizona	31.7
California	28.5
Nevada	31.2
Utah	24.7

Environmental justice study area: counties that may be affected by management direction, resulting in water shortages or changes to water-based recreation

- Dam
- Colorado River
- Colorado River tributary
- Colorado River Basin, Upper and Lower Basins
- States in the Colorado River Basin

— BUREAU OF —
RECLAMATION



Map 3-6 Tribal Populations

- Tribal Reservation and off-reservation trust land
- Colorado River
- Colorado River tributary
- Dam
- Colorado River Basin, Upper and Lower Basins
- States in the Colorado River Basin

Source: National Weather Service GIS. 2023, Reclamation GIS 2023, USGS National Hydrography Dataset GIS. 2023; Map production: U.S. Department of the Interior, Bureau of Reclamation, Upper and Lower Colorado Basin Regions; Date: October 13, 2023, Disclaimer: This map is intended for informational purposes only. Geographic features may have been compiled at varying scales and for different purposes. No representation is made as to the accuracy of this graphic.

Impact Analysis Area

The impacts analysis area is the same as that described in **Section 3.17.1**. This analysis provides baseline information for the environmental justice study area counties; however, there are communities who could experience more impacts from water shortages and changes to water deliveries. For instance, there are areas within the Arizona environmental justice study area counties in which there currently are no replacement or alternative water sources. Should these areas experience water shortages that result in available Colorado River water deliveries being reduced to zero, impacts would be more severe compared with areas where replacement or alternative water sources exist.

Assumptions

The Shortage Allocation Model does not account for replacement or alternative water sources. Refer to **Appendix E** for more information on the Shortage Allocation Model assumptions.

The modeled SEIS conservation assumptions are used to conduct CRMMS modeling. These assumptions are provided in **Section 3.7**, Issue 6, and **Appendix** D.

Impact Indicators

- Disproportionate and adverse human health or environmental impacts
- Shortage levels at which available water would be reduced to zero for priorities/users within environmental justice study area counties
- Percentage of traces with Lower Division shortage and DCP tiers

Issue 1: How would management decisions affect environmental justice communities?

Summary

Under the No Action Alternative, no modeled shortage levels resulted in available water being reduced to zero under any priorities for California and Nevada. However, if shortages reached 533,000 af, available water would be reduced to zero for certain entitlements within the CAP in Arizona's fourth priority, extending to additional entitlements at a shortage of 617,000 af. Arizona fifth and sixth priorities are assumed not to be available in any level of shortage. Some users in Maricopa, Pinal, and Pima Counties would have their CAP water supply reduced to zero.

It should be noted that shortage levels modeled for the No Action Alternative would be the same as those for the Proposed Action in the short term. However, projections based on low-flow hydrologic scenarios indicate that, without a change to current operational guidelines, decreasing reservoir levels would result in increased system shortages, potentially limiting the ability to deliver water. This could result in an increased level of impacts on environmental justice communities.

Under the Proposed Action, modeled shortage levels are the same as those under the No Action Alternative. As a result, available water would be reduced for the same counties in Arizona (Maricopa, Pinal, and Pima Counties, which represent the current CAP service area where CAP deliveries occur) as under the No Action Alternative. Impacts on irrigation and domestic use from water shortages would be the same as those described for the No Action Alternative. While the shortage levels at which available water would be reduced to zero would vary by state and priority, the same environmental justice study area counties would experience available water being reduced, or impacts from available water being reduced, under the Proposed Action for this time period. In the longer term, hydrologic models indicate that reservoir levels would be maintained above critical levels for a longer length of time with the implementation of the Proposed Action. Therefore, impacts on environmental justice communities could be reduced compared with the No Action Alternative in the long term.

Compared with the No Action Alternative, the Proposed Action would result in an increased level of system conservation, through the proposed SEIS system conservation. This would allow for a reduced potential for higher levels of modeled shortages and mandatory shortages to occur, and provide greater predictability for water users. For example, if an entity chose to enter into a system conservation agreement and voluntarily conserve Colorado River water, this would contribute to maintaining water levels in the system overall. It also would reduce the potential that mandatory shortages would be triggered in lower operational years. As a result, the Proposed Action would reduce the likelihood of the impacts on individual users from higher modeled shortage amounts, including those within environmental justice counties.

No Action Alternative

Existing system conservation and ICS were modeled using CRMMS. Under the No Action Alternative, total modeled system conservation is estimated to be 938,758 af. Detailed assumptions are provided in **Appendix D**. System conservation is Colorado River water conserved through agreements with individual users who are compensated. In contrast, ICS is not compensated. Under the No Action Alternative, existing modeled system conservation includes executed agreements with the following entities in Maricopa, Pinal, Pima, Mohave, Yuma, and La Paz Counties, Arizona: GRIC, Fort McDowell Yavapai Nation, CAWCD and certain CAP subcontractors, Mohave Valley Irrigation and Drainage District, Yuma Mesa Irrigation and Drainage District, and Gabrych Farms. Additionally, modeled system conservation includes an executed agreement with Palo Verde Irrigation District in Riverside and Imperial Counties, California.

Under the No Action Alternative, a range of volumes of total shortage to Lower Division States were analyzed using a Shortage Allocation Model. Potential water shortages would not impact water deliveries in California or Nevada to the degree that there would be zero water for any priorities under the No Action Alternative, as detailed in **Section 3.7**, Water Deliveries.

Eleven of the Arizona counties are environmental justice communities. Two of the three counties comprising the CAP service area are environmental justice communities (Pinal and Pima). Given the assumption that Arizona fifth and sixth priorities are assumed not to be available in any level of shortage, a Lower Basin shortage would cause the reduction of water deliveries first to the Arizona fourth-priority Colorado River entitlements, which include CAP Arizona fourth-priority (P4[ii]) and other post-1968 Arizona fourth-priority Colorado River contractors (P4[i]).

Under the No Action Alternative, there are shortage levels where available water for users under some priorities would be reduced to zero in Arizona. According to the model results, at water shortage levels ranging from 533,000 af to 1.100 maf, some water users within the Arizona environmental justice study area counties would be reduced to zero water availability under certain priorities of Colorado River water. These impacts are discussed in further detail below. The degree to which these shortages would result in disproportionate adverse impacts would depend on the availability and cost of alternative water supplies.

Irrigation

At shortage levels of 533,000 af and greater, available water for users under the Arizona fifth- (unused entitlement/apportionment) and sixth- (surplus) priority entitlements, and users of the CAP excess pool in Maricopa, Pinal, and Pima Counties, Arizona, would be reduced to zero.

Pinal and Pima Counties are identified as environmental justice communities. As such, the water users within these counties who would have water delivery reduced to zero would face disproportionate consumptive-use impacts on irrigation. Farmers who have used CAP excess water to irrigate crops would need to use alternative water supplies, such as groundwater, if available, to continue agricultural production.

The Salton Sea receives flows from excess irrigation drainage, particularly from the IID and CVWD, which are in Riverside and Imperial Counties, California. These two counties are considered environmental justice counties. Under the No Action Alternative, there would be no changes to current operational activities that would affect flows to the IID or CVWD. Therefore, the surface water elevation of the Salton Sea could continue to decrease at the current rate. Surface water elevation decreases could impact all communities adjacent to the Salton Sea, including environmental justice communities.

Domestic Use

Consumptive-use impacts on domestic uses would vary by the volume of total shortage to the Lower Division States. The number of counties, different types of priority holders, and different types of entitlement holders who would face zero water supply would increase as the volume of total shortage to Lower Division States increased (see **Appendix E**).

At levels of shortage of 533,000 af and greater, domestic water supply from the CAP NIA-B[25] priority in Maricopa, Pinal, and Pima Counties would not be available. If water shortages reached 617,000 af, available water for users under the CAP NIA-A priority would also be reduced to zero.

Tribal Allocations

The allocations discussed in this section are based on the Shortage Allocation Model, which is more detailed and specific than the regional analysis presented in **Section 3.7.2**, Issue 6 (see also **Appendix E**).

Under the No Action Alternative, available water for all users under CAP NIA-A priority in Maricopa, Pima, and Pinal Counties will be reduced to zero if water shortages reach 617,000 af. The Tohono O'odham Nation and GRIC hold CAP NIA allocations in this pool that would be reduced to zero. Beyond the CAP NIA pool, at higher levels of modeled shortage, the available water supply for Tribes holding other entitlements to Arizona fourth-priority water (P4[i] or P4[ii]) are projected

[25] NIA refers to the CAP Non-Indian Agricultural Priority subcontracts. The NIA-A and NIA-B designations approximate the shortage sharing provisions in applicable contracts and subcontracts, including paragraph 4.7(b)–(c) of the NIA subcontracts.

to be reduced. At the allocation level, this impacts six Tribal entitlements in Arizona (Hopi Tribe, GRIC, Ak-Chin Indian Community, San Carlos Apache Tribe, Salt River Pima-Maricopa Indian Community, and Tohono O'odham Nation [Schuk Toak and San Xavier Districts]); however, the Shortage Allocation Model does not account for the existence of external arrangements and commitments that would affect alternate water availability to these Tribes or the ultimate impacts of water unavailability to the entitlement (see **Appendix E**). However, even if water deliveries are reduced to Tribes during shortages, the entitlement to the underlying water rights would not be affected.

Proposed Action

As with the No Action Alternative, existing system conservation and ICS were modeled using CRMMS. However, the modeling assumptions for the Proposed Action also include additional SEIS conservation for operational years 2023 through 2026.

Under the Proposed Action, total modeled system conservation (including system conservation and ICS) is estimated to be 3,038,611 af. The modeling assumptions indicate an anticipated increased level of system conservation, compared with the No Action Alternative. Under the Proposed Action, additional entities in California and Arizona would participate in system conservation, with a total of nine entities in Arizona and five entities in California.

In addition to the existing system conservation being carried out by the entities described under the No Action Alternative, the San Carlos Apache Tribe, Colorado River Indian Tribes, and Welton-Mohawk Irrigation and Drainage District are assumed to participate in system conservation under the Proposed Action in Arizona. In California, additional system conservation would be carried out by two water districts (Coachella Valley Water District and Bard Water District), one irrigation district (Imperial Irrigation District), and one Tribe (Quechan Indian Tribe).

Further, the CRMMS modeling output demonstrates a reduced potential for higher shortage volumes to occur. Part of CRMMS modeling involves generating multiple time series, or "traces," of forecasted streamflow. The percentage of traces below critical elevations at Lake Powell and Lake Mead help us understand how changes to operational activities would affect reservoir elevations. Reservoir elevations are one metric that help characterize impacts on hydrologic resources and thereby characterize potential impacts on communities, including environmental justice communities who rely on such resources. As described in **Section 3.7.2**, the Proposed Action would result in higher elevations at Lake Mead, with fewer traces at higher shortage tiers, as compared with the No Action Alternative, in 2025 and 2026 (see **Figure 3-20**). In other words, the Proposed Action would reduce the potential for mandatory shortages to occur based on Lake Mead elevations.

The Shortage Allocation Model does not have a version unique to the Proposed Action since the distribution and priority of shortages are the same as under the No Action Alternative. However, the Shortage Allocation Model results provide for a meaningful comparison of alternatives, as they help to characterize existing conditions and thereby assess how the Proposed Action and associated proposed system conservations would impact overall water supply to specific water entitlement holders.

Hydrologic Resources and Water Deliveries

Irrigation

Under both alternatives, at higher levels of modeled shortage, available water would be reduced to zero for Arizona 5th- and 6th-priority contracts and CAP agricultural and other excess water users (see **Appendix E**). Under the Proposed Action, if higher levels of modeled shortage occurred, the irrigation impacts would be the same as those described under the No Action Alternative. However, under the Proposed Action modeled system conservation is estimated to be higher (compared with the No Action Alternative), as three additional California irrigation users (CVWD, BWD, and IID) and one Arizona irrigation user (Wellton-Mohawk Irrigation and Drainage District) would voluntarily conserve based on modeled assumptions. The additional system conservation proposed under the Proposed Action would contribute to a reduced potential for higher levels of modeled shortage to occur.

By avoiding higher levels of modeled shortage through increased system conservation, available water supply for irrigation use would be maintained in a manner that would reduce irrigation impacts for all entities who rely on the Lower Basin water supply for irrigation use, including those located in environmental justice counties in Arizona (La Paz, Mohave, and Yuma Counties) and California (Imperial and Riverside Counties).

While system conservation would result in some users located within environmental justice counties voluntarily reducing use of available water supply for irrigation, the voluntary nature of such reductions could reduce the severity of impacts on irrigation as compared with those resulting from mandatory reductions. For instance, irrigation users may have greater capacity to plan for and adjust to reduced water supply. This includes irrigation users who would face irrigation impacts at higher levels of modeled shortage.

The irrigation districts, irrigation and drainage districts, and water districts participating in system conservation in Arizona and California would be compensated under these system conservation agreements. As described in **Section 3.16**, a higher level of compensated conservation would offset to some degree the economic impacts associated with reduced agricultural production. However, the ultimate distribution of compensatory funds within the economy is unknown. There is insufficient data to determine the economic impacts of compensation on the agricultural sector due to the loss of indirect and induced jobs and income that may not be fully compensated. For example, compensated conservation funds may not be distributed from the entitlement holder to the agricultural workers, who may therefore still experience a loss of labor income. Similarly, funds may not be distributed to regional retail stores, restaurants, and other businesses that would typically be beneficiaries of the induced spending of labor income. While the water entitlement holder would be compensated, end point impacts would depend on compensation distribution. This is true for all water user groups (irrigation, domestic, and Tribal) who participate in system conservation.

As described in **Section 3.7.2**, Issue 6, under the Proposed Action there is the possibility that IID and CVWD could enter into additional system conservation agreements. Thus there could be reduced deliveries, resulting in potentially less inflow to the Salton Sea from irrigation drainage. Therefore, the Proposed Action could result in expedited (but not additional) lake bed exposure compared to the No Action Alternative, due to the possibility of less available agricultural runoff. As described in **Section 3.9**, lake bed exposure can result in air quality impacts. These air quality impacts could potentially impact nearby environmental justice communities to a higher degree.

Domestic Use

Under the Proposed Action, domestic use impacts would be the same as those described under the No Action Alternative. Under both alternatives, at higher levels of modeled shortage, available water supply for domestic use would be reduced to zero for CAP NIA-A and CAP NIA-B entitlement holders (see **Appendix E**). However, the additional system conservation proposed under the Proposed Action would contribute to a reduced potential for higher levels of modeled shortage to occur. By avoiding higher levels of modeled shortage through increased system conservation, available water supply for domestic use would be maintained in a manner that would reduce consumptive-use impacts on domestic uses for all entities, including users with CAP NIA-A and NIA-B priority entitlements located in environmental justice counties.

Under the Proposed Action, there would be additional system conservation carried out by domestic users (certain CAP subcontractors) in Arizona.

Tribal Allocations

Under the Proposed Action, impacts would be the same as those described under the No Action Alternative. Modeled system conservation is estimated to be higher, however, and two additional Tribal entitlement holders in Arizona (San Carlos Apache Tribe and Colorado Indian River Tribes) and one in California (Quechan Indian Tribe) would voluntarily conserve under the Proposed Action. These entities would be compensated for system conservation. While the water entitlement holder would be compensated, end point impacts would depend on compensation distribution.

The additional system conservation proposed under the Proposed Action would contribute to a reduced potential for higher levels of modeled shortage to occur. By avoiding higher levels of modeled shortage through increased system conservation, the potential for and severity of impacts on water supply for Tribal allocations would be reduced.

Gila, La Paz, Pima, Pinal, and Yuma Counties are identified as environmental justice communities. As such, the Tribal water entitlement holders located within these counties could face temporary, disproportionate consumptive-use impacts on irrigation and domestic use. Production on Tribal lands provides an important economic base for many Tribal communities, including those in the Arizona study area (Deol and Colby 2018). A lack of water supply could result in reduced agricultural production and a loss of Tribal revenue. Further, other Tribal uses of the entitlements include domestic, municipal and industrial, stock, and like uses, and a lack of water supply could result in reduced water availability for these purposes and a loss of Tribal revenue. However, it is important to note that losses in revenue are affected by other factors, including, but not limited to, the implementation of water rights settlements and availability of other resources. The Shortage Allocation Model does not account for the existence of external arrangements and commitments that would affect alternate water availability to these Tribes or the ultimate impacts of water unavailability to the entitlement.

Studies have documented impacts associated with losses in revenue. For example, one Utah State University study, which included several Tribes in Arizona, including the Tohono O'odham Nation, found that reductions in cattle and hay production due to drought result in reduced economic activity in related sectors and significant economic losses for Tribal economies in Arizona (Drugova et al. 2020). As detailed in **Section 3.16.2**, shortage may result in the loss of production for Tribal agricultural lands for a given year. Water delivery reductions may result in the fallowing of some Indian lands, with the potential for economic impacts, as described above. However, even if water deliveries are reduced to Tribes during shortage, the entitlement to the underlying water rights would not be affected. See **Section 3.18** for further information.

Water Quality

Potential changes to water quality were evaluated for salinity, temperature, metals, and perchlorate. Effects on these parameters would be minor and would not disproportionately affect any environmental justice communities in the study area. As elevations decrease, the dilution capacity of Lake Powell and Lake Mead would also decrease but would not likely result in any significant decrease in dilution capacity or increase in concentrations of metals of concern, including for environmental justice communities. However, quantified water-quality impacts related to dilution capacity are not available; therefore, it is difficult to project the quantified water-quality impacts, and alternatives cannot be compared (**Section 3.8**). Under any alternative, salinity would not exceed numeric salinity criteria established by the Colorado River Basin Salinity Control Forum.

Air Quality and Climate Change

As described in **Section 3.9.2**, under the Proposed Action there would potentially be more shoreline exposed at Lake Mead and Lake Powell as compared with the No Action Alternative. The increase in exposed shoreline would potentially have a negative effect on air quality.

At the Salton Sea, the current shoreline area could continue to decrease at the current rate. Under the Proposed Action, there is the possibility that IID and CVWD could take additional shortages; if so, there could be reduced river flows and thus potentially less inflow to the Salton Sea from irrigation drainage. However, both alternatives anticipate an increase in exposed shoreline, and this increase would potentially have a negative effect on air quality because the decreasing water level would increase fugitive dust. Since dust is already a concern for the Salton Sea area, additional dust would affect local air quality and public health.

The Salton Sea is located in two environmental justice counties in California: Riverside and Imperial. Under the Proposed Action, additional dust could result in disproportionate impacts on these environmental justice communities.

Under the Proposed Action, the reduction of hydropower could result in an increase in GHG emissions due to alternative power sources (see **Section 3.9**, Air Quality). When calculated, however, the potential GHG emissions from coal and natural gas alternatives are a very small percentage of the 11-state and US GHG emissions. The totality of climate change impacts is not attributable to any single action; nonetheless, this project-related emission, in combination with a variety of GHG emission sources around the world, could exacerbate climate-related impacts (albeit as a small contribution). Therefore, the Proposed Action could result in contributions to potential disproportionate effects on environmental justice communities.

Visual Resources

As described in **Section 3.10**, potential impacts on visual resources were considered (for both Lake Mead and Lake Powell) for attraction features, calcium carbonate rings, and sediment deltas, which would be viewed from adjacent highways, from the lake surface, and from trails in the area. Based on the potential higher lake elevations associated with the Proposed Action, there would be less modification to landscape character along the edge of Lake Powell and Lake Mead, including impacts on viewers, than under the No Action Alternative.

While some of these features (for example, Rainbow Bridge) are located within San Juan County, Utah, an environmental justice community, effects are not disproportionate or unique to any environmental justice community.

Also considered were potential impacts on landscape character along the Colorado River between Glen Canyon Dam and Lake Mead (associated with potentially lower flows through Grand Canyon) and impacts on landscape character associated with decreasing water deliveries/allocations in the Lower Division States (see **Section 3.10**, Visual Resources). Changes to the natural landscape character along the Colorado River between Glen Canyon Dam and Lake Mead would impact any environmental justice communities located within these areas. Additionally, there could be impacts on the irrigated, agricultural landscapes within the Lower Division States, where the influence of the Colorado River into adjacent lands could narrow as these areas would begin transition to their natural, arid condition, resulting in changes to landscape character compared with the existing condition. These changes to visual resources would also impact environmental justice communities within or adjacent to these landscapes. However, under the Proposed Action, the different release tiers would temper impacts on landscape character with the goal of maintaining consistent flows along the Colorado River (including through the Grand Canyon) while keeping Lake Powell above 3,500 feet. The proposed SEIS conservation would temper visual impacts on environmental justice communities.

Biological Resources

Potential impacts on vegetation, wildlife, and fish due to the No Action Alternative and Proposed Action would be similar, as the alternatives vary only by system conservation measures. The Proposed Action would result in slightly reduced impacts on wildlife. In some cases, impacts on fish and vegetation would be slightly higher under the Proposed Action, due to reduced water flows. However, potential impacts on biological resources would not disproportionately impact any environmental justice community identified within the study area.

Scoping and subsequent consultation did not result in the identification of any environmental justice community for whom indigenous fish, vegetation, or wildlife constituted a significant portion of their diet. There would be no difference in rates or patterns of subsistence consumption by environmental justice communities, including Indian Tribes, in comparison to the general population in the study area. See **Section 3.13**, Biological Resources, for more detailed information.

Cultural Resources

Section 3.11.2 analyzes how changes in operations would affect TCPs and resources of concern to Native Americans. For Lake Mead, the Proposed Action would have fewer negative impacts on cultural resources due to site exposure than the No Action Alternative, as pool elevations would be slightly higher. Adverse effects on sacred sites and TCPs could disproportionately impact Tribes for whom these resources provide cultural or spiritual significance and value. However, adverse effects on TCPs would be resolved through the LTEMP PA, land management agency actions, or the NHPA Section 106 process. See **Section 3.11**, Cultural Resources, for detailed information. Overall, the additional SEIS conservation would allow for reduced potential of higher modeled shortages and would result in fewer negative impacts on cultural resources than the No Action Alternative, as pool elevations would be slightly higher.

Under the Proposed Action, if conservation measures are required and implemented, less water would be flowing into the Salton Sea; this may lead to the exposure of cultural resources in the lake bed more quickly than under the No Action Alternative, but the result will eventually be the same as under the No Action Alternative. As such, disproportionate impacts on environmental justice communities are not anticipated.

Indian Trust Assets

Reclamation has concluded that the Proposed Action would have no significant impacts on Indian Trust Assets (ITAs). Reclamation is committed to protecting and maintaining ITAs and rights reserved by or granted to Indian Tribes or individual Indians by treaties, statutes, and executive orders. See **Section 3.18**, Indian Trust Assets, for more detailed information.

Electrical Power Resources

Changes to electrical power production have the potential to affect environmental justice communities disproportionately through possible increases in electricity rates resulting from decreased electrical power generation under the Proposed Action. Decreases in electrical power generation under the Proposed Action are anticipated to be highest in 2024 and decrease over the life of the project. However, the facilities potentially affected produce less than 2 percent of the total power produced in the region. Therefore, no substantial environmental justice effects are anticipated.

A decrease in available hydropower could result in reliance on other fuel sources for electricity generation. In California, utilities increased fossil fuel generation of electricity to compensate for the drought-driven decline in hydroelectricity, increasing state carbon dioxide emissions in 2011–2012 by 1.8 million tons of carbon, the equivalent of emissions from roughly 1 million cars (USGCRP 2018). Other southwestern states also shifted some generation from hydropower to fossil fuels (USGCRP 2018). If water shortages resulted in the need to rely on other fuel sources, environmental justice communities could face disproportionate health impacts associated with carbon dioxide emissions; such impacts are well documented (CDC 2021; EPA 2017; USGCRP 2018).

Recreation

Potential recreational impacts are primarily associated with reduced reservoir elevations affecting access or necessitating capital alterations to shoreline facilities around Lake Powell and Lake Mead.

Impacts on recreation are generally similar under both alternatives. Recreation impacts at Lake Powell would be slightly reduced under the Proposed Action because the Proposed Action preserves more water in Lake Powell and reduces overall variability in water surface elevations.

Individuals and businesses within San Juan County, Utah, the population of which is greater than 50 percent minority, could be affected by these recreational impacts. However, the effect would not be disproportionate to the recreational impacts experienced by other counties adjacent to Lake Powell and Lake Mead.

Socioeconomics

Under the Proposed Action, there is potential for shortages to result in economic impacts due to agricultural value changes, municipal water shortages, and changes to recreation-based economic contributions. The locations of impacts would vary by shortage level. While higher levels of modeled shortage could still occur under the Proposed Action, the higher level of system conservation would reduce the potential for higher levels of modeled shortage to occur, thereby maintaining water in the system and lessening socioeconomic impacts—including those to environmental justice communities—associated with higher levels of modeled shortage.

As described in **Section 3.12**, anticipated water shortages would result in agricultural production loss under both alternatives. Under both alternatives there would be an estimated potential of up to $116 million in agricultural revenue loss; however, these impacts would be tempered by system conservations under the Proposed Action. Potential agricultural revenue loss could result in disproportionate impacts on environmental justice communities, including Tribal populations, depending on how much Tribes rely on revenue from water deliveries. However, this analysis cannot characterize the level of magnitude of such impacts, as Tribal revenue data are not available.

Under the Proposed Action, the range of agricultural sector losses prior to consideration of compensation would be the same as modeled under the No Action Alternative. Increased system conservation would result in a higher level of compensated conservation than under the No Action Alternative (**Table 3-95**). This would offset to some degree the level of economic impacts associated with reduced agricultural production. As noted above, system conservation would be compensated under both alternatives. However, economic impacts associated with system conservation compensation, and resulting impacts on environmental justice communities, are difficult to determine. Depending on distribution of funds, there is potential for disproportionate adverse impacts on low-income and minority populations. Further, water being conserved through system conservation may no longer contribute to certain uses, resulting in potential for economic loss.

Cumulative Effects

The LTEMP SEIS flow options would not result in any changes to disproportionate adverse health or environmental impacts. Therefore, there is no expected change in impacts on environmental justice communities.

Food production, electricity generation, and human health in the Southwest are vulnerable to water shortages. In the Southwest, severe drought, wildfire, and temperatures have increased and are anticipated to continue. Trends of population growth have affected—and will continue to affect—

the demand for water, agricultural products, electricity, and housing. These trends will contribute to cumulative effects. Environmental justice communities, including Native Americans, are among the most at risk from climate change, often experiencing the worst effects because of higher exposure, higher sensitivity, and lower adaptive capacity for historical, socioeconomic, and ecological reasons (CDC 2021; EPA 2017; USGCRP 2018).

No cumulative effects would occur on environmental justice communities due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

3.18 Indian Trust Assets

3.18.1 Affected Environment

This section is summarized from Section 3.10, Indian Trust Assets (ITA), from the 2007 FEIS (Reclamation 2007) and is updated with changes since 2007. ITAs are assets held in trust by the federal government for the benefit of Native American Tribes or individuals (DOI 2023a). ITAs can be on or off reservation lands and can consist of land, water rights, mineral rights, hunting and fishing rights, grazing rights, or other assets.

Reclamation is consulting with Tribes, including those Tribes with water rights and water delivery contracts, regarding the proposed changes to the 2007 Interim Guidelines.

Analysis of the impacts on the Salton Sea are not relevant to this resource.

Water Rights and Trust Lands

Following the 2007 Interim Guidelines, water rights and trust lands include "federal reserved Indian rights to Colorado River water including rights established pursuant to *Arizona v. California*, Colorado River water Tribal delivery contracts where such contracts are part of a congressional approved water rights settlement; and Indian reservations" (Reclamation 2007). Reservations are treated as trust assets for the analysis, although they are not "technically synonymous with trust lands" (Reclamation 2007).

Indian Trust Assets Determined under *Arizona v. California*

Water rights of the Chemehuevi Indian Tribe, Colorado River Indian Tribes, Fort Mojave Indian Tribe, Fort Yuma-Quechan Tribe, and Cocopah Indian Tribe under the 1964 *Arizona v. California* decision and the 2006 Consolidated Decree are summarized in Table 3.10-1, Colorado River Mainstream Diversion Entitlement (Water Rights) in Favor of Indian Reservations, in Section 3.10.11 of the 2007 FEIS (Reclamation 2007).

Since the 2007 Interim Guidelines, water rights have been settled or partially settled for three additional Tribes (DOI 2023b). Water rights for the Navajo Nation in New Mexico were settled by the Northwestern New Mexico Rural Water Project Act of 2009 and for the Navajo Nation in Utah by the Navajo Utah Water Rights Settlement in 2022. The White Mountain Apache Tribe Water Rights Quantification Act of 2010 settled water rights for the White Mountain Apache Tribe. Water rights in Arizona for the Hualapai Tribe were settled under the Hualapai Tribe Water Rights Settlement Act of 2022. In addition, the Colorado River Indian Tribes Water Resiliency Act of 2022 authorizes the Colorado River Indian Tribes to enter into lease or exchange agreements, storage agreements, and agreements for conserved water.

Central Arizona Project

Tribal entitlements to CAP water and/or non-CAP Colorado River water delivered through the CAP in central Arizona are administered pursuant to water delivery contracts between Tribes and the Secretary. A summary of water rights settlements as of 2007 is presented in Section 3.10.1.2 of the 2007 FEIS (Reclamation 2007), and water rights for the CAP Tribes as of 2007 are summarized in Table 3.10-2, Central Arizona Project Indian Tribal Diversion Entitlements (Water Rights) (Reclamation 2007). As of 2023, water rights settlements involving CAP water have been executed with the Ak-Chin Indian Community, Fort McDowell Yavapai Nation, GRIC, San Carlos Apache Tribe, Salt River Pima-Maricopa Indian Community, Tohono O'odham Nation, Yavapai-Prescott Indian Tribe, Hualapai Tribe, and White Mountain Apache Tribe. CAP water is also retained for a future water rights settlement agreement approved by an Act of Congress that settles the Navajo Nation's claims to water in Arizona.

Hydroelectric Power and Generation

The Bureau of Indian Affairs operates Headgate Rock Dam and Powerplant, which supplies electricity to the Colorado River Indian Tribes and others (Reclamation 2007). The powerplant depends on Colorado River flows; however, "Reclamation has determined that the water appropriated to non-Colorado River Indian Tribes entities that flows through Headgate Rock Dam and generates powers is not an ITA" (Reclamation 2007) and will not be further discussed in this SEIS.

Cultural and Biological Resources

No cultural or biological resources that were considered ITAs for the 2007 Interim Guidelines analysis were identified by Tribes; however, concerns were expressed regarding TCPs, archaeological sites, sacred sites, fish and wildlife, wildlife habitat, and vegetation (Reclamation 2007).

3.18.2 Environmental Consequences

Methodology

Impacts on ITAs are drawn from several sources, including water deliveries (**Section 3.7**), socioeconomics (**Section 3.16**), and cultural resources (**Section 3.11**). Water deliveries are based on CRMMS modeling assumptions developed for the SEIS.

Impact Analysis Area

The impact analysis area consists of Native American Tribes with settled water rights, Native American reservations adjacent to the Colorado River, and the cultural resources analysis area (see **Section 3.10.2**).

Assumptions

The assumptions for the following analysis are:

- Changes in water deliveries will not affect settled water rights.
- Previously gathered data on TCPs and Tribal concerns are sufficient.
- Tribes may supply any additional information they believe should be considered in the ITA assessment.

Impact Indicators

Impact indicators for this analysis are:

- Changes in water allocations due to shortages
- Access changes to sacred sites
- Negative effects on TCPs not discussed in the 2007 FEIS or LTEMP

Issue 1: How would management of Colorado River allocations affect Tribal water rights and allocations?

Summary

Tribal water rights are established by law; however, annual water deliveries may change as a result of shortages and conservation measures. The Proposed Action may result in decreased water deliveries to Tribes that have agreed to conservation measures. This means under the Proposed Action more Tribes—those who participate in conservation measures—may have decreased deliveries in comparison to the No Action Alternative at a given surface water elevation at Lake Mead.

Water rights for individual Tribes are established by law. The determination of water allocations to individual entities is beyond the scope of this SEIS. As with the 2007 Interim Guidelines, "no vested water right of any kind, quantified or unquantified, including federally reserved Indian rights to Colorado River water, rights pursuant to the Consolidated Decree or Congressionally-approved water right settlements utilizing CAP water, will be altered as a result of any of the alternatives under consideration" (Reclamation 2007). A discussion of potential impacts on Tribal agricultural lands by alternative can be found in **Section 3.17**, Environmental Justice, in this SEIS.

See also **Section 3.7**, Water Deliveries, for a full discussion of impacts on water deliveries to all parties, as well as **Appendix E**, Shortage Allocation Model Documentation.

No Action Alternative

Under the No Action Alternative, water deliveries for Tribes follow the 2007 Interim Guidelines as analyzed in Section 4.10.1 of the 2007 FEIS (Reclamation 2007), the DCPs, and the current conservation measures agreed to by the Fort McDowell Yavapai Nation and the GRIC. Water deliveries to Tribes will fluctuate with water availability in Lake Powell and Lake Mead, as they will fluctuate for all entities that receive water from the Colorado River. Initially, water deliveries may remain near long-term averages, but reduced deliveries may occur if lake levels decline. Any water available will be distributed by priority among and within each state. As discussed in **Section 3.17.2**, Environmental Justice, this means that Tribes in Arizona who hold entitlements to CAP NIA-A priority water may have their available CAP NIA-A priority water reduced to zero if shortages reach a threshold level and Tribes with Arizona fourth priority water may also have their water reduced. In addition, shortages based on priority may result in the loss of production for Tribal agricultural lands. Any annual variability in water deliveries will not affect the underlying settled water rights.

Proposed Action

Under the Proposed Action, impacts would be the same as under the No Action Alternative; however, additional system conservation measures that would reduce water deliveries may be necessary if Lake Mead drops below 1,025 feet. Three additional Tribes (the Colorado River Indian Tribes, San Carlos Apache Tribe, and Quechan Indian Tribe) have agreed to voluntary conservation measures. Tribes that participate in the system conservation would be compensated.

Cumulative Effects

Reclamation has identified one past, present, and reasonably foreseeable future project that may, in conjunction with the proposed near-term Colorado River operations, contribute to cumulative effects on ITAs; this is the LTEMP SEIS. Reclamation is proposing to regulate flows from the Glen Canyon Dam to control smallmouth bass populations and implement more HFEs to deposit sediment along sandbars and beaches. These proposed actions would not contribute to cumulative impacts on water deliveries. No cumulative impacts on water deliveries to Tribes are anticipated.

No cumulative effects would occur on water deliveries to Tribes due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

Issue 2: How would management of Lake Powell and Lake Mead water flows and lake levels affect cultural resources or biological resources?

Summary

Previously inaccessible sacred sites at Lake Mead would be more accessible to visitation under both alternatives. No other impacts are expected.

No Action Alternative

Under the No Action Alternative, decreases in the pool elevations at Lake Mead may increase visitor access to sacred sites that were previously inaccessible or under water (see **Section 3.11.2**, above). No impacts on important elements of TCPs important to Native Americans, such as plants or animals, are anticipated for the No Action Alternative.

Proposed Action

Impacts on sacred sites and TCPs are the same under the Proposed Action as the No Action Alternative.

Cumulative Effects

Reclamation is proposing to regulate flows from the Glen Canyon Dam to control smallmouth bass populations and implement more HFEs to deposit sediment along sandbars and beaches. The proposed releases are within the previously approved flows analyzed in the LTEMP FEIS, but they may impact TCPs important to Native Americans. Adverse effects on TCPs, as historic properties, will be resolved under the LTEMP PA, land management agency actions, and the nonnative fish MOA in development. These effects should not contribute to cumulative impacts.

Adverse effects on TCPs are not anticipated from the proposed near-term Colorado River operations; however, if adverse effects are present, they will be resolved either under the LTEMP PA or Section 106 of the NHPA process. Therefore, the proposed near-term Colorado River operations will not contribute to cumulative impacts on ITAs.

No cumulative effects would occur on TCPs due to the proposed management plan evaluated in the Salton Sea 10-Year Plan or the environmental assessment for the implementation of the 10-Year Plan's projects.

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Chapter 4. Consultation and Coordination

4.1 Introduction

This chapter describes Reclamation's public involvement program and coordination with specific federal, state, and local agencies, along with Tribal consultations.

4.2 General Public Involvement Activities

The public involvement program leading to this Revised Draft SEIS included project scoping, consultation, and coordination with Tribes, agencies, stakeholders, and the public. Reclamation developed and implemented a public involvement plan to satisfy the public participation requirements set forth in NEPA and to establish a consistent and constant level of engagement with interested parties and stakeholders. The multifaceted approach consisted of informational materials, consultation and coordination meetings, general and stakeholder outreach, and media relations.

A variety of informational materials to educate and inform audiences about the study and related issues were employed. A website was established and maintained for this SEIS. It contained project documents, points of contact, and the project schedule. An electronic mailing list was used to notify interested parties of website postings, project meetings, and documents. A project email account was maintained live during the entire period of preparing this SEIS for interested parties to express opinions, ask questions, and submit comments.

Reclamation published an NOI to prepare an SEIS and a modified Record of Decision for the 2007 Interim Guidelines in the *Federal Register* on November 17, 2022. A 30-day scoping comment period was held from November 17, 2022, to December 20, 2022. Reclamation notified interested parties of the NOI and scoping comment period through an email notification to the project mailing list on December 1, 2022. The email consisted of an NOI and information on two public webinars.

Reclamation held two virtual public webinars during the scoping period. One meeting was held on November 29, 2022, from 10:00 a.m. to noon mountain standard time, and 184 people attended. The second virtual public meeting was held on December 2, 2022, from 11:00 a.m. to 1:00 p.m. mountain standard time, and 241 people attended. The webinars included an opening statement, a presentation that summarized the NOI, a range of hydrologic and operational scenarios that informed people about the SEIS analysis, an overview of potential alternatives being considered in the SEIS, information on the SEIS process schedule, and a question-and-answer session. The webinars were recorded and published on the project website.[1] Public comments were accepted during the comment period by email and mail. A scoping summary report was prepared to summarize all public comments received during scoping. Reclamation made the public scoping

[1] https://www.usbr.gov/ColoradoRiverBasin/SEIS.html

comments and the scoping summary report available for public viewing in an accessible format on the project website.

On April 14, 2023, the EPA published a Notice of Availability in the *Federal Register* for the original Draft SEIS. This kicked off a 45-day review period that ended on May 30, 2023. In May 2023, Reclamation held four virtual public meetings to provide information on the original Draft SEIS, answer questions, and take verbal comments. Each meeting presentation covered the same information. The question-and-answer and public comment portions of the meetings varied based on the public participants at each meeting. The webinars were recorded and published on the project website.

On May 22, 2023, representatives from the seven Colorado River Basin States proposed a new alternative for consensus-based system conservation in the Lower Basin. Reclamation filed with the EPA to withdraw the original Draft SEIS from public review. This resulted in the revision and reissuance of the Draft SEIS. Public comments received on the original Draft SEIS were reviewed, and they helped inform the revision of this Draft SEIS.

This Revised Draft SEIS is available for public review on the project website. Reclamation will hold two virtual open house meetings to provide opportunities to learn more about the project, provide analysis, speak with Reclamation managers and resource specialists, ask questions, and provide comments. Public comments will be accepted for 45 calendar days following the EPA's publication of the Notice of Availability in the *Federal Register*. Comments may be provided by email to CRinterimops@usbr.gov or by mail to Reclamation 2007 Interim Guidelines SEIS Project Manager, Upper Colorado Basin Region, 125 South State Street, Suite 8100, Salt Lake City, Utah 84138.

4.3 Cooperating Agency Involvement

In compliance with NEPA and its implementing regulations, Reclamation worked with five cooperating agencies in the preparation of this SEIS. As described in **Chapter 1**, cooperating agencies included the BIA, Service, NPS, WAPA, and USIBWC. In developing the Draft SEIS, Reclamation hosted seven cooperating agency virtual meetings to obtain data, information, resource analysis, and review of internal documents. Additionally, individual agencies provided specific assistance, including the following:

- The BIA administers the federal trust responsibility to Indian Tribes.
- The Service has jurisdiction by law and special expertise with respect to the ESA and biological resources within the study area and its administration of several wildlife refuges in the study area. The Service provided resource expertise and worked closely with Reclamation in developing two biological assessments to support consultation under Section 7 of the ESA.
- Given its jurisdiction of NPS units within the Basin and administration of recreation on Lake Powell and Lake Mead, the NPS provided data and analysis of potential impacts on resources under its management.
- The WAPA provided hourly release volume models for Glen Canyon Dam to aid in resource-specific modeling. The WAPA also provided hydroelectric modeling to assess

impacts on power generation and revenue across the major generation facilities in the Upper and Lower Basins.

- The USIBWC provided guidance and reviewed internal documents to ensure the SEIS adequately addressed treaty obligations and international commitments. The USIBWC has worked with Reclamation to ensure that Mexico has been kept informed of all permissibly available information regarding the SEIS process.

While not a cooperating agency, the USGS also contributed expertise and resource modeling support.

4.4 Tribal Consultation and Coordination

For purposes of this NEPA process, Reclamation is consulting and coordinating with Tribes who have entitlements to or contracts for Colorado River water and those that may be affected by or have interests in the proposed federal action. Representatives of various Indian Tribes also attended the scoping meetings in November and December 2022. Eighteen Tribes provided Reclamation with written comments on the proposed federal action and its potential effects on resources of Tribal concern, including ITAs.

4.4.1 Summary of Tribal Consultation and Coordination

There are many federally recognized Tribes with entitlements to or contracts for Colorado River water or who may be affected or have interests in the proposed federal action. There are 30 federally recognized Tribes within the geographic Basin. Reclamation consults regularly with these Tribes regarding Colorado River issues. These Tribes are listed in **Table 4-1** and shown on **Map 4-1**.

Table 4-1
Basin Tribes

- Ak-Chin Indian Community
- Chemehuevi Indian Tribe
- Cocopah Indian Tribe
- Colorado River Indian Tribes
- Fort McDowell Yavapai Nation
- Fort Mojave Indian Tribe
- Gila River Indian Community
- Havasupai Tribe
- Hopi Tribe
- Hualapai Indian Tribe
- Jicarilla Apache Nation
- Kaibab Band of Paiute Indians
- Las Vegas Tribe of Paiute Indians
- Moapa Band of Paiute Indians
- Navajo Nation
- Paiute Indian Tribe of Utah
- Pascua Yaqui Tribe
- Quechan Indian Tribe
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- San Juan Southern Paiute
- Southern Ute Indian Tribe
- Tohono O'odham Nation
- Tonto Apache Tribe
- Ute Indian Tribe of the Uintah and Ouray Reservation
- Ute Mountain Ute Tribe
- White Mountain Apache Tribe
- Yavapai-Apache Nation
- Yavapai-Prescott Indian Tribe
- Zuni Tribe

The Ten Tribes Partnership is a coalition of 10 federally recognized Tribes with rights and unresolved claims to Colorado River water. The partnership was created in 1992 and has an ongoing consultation relationship with Reclamation. Federally recognized Tribes of the Ten Tribes Partnership are listed in **Table 4-2**.

Table 4-2
Ten Tribes Partnership Tribes

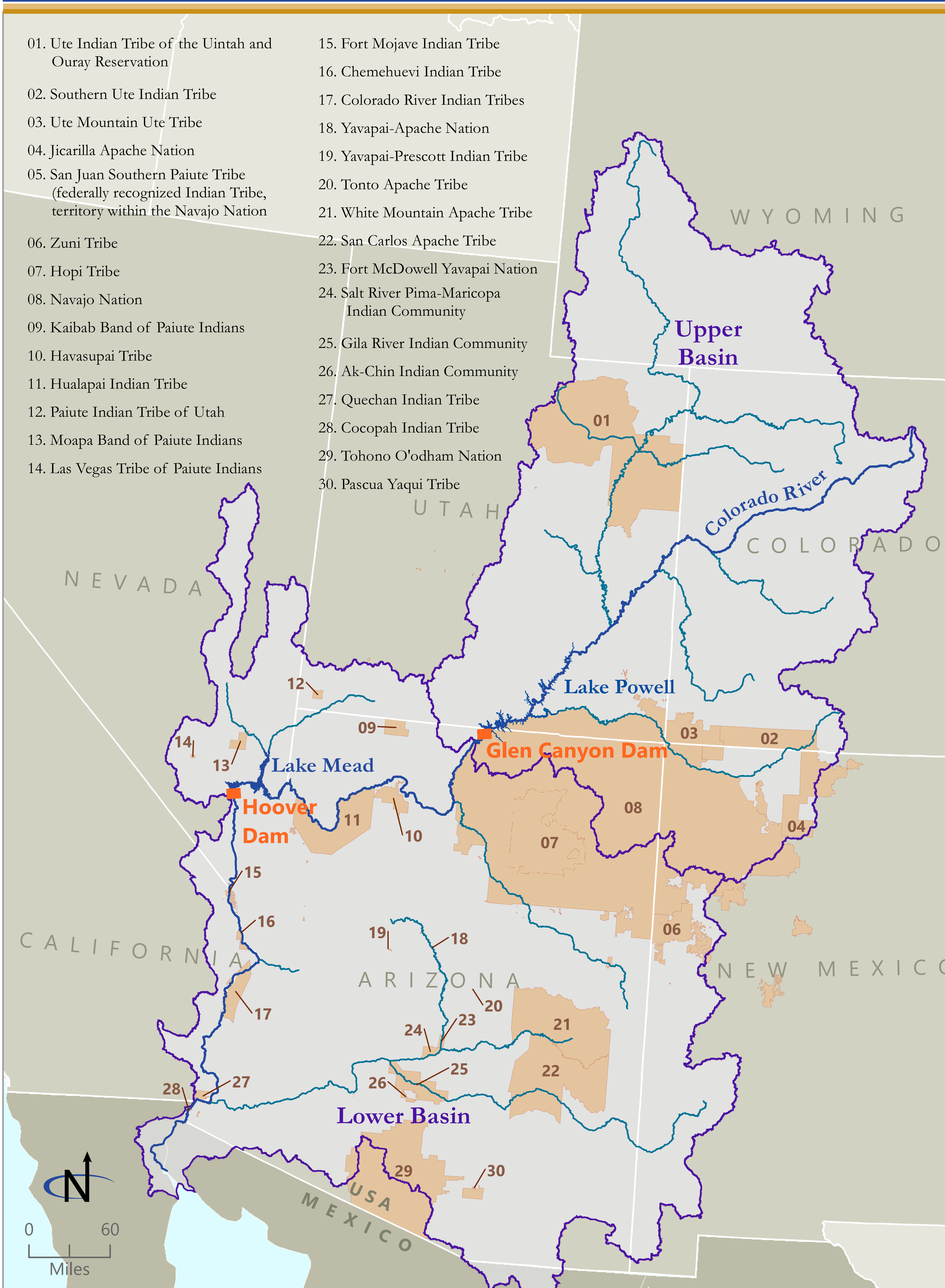
• Ute Mountain Ute Tribe	• Fort Mojave Indian Tribe
• Southern Ute Indian Tribe	• Colorado River Indian Tribes
• Ute Indian Tribe of the Uintah and Ouray Reservation	• Chemehuevi Indian Tribe
• Jicarilla Apache Nation	• Quechan Indian Tribe
• Navajo Nation	• Cocopah Indian Tribe

Of the 22 federally recognized Tribes in Arizona, 14 have fully resolved, adjudicated rights, or partially resolved rights to water from the Colorado River. A significant portion of that water is provided through the CAP. Reclamation has a long-standing and ongoing consultation relationship with Tribes receiving Colorado River water through the CAP. **Table 4-3** lists CAP Tribes.

Table 4-3
CAP Tribes

• Ak-Chin Indian Community	• San Carlos Apache Tribe
• Fort McDowell Yavapai Nation	• Tohono O'odham Nation
• Gila River Indian Community	• Tonto Apache Tribe
• Hualapai Tribe	• White Mountain Apache Tribe
• Pascua Yaqui Tribe	• Yavapai-Apache Nation
• Salt River Pima-Maricopa Indian Community	• Yavapai-Prescott Tribe

Reclamation consults not only with Tribes who hold water rights or are located within the geographic boundary of the Basin, but also Tribes who may be affected or have interests in actions on the Colorado River. **Table 4-4** lists the 43 federally recognized Tribes with whom Reclamation consults on issues regarding the Colorado River.



Map 4-1 Colorado River Basin Tribes

Tribal Reservation and off-reservation trust land
Colorado River
Colorado River tributary
Dam
Colorado River Basin, Upper and Lower Basins
States in the Colorado River Basin

Source: National Weather Service GIS. 2023, Reclamation GIS 2023, USGS National Hydrography Dataset GIS. 2023; Map production: U.S. Department of the Interior, Bureau of Reclamation, Upper and Lower Colorado Basin Regions; Date: March 25, 2023, Disclaimer: This map is intended for informational purposes only. Geographic features may have been compiled at varying scales and for different purposes. No representation is made as to the accuracy of this graphic.

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Table 4-4
Tribes Consulted on Colorado River Issues

• Ak-Chin Indian Community	• Pueblo of Pojoaque
• Chemehuevi Indian Tribe	• Pueblo of San Felipe
• Cocopah Tribe of Arizona	• Pueblo of San Juan
• Colorado River Indian Tribes	• Pueblo of Sandia
• Fort McDowell Yavapai Nation	• Pueblo of Santa Ana
• Fort Mojave Indian Tribe	• Pueblo of Santa Clara
• Gila River Indian Community	• Pueblo of Tesuque
• Havasupai Indian Tribe	• Pueblo of Zia
• Hopi Tribe	• Quechan Indian Tribe
• Hualapai Indian Tribe	• Salt River Pima-Maricopa Indian Community
• Jicarilla Apache Nation	• San Carlos Apache Tribe
• Kaibab Band of Paiute Indians	• San Juan Southern Paiute Tribe
• Las Vegas Tribe of Paiute Indians	• Southern Ute Indian Tribe
• Moapa Band of Paiute Indians	• Tohono O'odham Nation
• Navajo Nation	• Tonto Apache Tribe
• Paiute Indian Tribe of Utah	• Ute Indian Tribe of the Uintah and Ouray Reservation
• Pascua Yaqui Tribe	• Ute Mountain Ute Tribe
• Pueblo of Acoma	• White Mountain Apache Tribe
• Pueblo of Cochiti	• Yavapai-Apache Nation
• Pueblo of Jemez	• Yavapai-Prescott Tribe
• Pueblo of Laguna	• Zuni Tribe
• Pueblo of Nambe	

4.4.2 Tribal Consultation Efforts

An NOI to prepare this SEIS was published in the *Federal Register* on November 17, 2022. Since that date, Reclamation has engaged regularly with the Tribes described above. **Table 4-5** provides a summary of those Tribal consultation and coordination efforts conducted by Reclamation between publication of the NOI and August 30, 2023.

Table 4-5
Summary of Tribal Consultation Efforts

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
11/17/2022	Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Basin
11/22/2022	SEIS NOI Publication and Public Scoping Webinar Information Email Notification	Email communicating the Department's SEIS NOI publication in the *Federal Register* on November 17, 2022, and sharing of the upcoming scoping webinar information for the SEIS	Tribal leaders and representatives for Tribes throughout the Basin
11/23/2022	SEIS NOI Publication and Public Scoping Webinar Information Email Notification	Email communicating the Department's SEIS NOI publication in the *Federal Register* on November 17, 2022, and sharing of the upcoming scoping webinar information for the SEIS	San Juan-Chama project stakeholders
11/28/2022	SEIS NOI Publication, Purpose, and Public Scoping Process Correspondence	Letter from regional directors communicating the Department's SEIS NOI publication in the *Federal Register* on November 17, 2022, its purpose, and information on the scoping process for the SEIS	Tribal leaders for Tribes throughout the Basin
12/9/2022	Inter-Tribal Council of Arizona (ITCA) Tribal Leaders Water Policy Council and Colorado River Tribal Roundtable Meeting	Special ITCA meeting with all Basin Tribal leaders to provide an update on the SEIS NOI and scoping and an update on the post-2026 process	The ITCA extended an invitation outside Arizona to all Tribal leaders and representatives for Tribes throughout the Basin.
12/14/2022	Quechan Indian Tribe Meeting	Meeting with the Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Quechan Indian Tribe
12/15/2022	Ten Tribes Partnership Meeting	Bimonthly meeting with member Tribes of the Ten Tribes Partnership	The 10 member Tribes of the Ten Tribes Partnership

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
12/15/2022	Upper Basin Tribe Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Jicarilla Apace Nation, Navajo Nation, Paiute Indian Tribe of Utah, Southern Ute Indian Tribe, Ute Indian Tribe, and Ute Mountain Ute Tribe
12/15/2022	Navajo Nation Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Navajo Nation
12/15/2022	Ute Mountain Ute Tribe Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Ute Mountain Ute Tribe
12/15/2022	Colorado River Indian Tribes Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Colorado River Indian Tribes
12/15/2022	Jicarilla Apache Nation Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Jicarilla Apache Nation
12/15/2022	Ute Indian Tribe Meeting	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Ute Indian Tribe of the Uintah and Ouray Reservation
12/15/2022	Gila River Indian Community Consultation	The Gila River Indian Community requested government-to-government consultation to discuss the SEIS scoping process; relevant information to the SEIS process, such as hydrologic updates; and other system conservation offers.	Gila River Indian Community

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
12/15/2022	Southern Ute Indian Tribe Consultation	Meeting with Department and Reclamation leadership to discuss current issues on the Basin, including the SEIS scoping process and relevant information	Southern Ute Indian Tribe
1/13/2023	Southern Ute Indian Tribe Consultation	The Southern Ute Indian Tribe Council requested a meeting with Upper Basin regional leadership to discuss the contents of the Southern Ute Indian Tribe's SEIS scoping comment letter.	Southern Ute Indian Tribe
1/19/2023	Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Basin
2/8/2023	Ten Tribes Partnership Meeting	Bimonthly meeting with member Tribes of the Ten Tribes Partnership	The 10 member Tribes of the Ten Tribes Partnership
3/7/2023	SEIS Process and Tribal Consultation Timeline Correspondence	Letter from regional directors communicating Reclamation's planned timeline and process for government-to-government consultation on the Draft SEIS	Tribal leaders and representatives for Tribes throughout the Basin
3/17/2023	Upper Basin Tribes-States Dialogue Meeting	Reclamation invited to participate in semi-regular meeting between Upper Basin Tribes and States	Leaders and representatives of the six Upper Basin Tribes
3/23/2023	Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Basin
4/11/2023	Colorado River/SEIS Press Event	Press event at Glen Canyon Dam to announce the release of the Draft SEIS	Cocopah (representing Colorado River Basin Tribes)
4/11/2023	Colorado River Basin Tribal Information Exchange	Monthly meeting	Tribal Leaders and Representatives for Tribes throughout the Colorado River Basin
4/12/2023	Ten Tribes Partnership Meeting	Bimonthly meeting with member Tribes of the Ten Tribes Partnership	The 10 member Tribes of the Ten Tribes Partnership
4/25/2023	Ak-Chin Indian Community SEIS Consultation	Government-to-government consultation on the Draft SEIS in Maricopa, Arizona	Ak-Chin Indian Community

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
4/27/2023	Navajo Nation SEIS Technical Briefing	Navajo Nation requested an individual briefing on the Draft SEIS document.	Navajo Nation
4/28/2023	Chemehuevi Indian Community SEIS Consultation	Briefing to the council on the Draft SEIS in Havasu Lake, California	Chemehuevi Indian Tribe
5/1/2023	Navajo Nation SEIS Consultation	Government-to-government consultation on the Draft SEIS in Window Rock, Arizona	Navajo Nation
5/2/2023	Jicarilla Apache Nation SEIS Consultation	Government-to-government consultation on the Draft SEIS in Dulce, New Mexico	Jicarilla Apache Nation
5/3/2023	Tohono O'odham SEIS Consultation	Government-to-government consultation on the Draft SEIS in Sells, Arizona	Tohono O'odham Nation
5/4/2023	Southern Ute Indian Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in Ignacio, Colorado	Southern Ute Indian Tribe
5/4/2023	Gila River Indian Community SEIS Consultation	Government-to-government consultation on the Draft SEIS in Phoenix, Arizona	Gila River Indian Community
5/5/2023	Ute Mountain Ute Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in Towaoc, Colorado	Ute Mountain Ute Tribe
5/9/2023	Colorado River Indian Tribes SEIS Consultation	Government-to-government consultation on the Draft SEIS in Parker, Arizona	Colorado River Indian Tribes
5/10/2023	Fort Mojave Indian Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in Needles, California	Fort Mojave Indian Tribe
5/10/2023	Upper Basin Tribes-States Dialogue Meeting	Reclamation invited to participate in semi-regular meeting between Upper Basin Tribes and States. The meeting included a briefing on the Draft SEIS.	Upper Basin Tribes (SUIT, Ute Mountain Ute Tribe, Ute Indian Tribe, Jicarilla-Apache Nation, Navajo Nation, and Paiute Indian Tribe of Utah)
5/11/2023	Hopi Tribe SEIS Consultation	Government-to-government consultation (virtual) on the Draft SEIS	Hopi Tribe
5/15/2023	Hualapai Tribe SEIS Consultation	Government-to-government consultation (virtual) on the Draft SEIS	Hualapai Tribe
5/16/2023	Yavapai-Apache Nation SEIS Consultation	Government-to-government consultation (virtual) on the Draft SEIS	Yavapai-Apache Nation

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
5/17/2023	Colorado River Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Colorado River Basin
5/23/2023	San Carlor Apache Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in San Carlos, Arizona	San Carlos Apache Tribe
5/24/2023	Cocopah Indian Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in Yuma, Arizona	Cocopah Indian Tribe
5/24/2023	Quechan Indian Tribe SEIS Consultation	Government-to-government consultation on the Draft SEIS in Winterhaven, California	Quechan Indian Tribe
5/25/2023	Gila River Indian Community Second SEIS Consultation	Government-to-government consultation on the Draft SEIS in Chandler, Arizona	Gila River Indian Community
5/26/2023	Pascua Yaqui Tribe SEIS Consultation	Government-to-government Consultation (virtual) on the Draft SEIS	Pascua Yaqui Tribe
6/13/2023	Meeting with Gila River Indian Community	Virtual meeting	Gila River Indian Community
6/14/2023	Ten Tribes Partnership Meeting	Bimonthly meeting with member Tribes of the Ten Tribes Partnership	The 10 member Tribes of the Ten Tribes Partnership
6/15/2023	Colorado River Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Colorado River Basin
6/15/2023	Southern Ute Indian Tribe Visit	Southern Ute invited Upper Colorado Basin leadership to meet with the council to discuss the Colorado River, Tribal water infrastructure needs, and tour projects on the reservation.	Southern Ute Indian Tribe
7/20/2023	Colorado River Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Colorado River Basin
7/28/2023	SEIS Modeling Assumptions Technical Meeting for Tribes	Meeting with Colorado River Basin Tribal technical and legal representatives to discuss modeling assumptions used in the revised Draft SEIS	Tribal leaders and representatives for Tribes throughout the Colorado River Basin

Date	Meeting Title/Subject of Correspondence	Purpose	Tribes Invited
8/8/2023	Meeting with Gila River Indian Community	Hybrid meeting; in person in Washington, DC	Gila River Indian Community
8/9/2023	Ten Tribes Partnership Meeting	Bimonthly meeting with member Tribes of the Ten Tribes Partnership	The 10 member Tribes of the Ten Tribes Partnership
8/9/2023	Ak-Chin Indian Community SEIS Consultation	Government-to-government consultation on the Draft SEIS in Maricopa, Arizona	Ak-Chin Indian Community
8/24/2023	Colorado River Basin Tribal Information Exchange	Monthly meeting	Tribal leaders and representatives for Tribes throughout the Colorado River Basin
8/29/2023	Jicarilla Apache Nation Visit	Jicarilla Apache invited Upper Colorado Basin leadership to meet with the council to discuss the Colorado River and Tribal concerns	Jicarilla Apache Nation
8/30/2023	Ute Mountain Ute Tribe Visit	Ute Mountain Ute invited Upper Colorado Basin leadership to meet with the council to discuss the Colorado River, Tribal water infrastructure needs, and tour projects on the reservation.	Ute Mountain Ute Tribe

4.5 Endangered Species Act Section 7 Consultation

In 2007, the Service finalized ESA Section 7 consultation for the Interim Guidelines due to impacts on the threatened and endangered species described in **Section 3.13.1**. This SEIS to the Interim Guidelines effectively requires reinitiation of the 2007 consultation and the 2005 MSCP consultation. The ESA Section 7 interagency consultations (16 USC 1531) were initiated with the Service in January 2023. They continued through a series of meetings and email exchanges, during which listed species were identified, actions and action areas were discussed, and conservation measures were developed. Two biological assessments were developed, one for the Lower Colorado River[2] in relation to the Multi-Species Conservation Program, and one for the Upper Colorado River[3] in relation to LTEMP. Consultation is ongoing with an anticipated finalization of two biological opinions in the spring 2024.

[2] From Lake Mead to the SIB
[3] Lake Powell, Glen Canyon Dam, and the Colorado River downstream to Lake Mead

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List of Preparers

The Draft SEIS was prepared by Reclamation with resource modeling and analysis support from the National Park Service, Northern Arizona University, US Geological Survey, and Western Area Power Administration. This is a list of preparers who developed significant background material and various sections or they participated, to a significant degree, in the preparation of this Draft SEIS.

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Meghan Thiemann	Administration Team - Co-Lead
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Stephanie Powers	Administration Team - Budget
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Alex Pivarnik	Hydrology and Modeling Team
Jessica Khaya	Hydrology and Modeling Team
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Name	Project Role
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Lawrence Marquez	NHPA and Tribal Consultation Team
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Michelle Helms	Communications and IT Team - Public Affairs
Jeremy Brooks	Contracting Officer's Representative
Troy Ethington	GIS Lead
Mike Bernardo	Lower Basin Operations
Lesli Kirsch	Economist

Partner Agencies

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Chip Lewis	BIA	NEPA/Biological Resources
Garry Cantley	BIA	Cultural Resources
Mary Barger	BIA	Cultural Resources
Ray Roessel	BIA	Hydrology
Brett Meldrum	NPS	Socioeconomics and Recreation
Lisa Devore	NPS	Air Quality
Lynne Koontz	NPS	Socioeconomics and Recreation
Melissa Trammell	NPS	Fish
Rob Billerbeck	NPS	Recreation, Socioeconomics, Natural and Cultural Resources
Paul Larson	NPS - CLNP	GCNRA Recreation (Upstream)
Steve Young	NPS - CLNP	GCNRA Recreation (Upstream)
Brandon Holton	NPS - GCNP	Threatened and endangered birds and other wildlife
Elyssa Shalla	NPS - GCNP	Recreation and Socioeconomics
Emily Omana	NPS - GCNP	Fish
Greg Holmes	NPS - GCNP	Threatened and endangered birds and other wildlife
Jan Balsom	NPS - GCNP	Recreation
Jen Dierker	NPS - GCNP	Cultural resources
Michael Kearsley	NPS - GCNP	Recreation
Miranda Terwillinger	NPS - GCNP	Threatened and endangered birds and other wildlife
Amy Schott	NPS - GCNRA	Cultural Resources
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Heidie Grigg	NPS - GCNRA	Recreation and Socioeconomics
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Name	Agency	Role
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Chris Nycz	NPS - LMNRA	Cultural Resources
Bradley Butterfield	Northern Arizona University	Riparian vegetation modeling
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Dan Leavitt	Service	Fish and wildlife
Jeff Servoss	Service	Fish and wildlife
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Julie Crawford	Service	Fish and wildlife
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Melissa Mata	Service	Fish and wildlife
Nichole Engelmann	Service	Fish and wildlife
Rebecca Chester	Service	Fish and wildlife
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Bridget Deemer	USGS Grand Canyon Monitoring and Research Center	Water quality modeling
Bryce Mihalevich	USGS Grand Canyon Monitoring and Research Center	Water quality modeling
Charles Yackulic	USGS Grand Canyon Monitoring and Research Center	Fisheries modeling
Drew Eppehimer	USGS Grand Canyon Monitoring and Research Center	Fisheries modeling
Emily Palmquist	USGS Grand Canyon Monitoring and Research Center	Riparian vegetation modeling
Gerard Salter	USGS Grand Canyon Monitoring and Research Center	Sediment modeling
Joel Sankey	USGS Grand Canyon Monitoring and Research Center	Cultural (sediment) modeling
Lucas Bair	USGS Grand Canyon Monitoring and Research Center	Recreation impact modeling
Adrian Cortez	USIBWC	International considerations
Jennifer Peña	USIBWC	International considerations
Sally Spener	USIBWC	International considerations
Clayton Palmer	WAPA	Upper Basin hydroelectric generation and economic modeling
Jerry Wilhite	WAPA	Upper Basin hydroelectric generation and economic modeling
John Paulsen	WAPA	Lower Basin economic modeling
Xavier Gonzalez	WAPA	Lower Basin hydroelectric generation modeling

Contractor Technical Team and Support Staff

Name	Education	Experience (years)	Project Role
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Amy Lewis	MS, Environmental Science	26	NEPA Specialist
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Bronson Pace	Ph.D., Water Resources: Law, Management, and Policy	3	Information Manager/ Bibliography Lead
Camila Reiswig	MS, Agriculture and Applied Economics	10	Agricultural and Energy Economics
Chelsea Ontiveros	MS, Geographic Information Systems Technology	2	GIS
David Batts	MS, Natural Resource Management	30	Project Manager
David Scott	BS, Environmental Science,	5	Hydrology Lead/Hydropower
Jessie Olson	MLA, Environmental Planning	20	Technical Review
Katie Patterson	JD, Environmental Law	12	Deputy Project Manager
Kevin Doyle	BA, Sociology	37	NEPA Lead
Kirsten Davis	BS, Environmental Science	4	Transportation
Marcia Rickey, GISP	MS, Biology	21	GIS Lead
Megan Stone	BA, Environmental Studies	5	Environmental Justice
Noelle Crowley	MENV, Sustainability Planning and Management	4	Recreation
Shine Roshan	MS, Physics	4	Socioeconomics
Eduardo Sanchez Jr.	MNRS, Ecological Restoration	3	Technical Review
Valerie Stanson	MPH, Environmental Health	3	Water Resources
Zoe Ghali	MS, Integrative Physiology	14	Socioeconomics/ Environmental Justice Lead
Subcontractor - SWCA			
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Adrienne Tremblay	Ph.D., Anthropology	17	Cultural Resources
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Kevin Rauhe	BLA, Landscape Architecture	10	Visual Resources
Mary Anne McLeod	MS, Wildlife Conservation	30	Section 7/Avian Species

Name	Education	Experience (years)	Project Role
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Stephanie Graham	MS, Wildlife Biology	17	Section 7/Biological Assessment Lead
Stephanie Trapp	MS, Wildlife Science	7	Wildlife/Special Status Species
Stephen Zipper	MS, Natural Resources	13	Fisheries
Suzanne Griset	Ph.D., Anthropology	44	Section 106 Tribal Coordination Support
Subcontractor – Hazen and Sawyer			
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Diane Roher, PE	MS, Environmental Engineering	6	Hydrology/Water Deliveries
Elizabeth Crafton	Ph.D., Civil Engineering	9	Hydrology/Water Quality
Greg Gates, PE	MS, Environmental Health Engineering	30	Expert Scientist/Engineer
Luke Wang, PE	MS, Earth and Environmental Engineering	12	Database Manager
Melissa Estep	MS, Civil Engineering	11	Hydrology/Water Deliveries
Other Subcontractors			
Jeff Lukas	MS, Forestry	25	Climate Change
Robert Thomson	MS, Ecology	45	Senior NEPA Advisor
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Glossary

acre-foot (af)—Volume of water (43,560 cubic feet) that would cover 1 acre to a depth of 1 foot.

adaptive management—A method for examining alternative strategies for meeting measurable biological goals and objectives, and then, if necessary, adjusting future conservation management actions according to what is learned.

affected environment—Existing biological, physical, social, and economic conditions of an area that are subject to change, both directly and indirectly, as the result of a proposed human action.

algae—Simple plants containing chlorophyll; most live submerged in water.

allocation, allotment—Refers to a distribution of water through which specific persons or legal entities are assigned individual rights to consume pro rata shares of a specific quantity of water under legal entitlements. For example, a specific quantity of Colorado River water is distributed for use within each Lower Division State through an apportionment. Water available for consumptive use in that state is further distributed among water users in that state through the allocation. An allocation does not establish an entitlement; the entitlement is normally established by a written contract with the United States government. *See also* Lower Division States.

alluvium—Sedimentary material transported and deposited by the action of flowing water.

ambient—Surrounding natural conditions (or environment) in a given place and time.

amphibian—A vertebrate animal that has a life stage in water and a life stage on land. (Examples include salamanders, frogs, and toads.)

annual flow-weighted average concentration—A weighted average of monthly total dissolved solids (TDS) concentrations for a year, where the weight for each month is based on the relative flow for each month.

Annual Operating Plan for Colorado River Reservoirs (AOP)—A document describing how Reclamation will manage Colorado River resources over a 12-month period, consistent with the Long-Range Operating Criteria and the *Arizona v. California* 1964 Supreme Court Decree. The AOP is prepared annually by Reclamation in cooperation with the Basin States, Mexico, appropriate federal agencies, Indian Tribes, state and local agencies, and the general public, including governmental interests, as required by federal law. As part of the AOP process, the Secretary of the Department of the Interior (Secretary) makes annual determinations regarding the availability of Colorado River water for deliveries to the Lower Division States of the Colorado River Basin. *See also* Lower Division States.

apportionment—Refers to the distribution of water available to each Lower Division State in Normal, Surplus or Shortage condition years, as set forth, respectively, in Articles II(B)(1), II(B)(2), and II(B)(3) of the 1964 Supreme Court Decree in the case of *Arizona v. California.*

appropriative rights—The right to divert a specified quantity of water at a specified point of diversion for reasonable and beneficial uses at a specified place of use for a specified manner of use. Appropriative rights are generally "first-in-time, first-in-right"(that is, one appropriative right has priority over appropriative rights established later).

backwater—A relatively small, generally shallow area of a river with little or no current.

banked groundwater—Water that has been stored temporarily in a groundwater aquifer. Banked groundwater can be recovered for use at a later time.

base load—Minimum load in a power system over a given period of time.

Basin States—In accordance with the Colorado River Compact of 1922, the Colorado River Basin within the United States consists of those parts of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming within and from which waters drain naturally into the Colorado River. These seven states are referred to as the Basin States. *See also* Colorado River Compact of 1922.

biological assessment (BA)—A document identifying the likely effects of a proposed federal action on threatened and endangered species. To facilitate compliance with Section 7(a)(2) of the Endangered Species Act (ESA), federal agencies must prepare a BA pursuant to Section 7(c)(1) of the ESA. *See also* Endangered Species Act.

biological opinion (BO)—A document stating the opinion of the United States Fish and Wildlife Service (Service) and/or the National Marine Fisheries Service as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

bypass flows—Saline agricultural return flows from the Wellton-Mohawk Irrigation and Drainage District that are routed to the Cienega de Santa Clara in Mexico to ensure compliance with the salinity provisions of Minute 242 of the 1944 Water Treaty.

bypass tubes—Another term for river outlet works.

candidate species—A plant or animal species that is not yet officially listed as threatened or endangered under the ESA but is undergoing status review by the Service.

capacity—The maximum amount of energy that can be instantaneously produced.

catch—At a recreational fishery, refers to the number of fish captured, whether they are kept or released.

channel (watercourse)—An open conduit either naturally or artificially created that periodically or continuously contains moving water, or that forms a connecting link between two bodies of water.

Some terms used to describe natural channels are river, creek, run, branch, and tributary. Natural channels may be single or braided. Two terms used to describe artificial channels are canal and floodway.

Cladophora—Filamentous green alga important to the food chain in the Colorado River downstream of Glen Canyon Dam.

Colorado River Basin (Basin)—The drainage area of the Colorado River system. The Basin occupies an area of approximately 250,000 square miles in the southwestern United States and 3,500 square miles in northwestern Mexico. The Colorado River Compact of 1922 divided the Colorado River system into two subbasins: the Upper Basin and the Lower Basin. It also divided the seven states within the Basin into the Upper Division and the Lower Division. Upper Division States include Colorado, New Mexico, Utah, and Wyoming; Lower Division States include Arizona, California, and Nevada. Additionally, 30 federally recognized Tribes are in the Basin.

Colorado River Basin Project Act of 1968 (CRBPA)—An act authorizing construction of a number of water development projects, including the Central Arizona Project (CAP), and requiring the Secretary to develop the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs, or Long-Range Operating Criteria (LROC).

Colorado River Basin Salinity Control Forum—The organization dedicated to controlling Colorado River salinity; it consists of representatives of the seven Basin States.

Colorado River Compact of 1922—The agreement concerning the apportionment of the use of the waters of the Colorado River Basin, dated November 24, 1922, and executed by commissioners for Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. It was approved and proclaimed effective by Herbert Hoover, the president of the United States, and representative of the United States for purposes of the Compact, on June 25, 1929.

Colorado River Simulation System (CRSS)—An operational model of the Colorado River Basin based on a monthly time step.

Colorado River system—The portion of the Colorado River and its tributaries within the United States as defined in the Colorado River Compact of 1922.

compact—The Colorado River Compact of 1922.

compact point—The reference point designated by the Colorado River Compact of 1922 as dividing the Colorado River Basin into two subbasins, the Upper Basin and the Lower Basin. The compact point is Lee Ferry, Arizona. *See also* Lee Ferry Compact Point.

conductivity—A measure of water's ability to pass an electrical current.

Consolidated Decree—A decree entered by the United States Supreme Court on March 27, 2006, in the case of *Arizona v. California,* 547 US 150 (2006), incorporating all applicable provisions of the earlier-issued decisions and decrees in the matter. The Supreme Court reached a decision in the case of *Arizona v. California* in 1963 and implemented this decision in a 1964 decree, which was supplemented over time after its adoption.

consumptive use—For purposes of this supplemental environmental impact statement (SEIS), diversions of water from mainstream Colorado River, including water withdrawn from the mainstream through underground pumping, minus any measured and unmeasured return flows.

contractors—Those who hold entitlements to Colorado River water. Contractors consist of the federal government, states, Indian Tribes, and various public and private entities that are recognized under the Consolidated Decree, hold a Section 5 Contract with the Secretary, or have a Secretarial Reservation of water. *See also* Consolidated Decree.

conveyance loss—Water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. If the water is lost due to leakage, it may be considered return flow if it percolates to an aquifer and is available for reuse. If the water evaporates, it is considered consumptive use.

cooperating agency—With respect to the National Environmental Policy Act of 1969, as amended (NEPA) process, an agency that has jurisdiction by law or special expertise concerning an aspect of a proposed federal action and that is requested by the lead agency to participate in the preparation of an environmental impact statement (EIS).

covered species—Those species addressed in the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) for which conservation measures would be implemented and for which authorization for "take" is being requested under Section 10 of the ESA. *See also* take.

criteria—Standards used for making a determination.

critical habitat—Specific areas with physical or biological features essential to the conservation of a listed species and that may require special management considerations or protection. These areas have been legally designated via *Federal Register* notices.

cubic foot per second (cfs)—A measure of water flow equal to 1 cubic foot of water passing a point on the stream in 1 second of time.

cultural resource—A building, site, district, structure, or object significant in history, architecture, archaeology, culture, or science.

dead pool—Elevation at which water cannot be regularly released from a reservoir, which would effectively preclude Colorado River diversions to downstream users.

dead storage—Reservoir space from which stored water cannot be evacuated by gravity.

delta sediment—Deposit formed at the mouth of the Colorado River and other rivers where they enter Lake Powell, Lake Mead, or the Gulf of California.

depletion—Loss of water from a stream, river, or basin resulting from consumptive use.

deposition—Settlement of material out of the water column and on to the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

discharge (flow)—Volume of water that passes a given point within a given period of time; expressed in this SEIS in cubic feet per second (cfs). *See also* cubic foot per second.

dissolved oxygen (DO)—Amount of free oxygen found in water; perhaps the most commonly employed measurement of water quality. Low DO levels adversely affect fish and other aquatic life. The ideal dissolved oxygen for fish life is between 7 milligrams per liter (mg/L) and 9 mg/L; most fish cannot survive when DO falls below 3 mg/L.

diversion(s)—Colorado River water withdrawn from the mainstream, including water diverted from reservoirs or drawn from the mainstream by underground pumping.

domestic use—Refers to the use of water for household, stock, municipal, mining, milling, industrial, and other like purposes; excludes the generation of electrical power.

draw down—Lowering of a reservoir's elevation; process of depleting a reservoir or groundwater storage.

ecosystem—Complex system composed of a community of fauna and flora and that system's chemical and physical environments.

electric power system—Physically connected facilities for electricity generation, transmission, and distribution that are operated as a unit under one control.

electrical demand—Energy requirement placed upon a utility's generation at a given instant or averaged over any designated period of time.

endangered species—A species or subspecies whose survival is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA)—The Endangered Species Act (ESA) of 1973 (16 USC 1531–1544), as amended; under Section 9, it provides for the prohibition of "take" of any fish or wildlife species listed as threatened or endangered under the ESA unless specifically authorized by regulation. *See also* take.

energy—What is produced by power plants; measured in kilowatt hours.

entitlement—Refers to an authorization to beneficially consume Colorado River water pursuant to a decreed right; a contract with the United States through the Secretary or a Secretarial Reservation of water.

epilimnion—Thermal layering of water in lakes and streams. *See also* stratification.

firm energy or power—Non-interruptible energy or power guaranteed by the supplier to be available at all times except for reasons of uncontrollable forces or "continuity of service" contract provisions.

flood—An overflow or inundation that comes from a river or other body of water, and causes or threatens damage. Any relatively high streamflow overtopping the natural or artificial banks in any reach of a river or stream. A relatively high flow as measured by either gage height or discharge quantity.

flood control pool—Reservoir volume above the active conservation and joint-use pool that is reserved for flood runoff and then evacuated as soon as possible to keep that space ready for the next flood.

flood control release—The release of water from Lake Mead and the operation of Hoover Dam for flood control purposes pursuant to the reservoir operating criteria specified in the February 8, 1984, Field Working Agreement between the United States Army Corps of Engineers (USACE) and the Bureau of Reclamation (Reclamation), and the USACE regulations contained in 33 Code of *Federal Regulations* (CFR) 208.11.

flow—Volume of water passing a given point per unit of time expressed in cubic foot per second. *See also* cubic foot per second.

forage fish—Generally, small fish that reproduce prolifically and are consumed by predators.

fore bay—Impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of-river, and pumped storage).

fry—Life stage of fish between the egg and fingerling stages.

full pool—Volume of water in a reservoir at maximum design elevation.

gaging station—Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.

gigawatt-hour (GWh)—One billion watt-hours of electrical energy.

headwater—The source and upper part of a stream.

historic property—Any district, site, building, structure, or object listed on or eligible for listing on the National Register of Historic Places (36 CFR 800.16(l)(1)).

hydropower—The use of water to produce electricity.

hypolimnetic zone—The deep portion of a lake or reservoir volume generally classified as below the level of the thermocline.

hypolimnion—Thermal layering of water in lakes and streams; the lower stratum of the water column of a reservoir. This layer is generally undisturbed, and respiration and decomposition predominate. *Also see* stratification.

important farmlands—Prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance, as defined by the United States Department of Agriculture Natural Resources Conservation Service (formerly the Soil Conservation Service). The categorization of farmland is based on a soil classification system that accounts for the physical and chemical characteristics of the land and the suitability of the land for producing crops. Important farmlands are afforded special protection due to their importance to agricultural production.

impoundment—Body of water created by a dam.

in situ—In archaeology, and as used in this SEIS, an artifact that has not been moved from its original place of deposit.

incidental take—Defined under the ESA as take that is “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity” (50 CFR 17.22 and 17.32). *See also* take.

Indian trust assets (ITAs)—“legal interests” in “assets” held in “trust” by the federal government for federally recognized Indian Tribes or individual Indians.

inflow—Water flowing into a lake or reservoir from a river and/or its tributaries, or water entering a river from tributaries.

irrigated area—The gross farm area upon which water is artificially applied for the production of crops, with no reduction for access roads, canals, or farm buildings.

irrigation—The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.

juvenile—Young fish older than 1 year but not having reached reproductive age.

kilowatt-hour (kWh)—One thousand watt-hours of electrical energy.

land cover type—A classification system to describe vegetation and other habitat types (such as cottonwood willow, honey mesquite, and marsh).

landscape character—Overall visual appearance of a given landscape based on the form, line, color, and texture associated with the landscape’s vegetation, landforms/water, and human-made modifications. These factors give the area a distinctive quality that distinguishes it from its immediate surroundings.

Las Vegas Valley—The topographic basin containing the city of Las Vegas, the city of North Las Vegas, the city of Henderson, and certain unincorporated townships of Clark County.

Las Vegas Wash—The natural drainage channel for the entire Las Vegas Valley. It is dominated by wastewater flows from the city of Las Vegas, Clark County Sanitation District, and city of Henderson wastewater treatment plants. It terminates in the Las Vegas Bay of Lake Mead.

Law of the River—As applied to the Colorado River, a body of documents the Secretary uses to carry out the responsibility to manage the mainstream waters of the Lower Basin pursuant to applicable federal law. The Secretary is vested with this responsibility. This collective set of documents comprising numerous operating criteria, regulations, and administrative decisions included in federal and state statues, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary apportions the Colorado River waters and regulates the use and management of the Colorado River among the seven Basin States and Mexico.

lead agency—An agency initiating and overseeing the preparation of an EIS. For this SEIS, Reclamation is the lead agency for compliance with NEPA.

Lee Ferry Compact Point—Identified the reference point that marks the division between the two subbasins—the Upper Basin and the Lower Basin—created by the division of the Colorado River Basin in the Colorado River Compact of 1922. This reference point is in the mainstream Colorado River in Arizona, 1 mile below the confluence of the Colorado River with the Paria River.

Lees Ferry Gaging Station—The site of the United States Geological Survey (USGS) stream gage (Lees Ferry Gaging Station) in Arizona on the Colorado River upstream of its confluence with the Paria River, downstream of Glen Canyon Dam. Also, the location of Colorado River ferry crossings (1873 to 1928).

limnology—Scientific study of physical characteristics and the biology of lakes, ponds, and streams.

load—Amount of electrical power or energy delivered or required at a given point.

Lower Basin (States)—Those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters drain naturally into the Colorado River below the Lee Ferry Compact Point in Arizona. The Colorado River Compact of 1922 divided the Colorado River system into two subbasins: the Upper Basin and the Lower Basin. *See also* Lee Ferry Compact Point.

Lower Division (States)—Arizona, Nevada, and California. The Colorado River Compact of 1922 divided the seven Colorado River Basin states into two groups: Upper Division States and Lower Division States. The Lower Division States are Arizona, Nevada, and California. *See also* Basin States.

magnitude—A number characteristic of a quantity and forming a basis for comparison with similar quantities, such as flows.

mean monthly flow—Average flow for the month, usually expressed in cubic feet per second.

mean sea level (msl)—The average height of the surface of the oceans and seas measured throughout all stages of the tidal cycle, determined from hourly readings of tidal height, and computed over a long (usually 19-year) period. It is used as a datum plane (that is, it serves as the reference surface from which elevations and depths are measured).

median—Middle value in a distribution, above and below which lie an equal number of values.

megawatt (MW)—One million watts of electrical power (capacity).

megawatt-hour (MWh)—One million watt-hours of electrical energy.

Mesozoic era—The second-to-last era of earth's geological history, lasting from about 252 to 66 million years ago, comprising the Triassic, Jurassic, and Cretaceous periods.

metalimnion—Thermal layering of water in lakes and streams. *See also* stratification.

milligram per liter (mg/L)—Equivalent to one part per million.

National Environmental Policy Act of 1969, as amended (NEPA)—Law requiring federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an environmental impact statement, or EIS.

National Register of Historic Places (NRHP)—The Nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the NRHP is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archaeological resources. Properties listed on the NRHP include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture.

natural flow—The flow of any stream un-depleted by human activities.

non-system water—Waters originating from outside the Colorado River system.

normal condition—When the Secretary has determined that there is available for annual release 7.5 million acre-feet (maf) to satisfy consumptive use in the Lower Division States pursuant to Article II(B)(1) of the Consolidated Decree.

oligotrophic—A body of water characterized by low dissolved plant nutrient and organic matter, and rich in oxygen at all depths.

Paleontological resources—Any fossilized remains, traces, or imprints of organisms preserved in or on the earth's crust.

Paleozoic era (541–252 million years ago)—Means ancient life. The oldest animals on earth appeared just before the start of this era.

Pangea—A supercontinent that existed from about 300 to 200 million years ago and included most of the continental crust of the earth.

peak flow—Maximum instantaneous flow in a specified period of time.

peak load—Maximum electrical demand in a stated period of time.

penstock—Conduit pipe used to convey water from the reservoir through the dam under pressure to the turbines of a hydroelectric plant.

percentile—A statistical term. A descriptive measure that splits ranked data into 100 parts, or hundredths. For example, the 10th percentile is the value that splits the data in such a way that 10 percent of the values are less than or equal to the 10th percentile.

piscivorous—Habitually feeding on fish.

PM_{10} (PM10)—Particulate matter (PM) (dust particles) standard that includes particles with a diameter of 10 micrometers or less.

power—Electrical capacity generated, transferred, or used.

Present Perfected Right (PPR)—Many Colorado River water rights that originated as "perfected rights" specified in the 1964 United States Supreme Court Decree in the case of *Arizona v. California.* PPRs are the highest-priority Colorado River water rights that the 1964 Decree defines as those perfected rights existing on June 25, 1929 (the effective date of the Boulder Canyon Project Act of 1928).

priority—A ranking with respect to diversions of water relative to other water users.

probability—In this SEIS, the relative frequency with which a range of modeled values occurs. For example, the probability of Lake Mead's elevation exceeding 1,180 feet msl in June 2005 is equal to the number of modeled elevations greater than 1,180 feet msl in June 2005, divided by the total number of modeled elevations in June 2005.

public involvement—Process of obtaining citizen input into each stage of development of planning documents. Required as a major input into any EIS.

Quaternary period—A geologic time period that encompasses the most recent 2.6 million years, including the present day.

ramp rate—The rate of change in instantaneous output from a powerplant. The ramp rate is established to prevent undesirable effects due to rapid changes in loading or, in the case of hydroelectric plants, discharge.

rated head—Water depth for which a hydroelectric generator and turbines were designed.

reach—A specified segment of a river, stream, channel, or other water conveyance facility.

recruitment—Survival of young plants and animals from birth to a life stage less vulnerable to environmental change.

reregulating reservoir—A reservoir for reducing diurnal fluctuations resulting from the operation of an upstream reservoir for power production.

resampling—The digital process of changing the sample rate or dimensions of sampled data (for example, digital imagery or audio) by temporarily or areally analyzing and sampling the original data.

reserved water—In the case of Indian reservations, rights based on the doctrine of Indian reserved rights; in the case of federal establishments other than Indian reservations, a federal reservation of water for use on property under federal jurisdiction.

reservoir—A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

return flow—The portion of water previously diverted from a river or stream and subsequently returned to that river or stream; it is available for consumptive use by others.

return flow credit—In the accounting of consumptive use in the Lower Basin, Colorado River water that is returned to the river and is available for consumptive use by others in the year in which it was diverted is credited against a water user's total diversions.

riffle—A stretch of choppy water caused by an underlying rock shoal or sandbar.

riparian—Of, on, or pertaining to the bank of a river, pond, or lake.

river mile (RM)—Numbered along the Colorado River from south to north starting with RM 0.0 at the Southerly International Boundary (SIB) with Mexico. Dam locations are noted at their respective river miles.

river outlet works—Dam structures that conduct water from the reservoir to the river without passing through a powerplant; also referred to as jet tubes, bypass tubes, or outlet works.

river stage—Water surface elevation of a river above a datum.

RiverWare™—A commercial river system simulation computer program that was configured to simulate operation of the Colorado River for this SEIS.

runoff—That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of humans in or on the stream channels.

sacred site—A specific location identified by a Native American Tribe as sacred for its religious significance to, or ceremonial use by, a Native American religion.

salinity—A term used to refer to the dissolved minerals in water; also referred to as total dissolved solids (TDS). *See also* total dissolved solids.

sandbar—A long, narrow deposition of sediment within a river.

Secretary—The Secretary of the Department of the Interior, and duly appointed successors, representatives, and others with properly delegated authority.

Section 10(a)(1)(B) permit—The section of the ESA that authorizes the Service to issue nonfederal entities a permit for the incidental take of endangered and threatened wildlife species. This permit allows the nonfederal entity to proceed with an activity that is legal in all other respects, but that results in the "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." *See also* take.

sediment—Unconsolidated solid material that comes from weathering of rock and is carried by, suspended in, or deposited by water or wind.

sediment load—Mass of sediment passing through a stream.

seepage—Relatively slow movement of water through a medium, such as sand.

SEIS conservation— Part of the specific proposal submitted by the Lower Basin states in the Proposed Action. It has a specific amount as part of that action – 3.0 maf of SEIS conservation by the end of 2026, with at least 1.5 maf of that conserved in 2023 and 2024.

shortage condition—When the Secretary has determined that there is available for annual release less than 7.5 maf to satisfy consumptive use in the Lower Division States pursuant to Article II(B)(3) of the Consolidated Decree.

spawn—To lay eggs, especially fish.

spills—Water releases from a dam in excess of powerplant capacity.

spillway—Overflow facility at a dam, usually consisting of a sill at the full-reservoir elevation.

spinning reserves—Available capacity of generating facilities synchronized to the interconnected electric system so that it can be called upon for immediate use in response to system problems or sudden load changes.

stage—Reservoir elevation.

standards—A means established by authority as a rule for the measure of quality, such as cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water.

storage—Water artificially impounded in surface or underground reservoirs for future use. Water naturally detained in a drainage basin, such as groundwater, channel storage, and depression storage. The term "drainage basin storage" or simply "basin storage" is sometimes used to refer collectively to the amount of water in natural storage in a drainage basin. *See also* conservation storage and dead storage.

stormwater—Consists of water that originates from precipitation, such as heavy rain or snow.

stratification—Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature: (1) epilimnion—top layer with essentially uniform warmer temperature, (2) metalimnion—middle layer of rapid temperature decrease with depth, and (3) hypolimnion—bottom layer with essentially uniform colder temperatures.

streamflow—The discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than runoff, as streamflow may be applied to discharge whether it is affected by diversion or regulation.

suspended load—Sediment that is supported by the upward components of turbulence in a stream and that stays in suspension for an appreciable length of time.

surplus condition—When the Secretary has determined that there is available for annual release more than 7.5 maf to satisfy consumptive use in the Lower Division States pursuant to Article II(B)(2) of the Consolidated Decree.

system conservation— a voluntary reduction of Consumptive Use of Colorado River water that can be estimated or measured.

system storage—The total volume of water available in the Colorado River Basin at a specific point in time.

system water—Waters originating from the Colorado River system.

tail water—Water immediately downstream of the outlet from a dam or hydroelectric powerplant where the water is more similar to that in the reservoir than farther downstream.

take—As defined by the ESA, a means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 United States Code 1531[18]).

thermocline—The zone of maximum change in temperature in a waterbody, separating upper (epilimnetic) from lower (hypolimnetic) zones.

threatened species—A species or subspecies that is likely to become endangered in the foreseeable future.

total dissolved solids (TDS)—Dissolved materials in the water, including ions such as potassium, sodium, chloride, carbonate, sulfate, calcium, and magnesium. In many instances, the term "TDS" is used to reflect salinity, since these ions are typically in the form of salts.

traces —Multiple time series of forecasted streamflow used in hydrological modeling. Multiple traces are sometimes referred to as an ensemble.

traditional cultural place—A type of historic property that is rooted in a community's history and important to that community's cultural identity.

tributary—River or stream flowing into a larger river or stream.

turbidity—Cloudiness of water, measured by how deeply light can penetrate into the water column from the surface.

turbine—A rotary mechanical device that uses water flow to turn and convert it into useful energy.

Upper Basin (States)—Those parts of the states of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters drain naturally into the Colorado River above the Lee Ferry Compact Point in Arizona. The Colorado River Compact of 1922 divided the Colorado River system into two subbasins: the Upper Basin and the Lower Basin. *See also* Lee Ferry Compact Point.

Upper Colorado River Commission—Commission established by the Upper Colorado River Compact of appointed members from the Upper Division States whose purpose is to secure the storage of water for beneficial consumptive use in the Upper Basin.

Upper Division (States)—Colorado, New Mexico, Utah, and Wyoming. The Colorado River Compact of 1922 divided the seven Colorado River Basin states into two groups: Upper Division States and Lower Division States. The Upper Division States are Colorado, New Mexico, Utah, and Wyoming. *See also* Basin States.

Visual resources—Physical features that make up the visible landscape (features such as land, water, vegetation, topography, and human-made features such as buildings, roads, utilities, and structures) as well as the response of viewers to those features.

Water Year—That period of 12 months ending September 30 of each year.

Waters of the United States—In accordance with the Clean Water Act, waters of the United States include (1) all waters that may be susceptible to use in interstate or foreign commerce; (2) all interstate waters, including interstate wetlands; (3) all other waters, such as intrastate lakes, rivers, streams (including intermittent streams), mud flats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce, including any such waters; (4) all impoundments of waters otherwise defined as waters of the United States; (5) tributaries of waters identified in this SEIS; (6) the territorial seas; and (7) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in this SEIS.

watershed—The drainage area upstream of a specified point on a stream.

Index

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Appendix A
Overview of Colorado River Operations

Appendix A. Overview of Colorado River Operations

A.1 Introduction

This appendix summarizes Colorado River operations, including the distribution of Colorado River water under the Law of the River, and the reservoirs and diversion facilities through which the water supply is administered.

A.2 Apportionment of Water Supply

This section summarizes the Law of the River, Colorado River apportionments of the Basin States, and the allotment to Mexico pursuant to the 1944 Water Treaty.

A.2.1 The Law of the River

The Secretary is vested with the responsibility to manage the mainstream waters of the Colorado River Basin pursuant to applicable federal law. This responsibility is carried out consistent with a body of documents commonly referred to as the Law of the River. The Law of the River comprises numerous operating criteria, regulations, and administrative decisions included in federal and state statutes, interstate compacts, court decisions and decrees, an international treaty, and contracts with the Secretary. Documents that are generally considered part of the Law of the River include, but are not limited to, those listed in **Table A-1**, below.

Table A-1
Selected Documents Included in the Law of the River

▪ The River and Harbor Act of March 3, 1899 ▪ The Reclamation Act of June 17, 1902 ▪ Reclamation of Indian Lands in Yuma, Colorado River and Pyramid Lake Indian Reservations Act of April 21, 1904 ▪ Yuma Project authorized by the Secretary of the Interior on May 10, 1904, pursuant to Section 4 of the Reclamation Act of June 17, 1902 ▪ Warren Act of February 21, 1910 ▪ Protection of Property Along the Colorado River Act of June 25, 1910 ▪ Patents and Water-Right Certificates Acts of August 9, 1912, and August 26, 1912	▪ The Colorado River Storage Project Act of April 11, 1956 ▪ The Water Supply Act of July 3, 1958 ▪ The Boulder City Act of September 2, 1958 ▪ Report of the Special Master, Simon H. Rifkind, *Arizona v. California*, et al., December 5, 1960 ▪ The Consolidated Decree entered by the United States Supreme Court in the case of *Arizona v. California*, 547 US 150 (2006) (Consolidated Decree) ▪ International Flood Control Measures, Lower Colorado River Act of August 10, 1964

Table A-1
Selected Documents Included in the Law of the River

- Yuma Auxiliary Project Act of January 25, 1917
- Availability of Money for Yuma Auxiliary Project Act of February 11, 1918
- Sale of Water for Miscellaneous Purposes Act of February 25, 1920
- Federal Power Act of June 10, 1920
- The Colorado River Compact of November 24, 1922
- The Colorado River Front Work and Levee System Acts of March 3, 1925, and January 21,1927–June 28, 1946
- The Boulder Canyon Project Act of December 21, 1928 (BCPA)
- The California Limitation Act of March 4, 1929
- The California Seven Party Agreement of August 18, 1931
- The Parker and Grand Coulee Dams Authorization of August 30, 1935
- The Parker Dam Power Project Appropriation Act of May 2, 1939
- The Reclamation Project Act of August 4, 1939
- The Boulder Canyon Project Adjustment Act of July 19, 1940
- The Flood Control Act of December 22, 1944
- Treaty between the United States and Mexico Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande of February 3, 1944 (1944 Water Treaty)
- Gila Project Act of July 30, 1947
- The Upper Colorado River Basin Compact of October 11, 1948
- The Consolidated Parker Dam Power Project and Davis Dam Project Act of May 28, 1954
- The Palo Verde Diversion Dam Act of August 31, 1954
- Change Boundaries, Yuma Auxiliary Project Act of February 15, 1956
- Southern Nevada (Robert B. Griffith) Water Project Act of October 22, 1965
- The Colorado River Basin Project Act of September 30, 1968
- Criteria for the Coordinated Long-Range Operation of Colorado River Reservoirs, June 8, 1970, amended March 21, 2005
- Supplemental Irrigation Facilities, Yuma Division Act of September 25, 1970
- 43 CFR 417, Lower Basin Water Conservation Measures, September 7, 1972
- Minute 218, March 22, 1965; Minute 241, July 14, 1972 (replaced Minute 218); Minute 242, August 30, 1973 (replaced Minute 241); Minute 306, December 12, 2000; Minute 317, June 27, 2010; and Minute 323, September 21, 2017, of the 1944 Water Treaty
- The Colorado River Basin Salinity Control Act of June 24, 1974
- The Hoover Power Plant Act of August 17, 1984
- Numerous Colorado River Water Delivery and Project Repayment Contracts with the States of Arizona and Nevada, cities, water districts, and individuals
- Hoover and Parker-Davis Power Marketing Contracts
- The Reclamation States Emergency Drought Relief Act of 1991
- The Grand Canyon Protection Act of October 30, 1992
- Operation of Glen Canyon Dam, Record of Decision (1996)
- Interim Surplus Guidelines Record of Decision, January 17, 2001 (66 *Federal Register* 7772)
- Interim 602(a) Storage Guideline, May 19, 2004 (69 *Federal Register* 28945)
- The Colorado River Water Delivery Agreement of October 10, 2003 (69 *Federal Register* 12202)
- Glen Canyon Dam Long-Term Experimental and Management Plan – Final EIS and ROD, December 2016 (Reclamation 2016)
- Colorado River Basin Drought Contingency Plans (Reclamation 2019)

Among other provisions of applicable federal law, NEPA and the ESA, as amended, provide a statutory overlay on certain actions taken by the Secretary. For example, as noted in **Chapter 1**, preparation of this SEIS has been undertaken pursuant to NEPA.

A.2.2 Apportionment to the Basin States

The initial apportionment of water from the Colorado River was determined as part of the Colorado River Compact (1922), which divided the Colorado River system into two subbasins, the Upper Basin and the Lower Basin, and divided the seven Basin States into Upper Division States and Lower Division States (**Map A-1**).

The compact apportioned to the Lower Basin and the Upper Basin, in perpetuity, the exclusive beneficial consumptive use of 7.5 maf of water per year. In addition to this apportionment, Article III(b) of the compact gives the Lower Basin the right to increase its beneficial consumptive use by 1.0 maf per year. The compact also stipulates in Article III(d) that the Upper Division States will not cause the flow of the river at the Lee Ferry Compact Point to be depleted below an aggregate of 75 maf for any period of 10 consecutive years.

The compact, in Article VII, states that nothing in the compact shall be construed as affecting the obligations of the United States to Indian Tribes. While the rights of most Indian Tribes to Colorado River water were subsequently adjudicated, some Tribal rights remain unadjudicated. To the extent that Indian Tribes consumptively use water from the Colorado River, such uses are included in the apportionment of the appropriate Basin State.

Upper Division State Apportionments. The Upper Colorado River Basin Compact of 1948 established the Upper Division State apportionments. These apportionments allocate the Upper Division States' consumptive use after deduction of up to 50,000 afy for Arizona as follows: Colorado, 51.75 percent; New Mexico, 11.25 percent; Utah, 23.00 percent; and Wyoming, 14.00 percent. The Upper Division State apportionments have not yet been fully developed.

Lower Division State Apportionments. Lower Division State apportionments were established by Congress in the BCPA and by the Secretary's water delivery contracts under the BCPA. These apportionments are Arizona (2.8 maf), California (4.4 maf), and Nevada (0.3 maf), totaling 7.5 maf, subject to annual increases or reductions pursuant to Secretarial determinations of a Surplus or a Shortage Condition. Under Article II(B)(2) of the Consolidated Decree, when the Secretary determines there is a Surplus Condition, 46 percent of the available water supply in excess of 7.5 maf may be apportioned for use in Arizona, 50 percent may be apportioned for use in California, and 4 percent may be apportioned for use in Nevada.

The Consolidated Decree confirms the apportionments to the Lower Division States established by the BCPA and guides the Secretary's operation of facilities, including Hoover Dam, on the lower Colorado River. If water apportioned for use in a Lower Division State is not consumed by that state in any year, the Secretary may release the unused water for use in another Lower Division State. Water that is stored off stream by a Lower Division State is accounted as consumptive use to the state that stored the water in the year it was stored.

All mainstream Colorado River waters apportioned to the Lower Basin, except for approximately 10,000 af remaining of Arizona's apportionment, have been fully allocated to specific entities and, except for certain federal establishments, placed under permanent water delivery contracts with the Secretary for irrigation or domestic use. Federal establishments with federal reserved rights established pursuant to Article II(D) of the Consolidated Decree are not required to have a contract with the Secretary; however, the water allocated to a federal establishment is included within the apportionment of the Lower Division State in which the federal establishment is located.

The highest-priority lower Colorado River water rights are PPRs, which the Consolidated Decree defines as those perfected rights existing on June 25, 1929, which is the BCPA's effective date. The Consolidated Decree also recognizes federal Indian reserved rights for the quantity of water necessary to irrigate all the practicably irrigable acreage on five Indian reservations along the lower Colorado River (the Chemehuevi Indian Tribe, Colorado River Indian Tribes, Fort Mojave Indian Tribe, Fort Yuma-Quechan Tribe, and Cocopah Indian Tribe). The Consolidated Decree defines the rights of Indian and other federal reservations to be federal establishment PPRs, and further prescribes a specific order in which federal establishment and other PPRs must be satisfied, generally by priority date without regard to state lines. In any year in which less than 7.5 maf of Colorado River water is available for consumptive use in the Lower Division States, PPRs will be satisfied first.

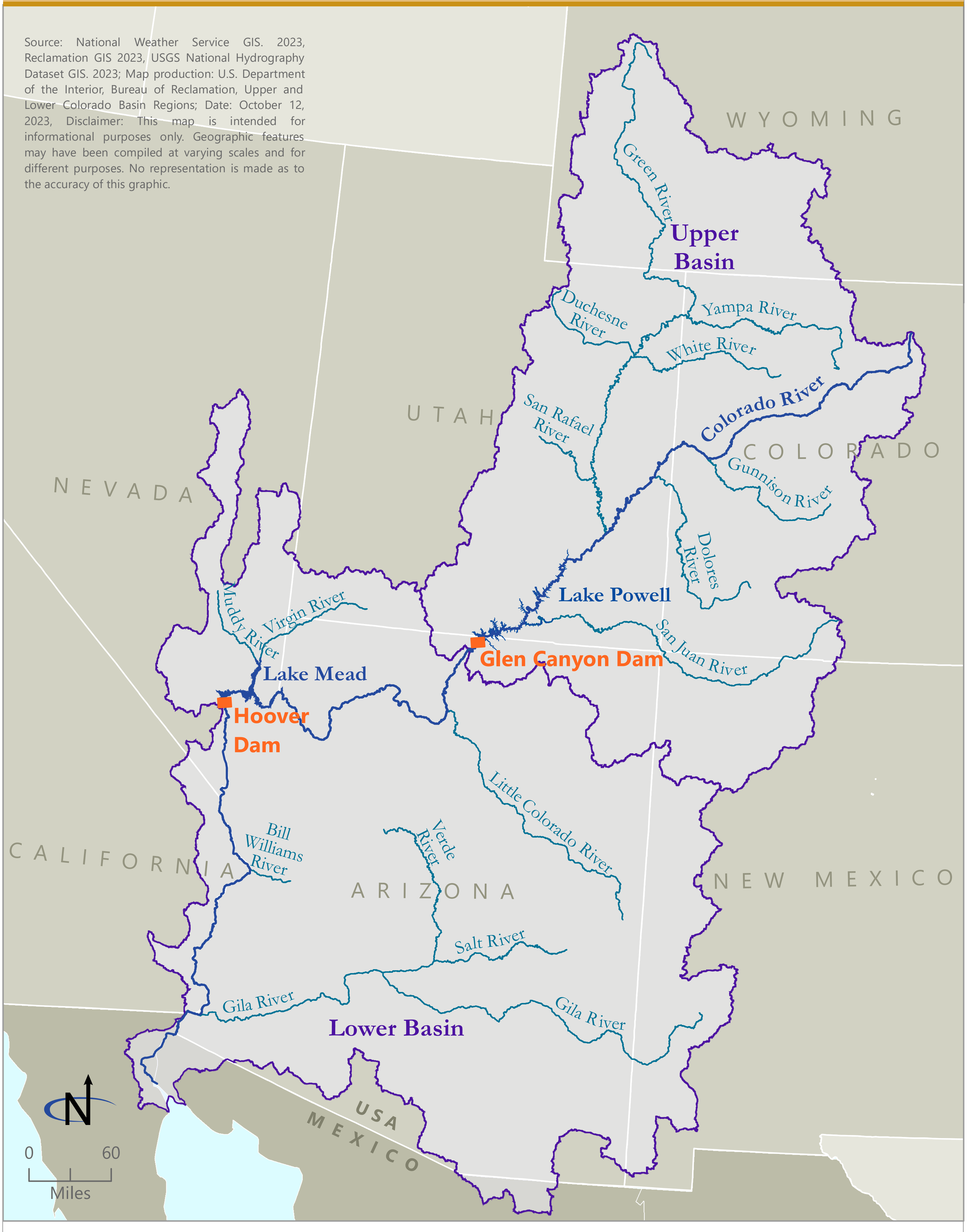
Waters available to a Lower Division State within its apportionment, but having a priority date later than June 25, 1929, have been allocated by the Secretary through execution of water delivery contracts to water users within that state, as required by Section 5 of the BCPA. The Lower Division States have separate intrastate priority systems in accordance with those contracts.

A.2.3 Allotment to Mexico (Pursuant to the 1944 Water Treaty)

Allocation of Colorado River water to Mexico is governed by the 1944 Water Treaty. To assess the potential effects of the alternatives in this SEIS, certain modeling assumptions (discussed in **Chapter 2**) are used that display projected water deliveries to Mexico. These assumptions include continued implementation of Minute 323 to the 1944 Water Treaty. Reclamation's modeling assumptions are not intended to constitute an interpretation or application of the 1944 Water Treaty or to represent current United States policy or a determination of future United States policy regarding deliveries to Mexico.

The United States will conduct all necessary and appropriate discussions regarding the Proposed Action and implementation of the 1944 Water Treaty with Mexico through the USIBWC in consultation with the Department of State.

BUREAU OF RECLAMATION



Map A-1
Upper and Lower Division States of the Colorado River

- Colorado River
- Colorado River tributary
- Dam
- Colorado River Basin, Upper and Lower Basins

States in the Colorado River Basin (Wyoming, Colorado, Utah, and New Mexico are Upper Division states, and Arizona, California, and Nevada are Lower Division states)

While portions of northwestern Mexico are part of the Basin, these areas are not within the geographic scope of analysis for this SEIS. This SEIS does not address water deliveries to Mexico.

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A.3 Water Operations

A.3.1 Lake Powell and Lake Mead and the Diversion Facilities

The Colorado River system contains numerous reservoirs that provide an aggregate of approximately 60 maf of storage. Of these reservoirs, Lake Powell and Lake Mead constitute approximately 83 percent of this storage; Lake Powell provides 23.3 maf of this storage, and Lake Mead can store up to 26.2 maf.

A.3.2 Hydropower Generation

Reclamation is authorized by legislation to produce electric power at both Glen Canyon Dam and Hoover Dam. While Reclamation is the federal agency authorized to produce power at the major Colorado River system dams, WAPA is the federal agency authorized to market and deliver this power. WAPA enters into electric service contracts on behalf of the United States with public and private utility systems for distribution of hydroelectric power produced at Reclamation facilities in excess of project demand.

A.3.3 Current Operational Guidelines

The following details the post-2007 Colorado River operational guidelines:

- Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead – Final EIS and ROD, November 2007 (Reclamation 2007)

  The 2007 Interim Guidelines are the specific interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim guidelines were intended to remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026. They also would provide guidance each year in development of the AOP. The 2007 Interim Guidelines considered four operational elements that collectively are designed to address the purpose and need for the proposed federal action. The 2007 Interim Guidelines were used by the Secretary to:

  - determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Lower Division States (Arizona, California, and Nevada) below 7.5 maf (a "Shortage") pursuant to Article II(B)(3) of the Consolidated Decree;
  - define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
  - allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and nonsystem water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and
  - determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division States.

- Glen Canyon Dam Long-Term Experimental and Management Plan – Final EIS and ROD, December 2016 (Reclamation 2016)

Reclamation and the NPS developed and implemented the LTEMP for operations of Glen Canyon Dam, the largest unit of the CRSP. The LTEMP provides a framework for adaptively managing Glen Canyon Dam's operations through 2036, consistent with the GCPA and other provisions of applicable federal law. The LTEMP determines the specific options for dam operations, non-flow actions, and appropriate experimental and management actions that meet the GCPA's requirements and minimize impacts on resources within the area affected by dam operations, commonly referred to as the Colorado River Ecosystem, including those of importance to American Indian Tribes.

- Colorado River Basin Drought Contingency Plans

  In 2019, the DCPs were signed pursuant to congressional direction provided in Public Law 116-14. The DCPs outline strategies to address the ongoing historic drought in the Colorado River Basin. The Upper Basin DCP is designed to reduce the risk of reaching critical elevations at Lake Powell and to help assure continued compliance with the 1922 Colorado River Compact.

  The DROA is one element of the Upper Basin DCP. The DROA identifies a process to temporarily move water stored in the CRSP Initial Units above Lake Powell—Blue Mesa Reservoir (a component of the Aspinall Unit), Flaming Gorge, and Navajo—to Lake Powell when Lake Powell is projected to approach elevation 3,525 feet, which was identified in the DROA as the target elevation. This elevation provides a 35-foot buffer above the minimum power pool of 3,490 feet. Maintaining an elevation above 3,525 feet will help ensure compliance with interstate water compact obligations, maintain the ability to generate hydropower at Glen Canyon Dam, and minimize adverse effects on resources and infrastructure in the Upper Basin.

  Pursuant to the DROA, Reclamation worked with the Upper Division States on a DROA in 2022 with the goal of implementing operational measures to augment water deliveries from the three upstream CRSP Initial Units (that is, Aspinall, Flaming George, and Navajo) to prop up Lake Powell. Reclamation continues to closely monitor hydrologic conditions and projections to identify appropriate upstream release volumes to maintain Lake Powell's water level above the target elevation.

Appendix B

Hydrology Analysis for the No Action Alternative, Action Alternatives 1 and 2, and the Proposed Action

Contents

Tables

Figures

Attachments

Appendix B. Hydrology Analysis for the No Action Alternative, Action Alternatives 1 and 2, and the Proposed Action

B.1 Introduction

Action Alternatives 1 and 2 were analyzed in the original Draft SEIS issued April 14, 2023, which modeled changes to operations for both Glen Canyon Dam and Hoover Dam as developed by Reclamation. As described in **Chapter 2**, Action Alternatives 1 and 2 were eliminated from detailed analysis in this revised Draft SEIS due to updated hydrology and the addition of the Proposed Action, which provides a similar risk reduction compared with Action Alternatives 1 and 2. This appendix provides a detailed hydrologic analysis of the No Action Alternative, Action Alternatives 1 and 2, and the Proposed Action; this analysis was used to inform Reclamation's decision to eliminate Action Alternatives 1 and 2 from detailed analysis.

Reclamation updated the modeling assumptions for Action Alternatives 1 and 2 since publication of the original Draft SEIS due to updated hydrology (see the **Dear Reader Letter)**; these assumptions are summarized in **Section B.2.1**. This analysis does not cover the breadth of resources or geographic locations included in **Chapter 3** of this revised Draft SEIS; instead, it focuses on higher-level comparisons with respect to hydrologic resources and water deliveries, which are the primary categories from which relative effects on other resources can be inferred.

B.2 Modeling Approach

This section summarizes the assumptions that Reclamation used in the hydrologic modeling and the metrics used to analyze the alternatives. Future Colorado River system conditions during the analysis period for all alternatives were simulated using the June 2023 CRMMS. Details on the modeling assumptions used for the comparative analysis are found in **Sections B.3.1, B.3.2**, and **B.3.3**. **Section B.3.4** summarizes the metrics used to compare the submitted alternatives.

B.2.1 Modeling Assumptions

The No Action Alternative and the Proposed Action are described in **Chapter 2** with detailed modeling assumptions in **Section 3.3.4** and **Appendix D,** CRMMS Model Documentation.

The following section summarizes the assumptions for Action Alternatives 1 and 2, which have been updated since the original Draft SEIS. In this revised Draft SEIS, no additional shortages are modeled in 2024, and shortages for Action Alternatives 1 and 2 are the same in 2025 and 2026, with a maximum total shortage of 2.083 maf. Additionally, no potential DROA contributions are modeled in this revised Draft SEIS. Assumptions common to all alternatives that were summarized in **Section 3.3.4** also apply to Action Alternatives 1 and 2.

The hydrologies used in this appendix are derived from the June 2023 Colorado Basin River Forecast Center's ESP Upper Basin forecast and associated Lower Basin intervening flows. Three sets of ESPs are used in the SEIS modeling:

- 100 percent ESP: There is no adjustment to the streamflow forecasts.
- 90 percent ESP: Streamflow forecasts are reduced by 10 percent.
- 80 percent ESP: Streamflow forecasts are reduced by 20 percent.

Detailed hydrologic inputs, initial conditions, and other modeling assumptions not described in the following sections are consistent with the assumptions included for the No Action Alternative and Proposed Action (see **Appendix D**).

Assumptions for Action Alternative 1

Assumptions for Action Alternative 1 are summarized below. Detailed modeling assumptions for CRMMS can be found in **Attachment B-1.**

- Only operational changes for Lake Powell and Lake Mead, as per Section 2.D, Section 6.C, and Section 6.D of the 2007 Interim Guidelines, were considered; otherwise, operations for Lake Powell and Lake Mead are consistent with operations under the No Action Alternative.
- The Mid-Elevation Release Tier and Lower Elevation Balancing Tier in Lake Powell are replaced with the Lower Elevation Release Tier in operating years 2025 and 2026.
- The new Lower Elevation Release Tier in Lake Powell is operational if the elevation in Lake Powell at the end of the year is below 3,575 feet. Releases will be between 6.0 and 8.23 maf depending on the elevation of Lake Powell and the hydrology. Releases may be further reduced to prevent Lake Powell from dropping below 3,500 feet.
- Deliveries to the Lower Division States during Shortage Condition Years 2025 and 2026 (up to 2.083 maf) are described in **Section B.2.3**.
- Shortage reductions in excess of the 2007 ROD shortages and 2019 DCP contributions are distributed to the Lower Basin based on priority.
- DCP contributions and ICS assumptions are consistent with the official June 2023 CRMMS simulation.
- System conservation volumes in 2023 and 2024 are consistent with the official June 2023 CRMMS simulation. In 2025 and 2026, system conservation volumes are set to zero.

Assumptions for Action Alternative 2

Assumptions for Action Alternative 2 are summarized below. Detailed modeling assumptions for CRMMS can be found in **Attachment B-1.**

- Only operational changes for Lake Powell and Lake Mead, as per Section 2.D, Section 6.C, and Section 6.D of the 2007 Interim Guidelines, were considered; otherwise, operations for Lake Powell and Lake Mead are consistent with operations under the No Action Alternative.

- The Mid-Elevation Release Tier and Lower Elevation Balancing Tier in Lake Powell are replaced with the Lower Elevation Release Tier, which is operated the same way as in Action Alternative 1.
- Deliveries to the Lower Division States during Shortage Condition Years 2025 and 2026 (up to 2.083 maf) are described in **Section B.2.3**.
- Shortage reductions in excess of the 2007 ROD shortages and 2019 DCP contributions are distributed in the same percentage across all Lower Basin water users at the specified Lake Mead elevations. The distribution of reductions is based on each user's consumptively used water in 2021.
- DCP contributions and ICS assumptions are consistent with the official June 2023 CRMMS simulation.
- System conservation volumes in 2023 and 2024 are consistent with the official June 2023 CRMMS simulation. In 2025 and 2026, system conservation volumes are set to zero.

B.2.2 Coordinated Reservoir Operations

Under Action Alternatives 1 and 2, the annual Lake Powell release is based on the volume of water in storage or the corresponding elevation of Lake Powell and Lake Mead, as described in the Operational Tiers below (see **Table B-1**). The Equalization and Upper Elevation Balancing Tiers are the same as under the No Action Alternative. In operating years 2025 and 2026, the Mid-Elevation Release Tier and Lower Elevation Balancing Tier are combined into a single Lower Elevation Release Tier, and a protection level is also included. The applicable Operational Tier is based on the August 24-Month Study projections of the January 1 system storage and reservoir water surface elevations for the following operating year.

Hourly, daily, and monthly releases from Lake Powell for coordinated operations would be consistent with the parameters of the ROD for the LTEMP FEIS (Reclamation and NPS 2016). Monthly releases from Glen Canyon Dam would be distributed proportionally across months for annual releases below 7.0 maf (see **Figure B-1** for monthly distributions in a year when the annual release is 8.23 maf). If annual flows were adjusted mid-year, they would be distributed to meet the goals of LTEMP, including the potential distribution across monthly or experimental flow patterns, and including the unique resource considerations specific to any mid-year annual adjustments.

Hourly and daily releases would follow LTEMP parameters, so long as sufficient water is available from the annual release. If sufficient water is not available from the annual release to meet hourly and daily LTEMP release parameters, hourly and daily releases would follow the base operation daily and nightly minimum flows (8,000 cfs and 5,000 cfs, respectively), for as long as possible. If sufficient water is not available from the annual release to support the base operation nightly minimum flow of 5,000 cfs, hourly and daily releases would be consistent with the run of the river[1] to match Lake Powell inflows consistent with protecting an elevation of 3,500 feet at Lake Powell.

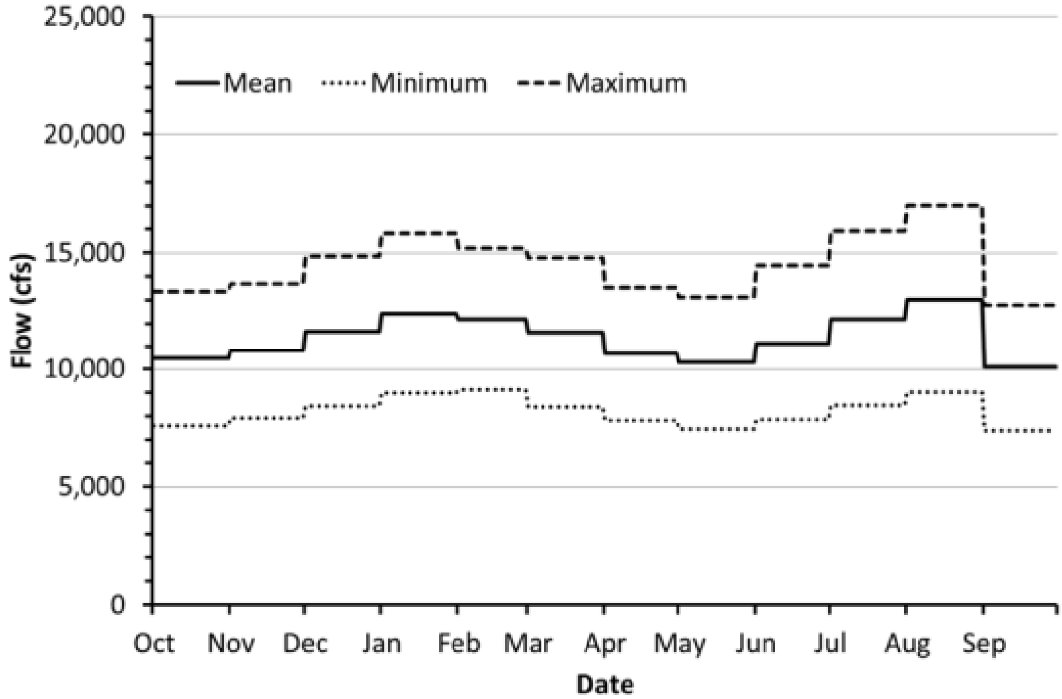
[1] In general, "run of the river" means the inflow equals the outflow, adjusted for operational considerations, such as evaporation, seepage, and release capacity.

Table B-1
Lake Powell Operational Tiers, Action Alternatives 1 and 2

Lake Powell Operational Tiers (subject to April adjustments or mid-year review modifications)		
Lake Powell Elevation (feet)	**Lake Powell Operational Tier**	**Lake Powell Active Storage*** (maf)
3,700	**Equalization Tier** Equalize, avoid spills, or release 8.23 maf	**23.31**
3,636–3,666 (see Table 2.3-1 in the 2007 FEIS)	**Upper Elevation Balancing Tier** Release 8.23 maf; if Lake Mead <1,075 feet, balance contents with a minimum/maximum release of 7.0/9.0 maf	**14.65–18.36** (2008–2026)
3,575	**Lower Elevation Release Tier** Set initial release of 6.0 maf; adjust releases based on the April Lake Powell end-of-water-year elevation projection: ≥3,575 feet, release 8.23 maf <3,575 feet AND ≥3,550 feet, release 7.48 maf <3,550 feet AND ≥3,525 feet, release 7.0 maf <3,525 feet AND ≥3,500 feet, maintain release of 6.0 maf <3,500 feet, reduce releases (gains equal losses) such that Lake Powell ends the operating year at 3,500 feet	**8.90**
3,500	**Protection Level** <3,500 feet, in any month, reduce releases (gains equal losses) such that Lake Powell ends the operating year at 3,500 feet	**4.22**
3,370		**0**

*Active storage values have been updated from 2007 based on the 2018 bathymetry.

Figure B-1
Mean, Minimum, and Maximum Monthly Flows under LTEMP in an 8.23-maf Year



Lower Elevation Release Tier

When the projected January 1 Lake Powell elevation is below 3,575 feet, an initial annual release in the amount of 6.0 maf would be set from Lake Powell. Reclamation may then adjust the annual release based on the April 24-Month Study, as outlined below:

- If the April 24-Month Study projects the end-of-water-year elevation to be at or above 3,575 feet, an adjustment would be made to release 8.23 maf from Lake Powell.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,575 feet and at or above 3,550 feet, an adjustment would be made to release 7.48 maf from Lake Powell.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,550 feet and at or above 3,525 feet, an adjustment would be made to release 7.0 maf from Lake Powell.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,525 feet and at or above 3,500 feet, the release of 6.0 maf from Lake Powell would be maintained.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,500 feet, the dam would be operated to maintain an elevation of at least 3,500 feet. Additionally, up to 6.0 maf would be released over the year with a goal of maintaining LTEMP minimum flows, subject to run-of-the-river conditions, operational constraints, and prudent operations as determined by Reclamation.

Protection Level

If, in any month, Lake Powell's elevation is below 3,500 feet, the Lake Powell release would be set to maintain or increase the elevation with a maximum release of 6.0 maf; the goal would be to maintain LTEMP minimum flows, subject to run-of-the-river conditions, operational constraints, and prudent operations as determined by Reclamation.

B.2.3 Shortage Sharing and Water Delivery Reduction Assumptions

A summary of the modeling assumptions for the alternatives, with respect to the reduction of deliveries due to shortage and DCP contributions to the Lower Division States, including the distribution of shortages by state for 2025 and 2026, is provided in **Table B-2**, **Table B-3**, and **Table B-4**. The distribution of shortages to individual users based on CRMMS modeling assumptions for Action Alternatives 1 and 2 can be found in **Attachment B-2**. System conservation volumes are summarized in **Attachment B-1**, **Table Attachment B-3**.

Table B-2 shows the Lower Basin shortages under the 2007 Interim Guidelines, contributions under the 2019 DCPs, and additional shortages modeled under Action Alternatives 1 and 2 in calendar years 2025 and 2026. **Table B-3** shows the assumptions for Action Alternative 1 regarding the breakdown of shortages and contributions by state, according to priority.

Table B-2
Lower Division States' Shortages and DCP Contributions, Action Alternatives 1 and 2 (2025–2026)*

Lake Mead Elevation (feet)	Existing 2007 ROD Shortages and 2019 DCP Contributions			Additional Shortages under Action Alternatives 1 and 2	
	2007 ROD Shortages (1,000 af)	2019 DCP Contributions (1,000 af)	Total (1,000 af)	Additional Shortages (1,000 af)	Total Shortages + Contributions (1,000 af)
1,090 – >1,075	0	200	200	200	**400**
1,075 – 1,050	333	200	533	533	**1,066**
<1,050 – >1,045	417	200	617	617	**1,234**
1,045 – >1,040	417	450	867	867	**1,734**
1,040 – >1,035	417	500	917	1,166	**2,083**
1,035 – >1,030	417	550	967	1,116	**2,083**
1,030 – 1,025	417	600	1,017	1,066	**2,083**
<1,025	500	600	1,100	983	**2,083**

* This table only shows combined Lower Division State shortage volumes and DCP contributions. In addition to the volumes shown in this table, the analysis for each alternative includes water delivery reductions to Mexico under low-elevation reservoir conditions and Mexico's savings that contribute to the Binational Water Scarcity Contingency Plan, in accordance with Minute 323 to the 1944 Water Treaty.

Table B-3
Lower Division States' Shortages and DCP Contributions by State, Action Alternative 1 (2025–2026)

Lake Mead Elevation (feet)	2007 ROD Shortage + 2019 DCP Contributions (1,000 af)				Action Alternative 1 Additional Shortage* (1,000 af)				Total Shortages + Contributions (1,000 af)			
	AZ	NV	CA	Total	AZ	NV	CA	Total	AZ	NV	CA	Total
1,090 – >1,075	192	8	0	200	192	8	0	200	384	16	0	400
1,075 – 1,050	512	21	0	533	511	22	0	533	1,023	43	0	1,066
<1,050 – >1,045	592	25	0	617	593	24	0	617	1,185	49	0	1,234
1,045 – >1,040	640	27	200	867	912	42	0	955	1,552	69	200**	1,734***
1,040 – >1,035	640	27	250	917	987	56	123	1,166	1,627	83	373	2,083
1,035 – >1,030	640	27	300	967	987	56	73	1,116	1,627	83	373	2,083
1,030 – 1,025	640	27	350	1,017	987	56	23	1,066	1,627	83	373	2,083
<1,025	720	30	350	1,100	907	53	23	983	1,627	83	373	2,083

*The additional shortage volumes decrease at elevation 1,025 feet because the shortages under the 2007 Interim Guidelines increase by the same amount. Therefore, the additional shortage amounts necessary to get to the 2.083 maf total are lower.
**In this elevation tier, the 2019 DCP contributions for California exceed what would be required under Action Alternative 1. As a result, no additional shortage is required in this elevation tier for California.
***Because the 2019 DCP contributions for California exceed the total shortage and contribution volume as modeled by the shortage allocation model, the sum of the three state totals exceeds the total shortage and contribution volume.

Figure B-2 shows a graphical view of Lower Basin shortages and contributions from the 2007 Interim Guidelines and the 2019 DCPs, plus additional shortages modeled under Action Alternative 1.

For Action Alterative 2, **Table B-4** displays the percentage of the additional shortage volumes at specified Lake Mead elevations and the distribution for each Lower Division State. As stated above, the total additional shortage volumes for the Lower Basin are the same under Action Alternative 2 as under Action Alternative 1. The additional shortage volumes identified in **Table B-2** for calendar years 2025 and 2026 would be achieved by a reduction of available Lower Basin annual consumptive use, distributed in the same percentage across all Lower Basin water users at the specified Lake Mead elevations. The distribution of reductions modeled for Action Alternative 2 is based on each user's consumptively used water in 2021, as reported in Reclamation's final Colorado River Accounting and Water Use Report: Arizona, California, and Nevada. This report was prepared pursuant to Article V of the Supreme Court's decree in *Arizona v. California* (as adjusted for conservation).

Figure B-2
Modeled Lower Basin Shortages and DCP Contributions, Action Alternatives 1 and 2

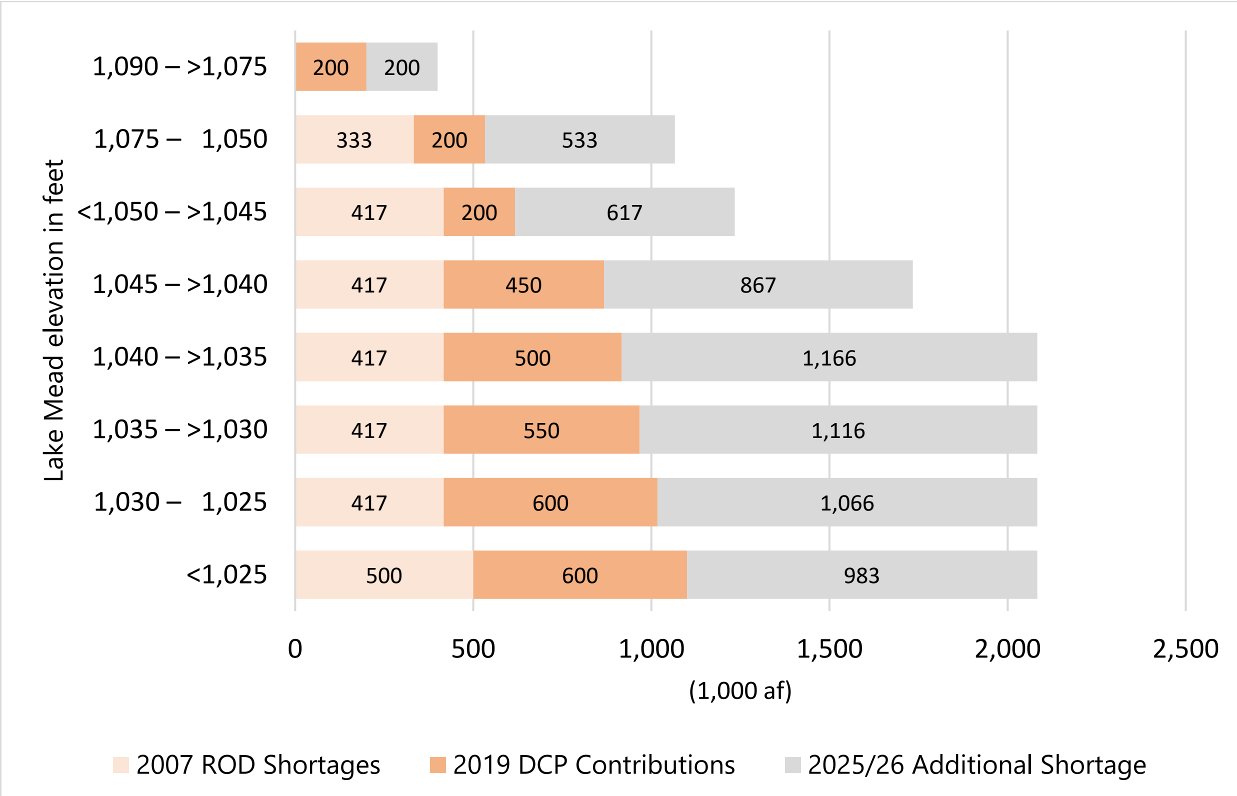


Table B-4
Lower Division States' Shortages and DCP Contributions by State, Action Alternative 2 (2025–2026)

Lake Mead Elevation (feet)	2007 ROD Shortages + 2019 DCP Contributions (1,000 af)				Additional Shortage* (1,000 af)					Total Shortage + Contributions (1,000 af)			
	AZ	NV	CA	Total	Percentage Additional Reduction**	AZ	NV	CA	Total	AZ	NV	CA	Total
1,090 – >1,075	192	8	0	200	2.67	75	8	117	200	267	16	117	400
1,075 – 1,050	512	21	0	533	7.11	199	21	313	533	711	42	313	1,066
<1,050 – >1,045	592	25	0	617	8.23	230	25	362	617	822	50	362	1,234
1,045 – >1,040	640	27	200	867	11.56	324	35	509	867	964	62	709	1,734
1,040 – >1,035	640	27	250	917	15.55	435	47	684	1,166	1,075	74	934	2,083
1,035 – >1,030	640	27	300	967	14.88	417	45	655	1,116	1,057	72	955	2,083
1,030 – 1,025	640	27	350	1,017	14.21	398	43	625	1,066	1,038	70	975	2,083
<1,025	720	30	350	1,100	13.11	367	39	577	983	1,087	69	927	2,083

*The additional shortage volumes decrease at elevation 1,025 feet because the shortages under the 2007 Interim Guidelines increase by the same amount. Therefore, the additional shortage amounts necessary to get to the 2.083 maf total are lower.
**Percentage of 2021 consumptive use

B.2.4 Comparison Metrics

All modeled alternatives are compared in **Section B.3** using the following metrics:

Lake Powell

- Monthly pool elevation
- Percentages of traces that fall below an elevation of 3,490 feet in any month in a water year
- End-of-water-year pool elevation
- Annual water year release
- Ten-year Lees Ferry gage flows

Lake Mead

- Monthly pool elevation
- Percentages of traces that fall below an elevation of 1,020 feet in any month in a calendar year
- End-of-calendar-year pool elevation
- Annual calendar year release

Shortage Sharing and Water Delivery

- Depletions by Lower Division States
- Annual shortages and DCP contributions to Lower Division States
- Annual shortages, DCP contributions, and system conservation for the Lower Division States

B.3 Modeling Results

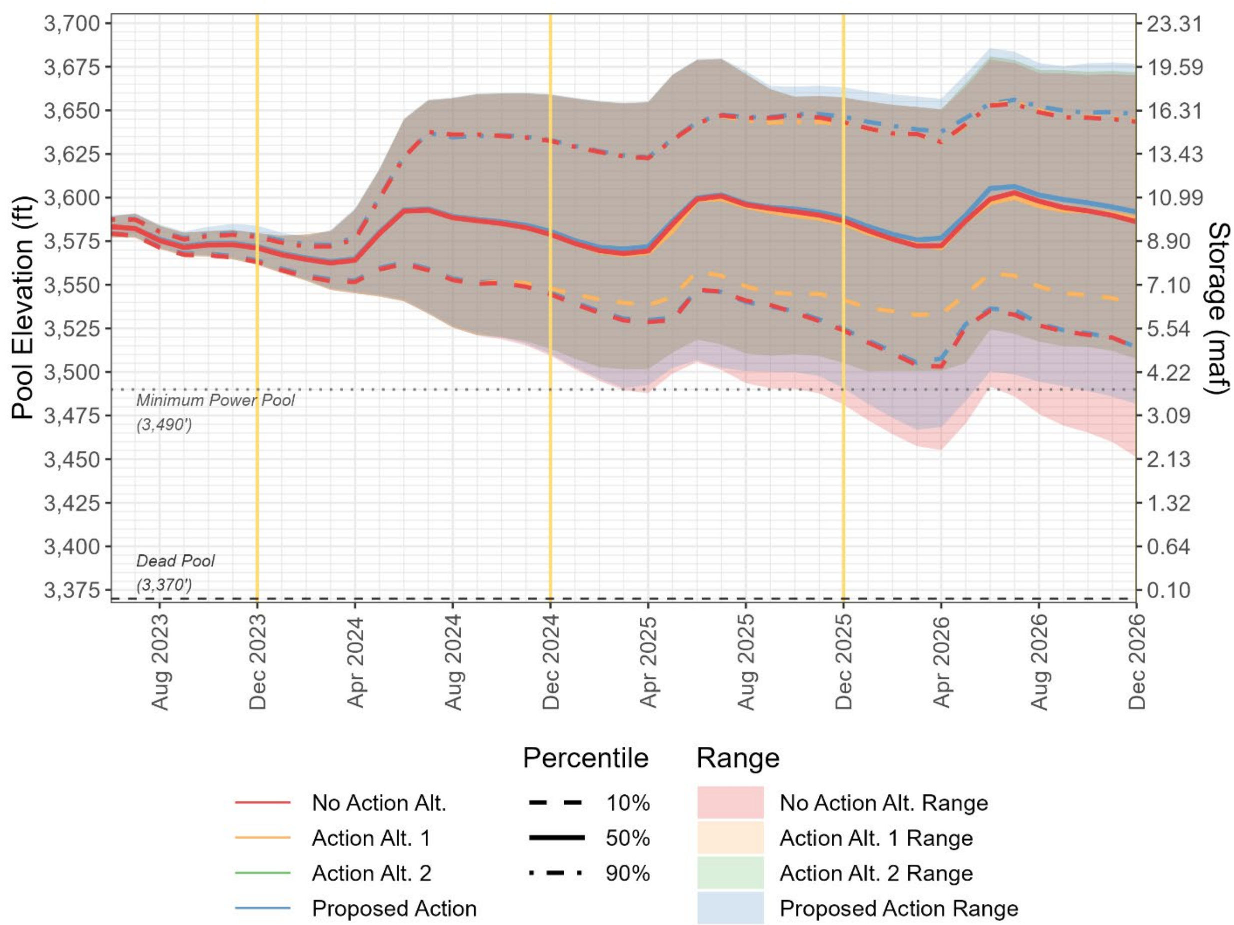
This section compares the No Action Alternative, Action Alternative 1, Action Alternative 2, and the Proposed Action. All statistics calculated reflect the hydrologic scenarios and other assumptions used in modeling; the statistics are not intended to suggest actual probabilities of any events occurring. However, it is meaningful to compare statistics across alternatives to differentiate performance. See **Appendix D** for more information about the hydrologic scenarios used and other modeling assumptions.

B.3.1 Lake Powell

Monthly Pool Elevations

Figure B-3 presents a comparison of the 10th, 50th, and 90th percentiles of modeled Lake Powell elevations for all alternatives as dashed, solid, and dash-dotted lines, respectively. It also shows “clouds” representing the full ranges of modeled elevations for the alternatives through 2026.

Figure B-3
Lake Powell End-of-Month Pool Elevations



In **Figure B-3**, the cloud extents, or full ranges of modeled Lake Powell elevations, are similar for all alternatives at the high end and median. The lower bound of the No Action Alternative and Proposed Action cloud drops to 3,500 feet in 2025 and decreases to a minimum of 3,451 feet and 3,467 feet in 2026, respectively. The lower bound of the clouds for Action Alternatives 1 and 2 does not drop below 3,490 feet; this is because these alternatives include a provision to protect a Lake Powell elevation of 3,500 feet.

In **Figure B-3,** the 10th percentiles of the No Action Alternative and Proposed Action are nearly identical; they decrease to a Lake Powell elevation of nearly 3,500 feet in April 2026. Action Alternatives 1 and 2 are highest at the 10th percentile and have the same Lake Powell elevation through 2026; this is because Glen Canyon Dam operations are the same under both alternatives.

Percentages of Traces below Critical Elevations

Figure B-4 shows the percentage of modeled traces that fall below a Lake Powell elevation of 3,490 feet at any time during a water year for 2024 through 2026. Remaining above 3,490 feet is critical to ensuring Glen Canyon Dam can continue to operate as designed.

Figure B-4
Lake Powell Minimum Water Year Elevation, Percentage of Traces Less than Elevation 3,490 Feet

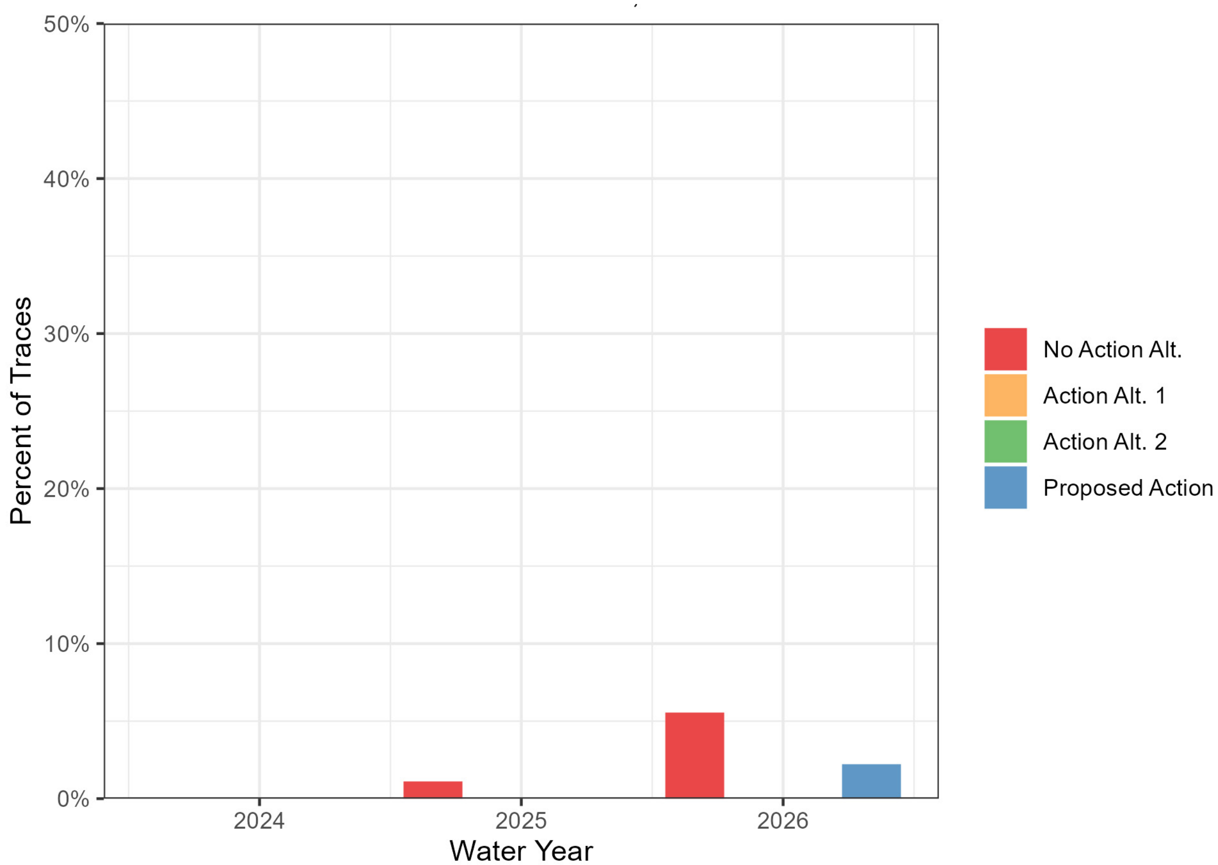


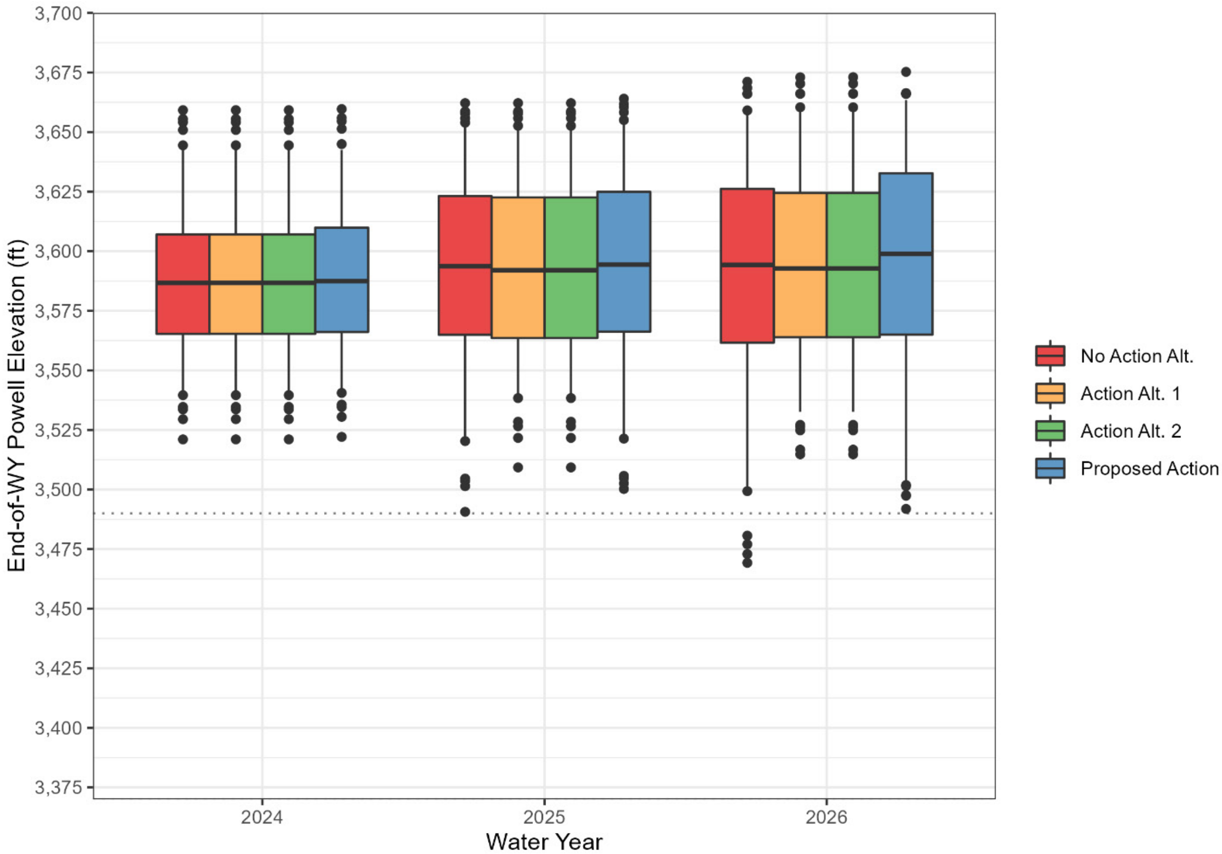
Figure B-4 shows that no alternatives drop below a Lake Powell pool elevation of 3,490 feet until 2025. Under the No Action Alternative, 1.5 percent of modeled traces in 2025 and 6.0 percent of modeled traces in 2026 result in the Lake Powell pool elevation dropping below 3,490 feet. Under Action Alternatives 1 and 2, no traces drop below a Lake Powell pool elevation of 3,490 feet due to the operations for the protection level of 3,500 feet. The Proposed Action has 2 percent of traces falling below 3,490 feet at Lake Powell in 2026.

Annual Pool Elevations

Figure B-5 shows the distributions of modeled Lake Powell elevations on September 30 in 2024, 2025, and 2026. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines.

Figure B-5 comparisons are consistent with those described above for **Figure B-3**. All alternatives have a similar range, especially at the highest pool elevations. The end-of-water-year Lake Powell pool elevations in 2025 and 2026 are lowest under the No Action Alternative, followed by the

Figure B-5
Lake Powell End-of-Water-Year Pool Elevations



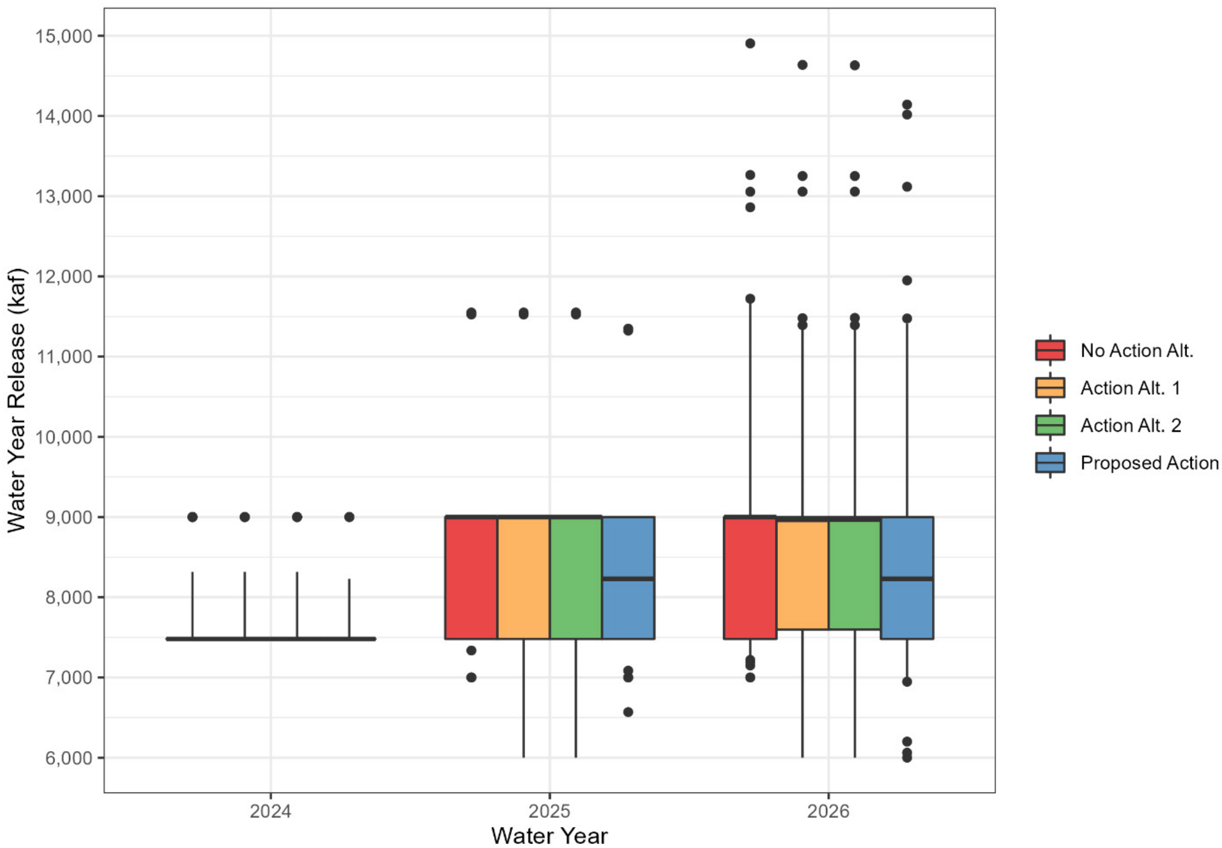
Proposed Action. Since Action Alternatives 1 and 2 protect the 3,500-foot elevation, the lowest end-of-water-year pool elevations are higher than under the No Action Alternative and the Proposed Action. The median end-of-water-year pool elevation for the Proposed Action is the highest at 3,599 feet in 2026, compared with the No Action Alternative and Action Alternatives 1 and 2, which have a median pool elevation of 3,594 and 3,593 feet, respectively.

Annual Releases

Figure B-6 shows the distributions of modeled Glen Canyon Dam water year releases in 2024, 2025, and 2026. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines.

The modeled Glen Canyon Dam water year releases shown in **Figure B-6** reflect the different approaches to Lake Powell operations assumed in the alternatives. The Proposed Action and Action Alternatives 1 and 2 limit releases to protect a Lake Powell elevation of 3,500 feet using different methods. The Proposed Action limits releases once an elevation of 3,500 feet is projected to be reached, while Action Alternatives 1 and 2 adjust releases before a 3,500-foot elevation is reached. Therefore, they have a slightly different distribution of releases at the low end.

Figure B-6
Glen Canyon Dam Water Year Releases



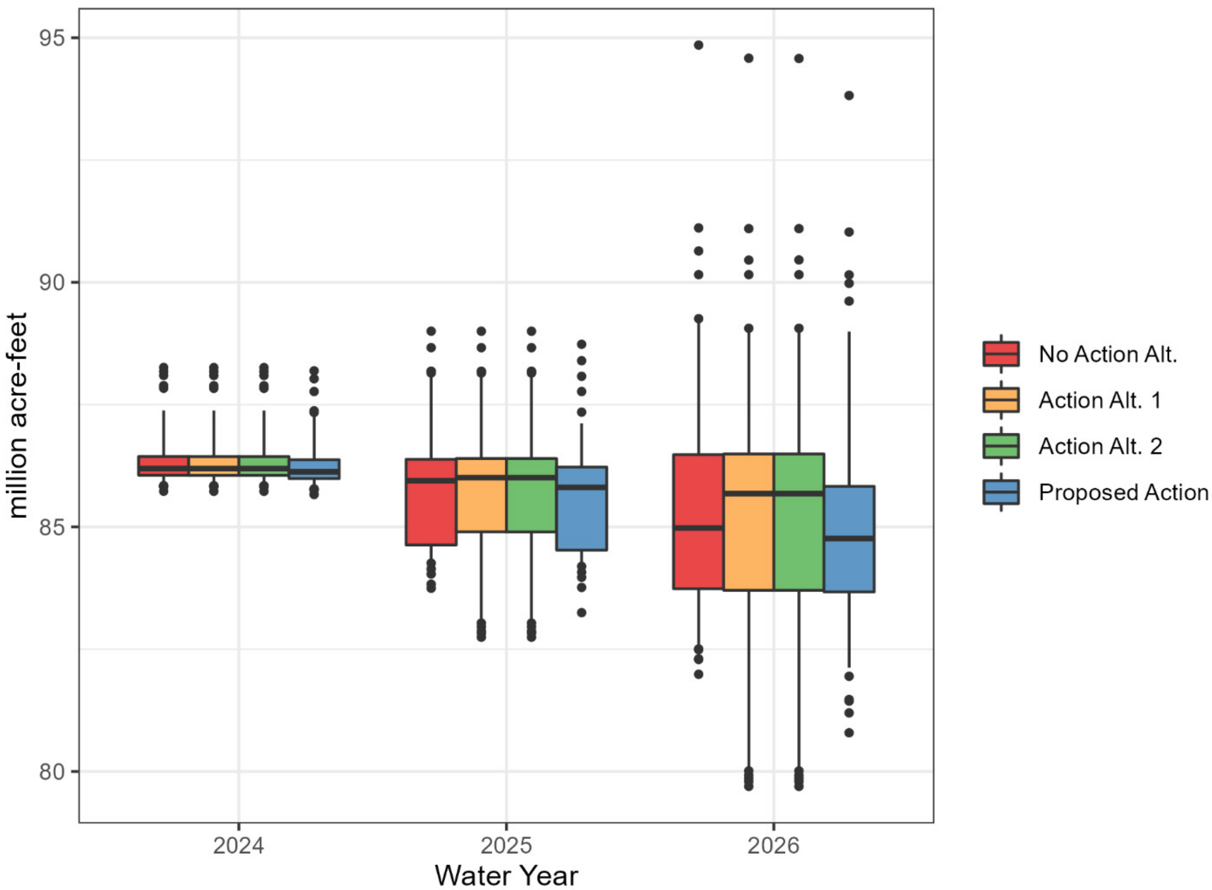
When Lake Powell is between elevations 3,500 and 3,575 feet, Action Alternatives 1 and 2 only have set release volumes (not balancing). Under Action Alternatives 1 and 2, the set releases range between 6 and 8.23 maf, which can be seen in the height of the box and whiskers. The No Action Alternative and Proposed Action set release volumes by balancing the storage of Lakes Powell and Mead when Lake Powell is below 3,525 feet; therefore, the No Action Alternative and Proposed Action have more variability in release volumes.

At the median, the No Action Alternative and Action Alternatives 1 and 2 are the same at 9.0 maf in 2025 and 2026. The Proposed Action has a lower release in 2025 and 2026. This is due to decreased balancing releases in the Upper and Lower Elevation Balancing Tiers resulting from increased storage in Lake Mead.

Ten-Year Lees Ferry Gage Flows

Figure B-7 shows the distribution of modeled 10-year running sums of Lees Ferry gage flows in 2024, 2025, and 2026. The modeled 2024 flow is calculated using the observed deliveries from 2015 through 2022, and a modeled delivery volume in 2023. There is some variability in the 2023 volume; however, it is common to all alternatives except the Proposed Action, which has small changes to balancing releases due to changes in releases from Lake Mead. The modeled 2025 volume is

Figure B-7
Lees Ferry Gage 10-Year Running Total



calculated without the 2015 observed volume, and the modeled 2026 volume is calculated without the 2015 and 2016 observed volumes.

Figure B-7 shows the 10-year volume resulting from a single hydrologic trace. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines.

Figure B-7 shows that under all alternatives, the median modeled 10-year total flows decline over time. This is partially because relatively high Glen Canyon Dam releases from 7 or more years ago drop out of the running total. All action alternatives have lower 10-year flows in the driest modeled traces than the No Action Alternative; this is because they model limited releases to protect Lake Powell's elevation of 3,500 feet.

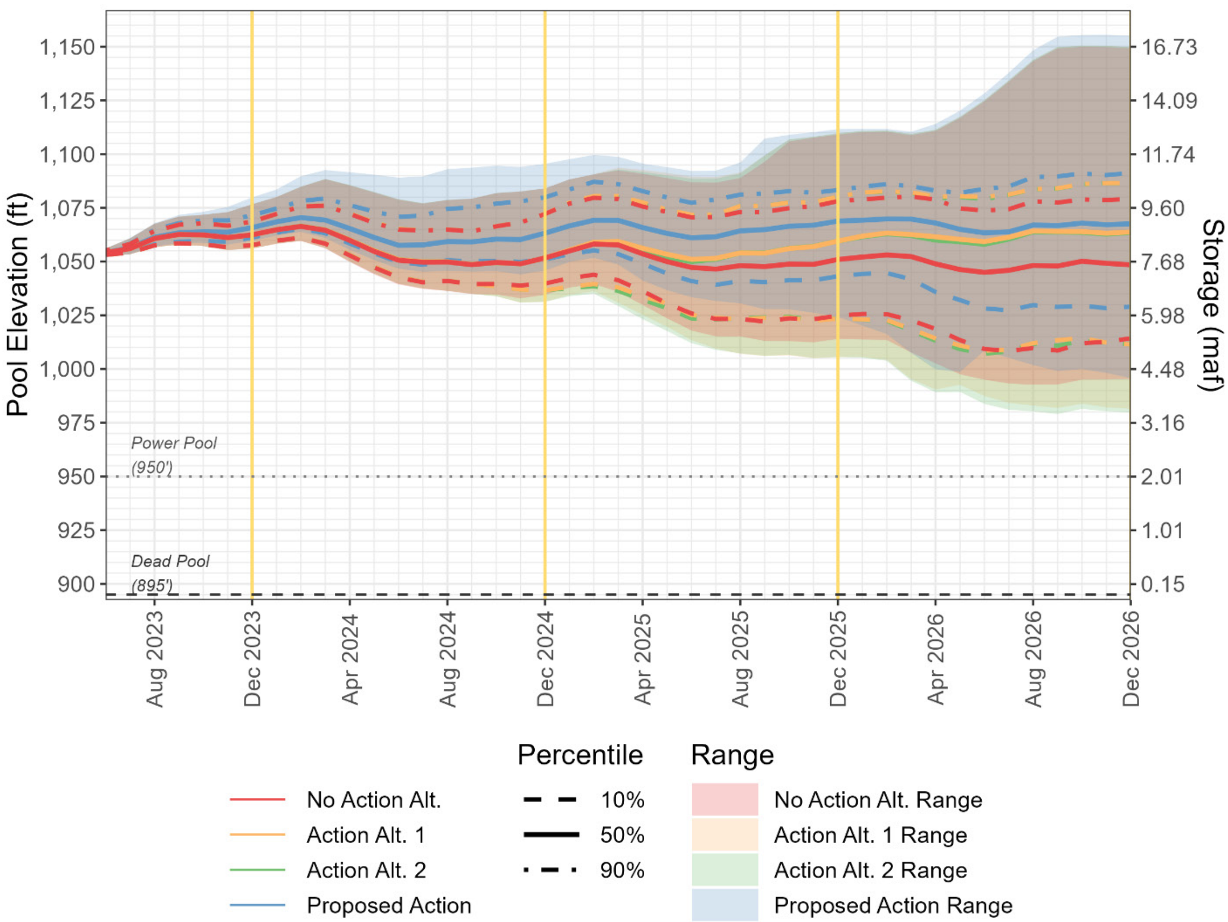
The median 10-year flows under Action Alternatives 1 and 2 are higher than under the No Action Alternative and the Proposed Action in 2025 and 2026. The Proposed Action has the lowest median 10-year flows because Lake Powell releases are lower in 2025 and 2026. By 2025, all alternatives result in 10-year totals below 82.3 maf in some modeled traces. In 2026, 2 percent of traces fall below the 10-year totals of 82.3 maf under the No Action Alternative, 16 percent of traces fall below the 10-year totals of 82.3 maf under Action Alternatives 1 and 2, and 6 percent of traces fall below the 10-year totals of 82.3 maf under the Proposed Action. There are no modeled traces that fall below 75 maf for the 10-year total.

B.3.2 Lake Mead

Monthly Pool Elevations

Figure B-8 presents a comparison of the 10th, 50th, and 90th percentiles of modeled Lake Mead elevations for all alternatives as dashed, solid, and dash-dotted lines, respectively. It also shows clouds representing the full ranges of modeled elevations for the alternatives through 2026.

Figure B-8
Lake Mead End-of-Month Pool Elevations



The upper bounds of the clouds in **Figure B-8** vary slightly between all alternatives, especially the Proposed Action. The Proposed Action's upper bound increases and is higher than the upper bound for the other alternatives, especially in 2024, due to larger volumes of SEIS conservation[2] starting in 2023. In 2026, the No Action Alternative and Action Alternatives 1 and 2 have the lowest upper bound of modeled Lake Mead elevations, while the Proposed Action has the highest upper bound. The alternatives have more variability between them at the lower bounds of the clouds. The Proposed Action has the highest lower bound at the end of 2024, while the No Action Alternative and Action Alternatives 1 and 2 have the lowest elevations at the lower bound.

In May 2026, the Proposed Action's minimum increases slightly due to adjustments in Glen Canyon Dam releases to protect 3,500 feet. These adjustments result in lower releases in April 2026 and higher releases in May 2026 as inflows to Lake Powell increase during the runoff season; these inflows can be released from Glen Canyon Dam while maintaining 3,500 feet. At the end of 2026, Action Alternatives 1 and 2 have the lowest modeled elevations at 982 feet and 980 feet, respectively, while the No Action Alternative and Proposed Action end 2026 approximately 13 to 16 feet higher at around 995 feet and 996 feet, respectively.

In **Figure B-8**, the 10th percentiles of modeled Lake Mead elevations have a slightly different result than the lower bound. At the 10th percentile, the No Action Alternative and Action Alternatives 1 and 2 are approximately the same, while the Proposed Action has higher elevations. At the median, the Proposed Action has higher pool elevations than the other alternatives through 2026. Initially, the other alternatives have a decreasing pool elevation at the median through the end of 2024. In 2025, Action Alternatives 1 and 2 start to have an increasing median pool elevation due to additional Lower Division State shortages, compared with the No Action Alternative. By the end of 2026, the Proposed Action is only 4 feet above Action Alternatives 1 and 2 at the median, while the No Action Alternative is 20 feet lower than the Proposed Action. At the 90th percentiles of modeled elevations, the No Action Alternative is lower than the other alternatives, with the Proposed Action having the highest elevations.

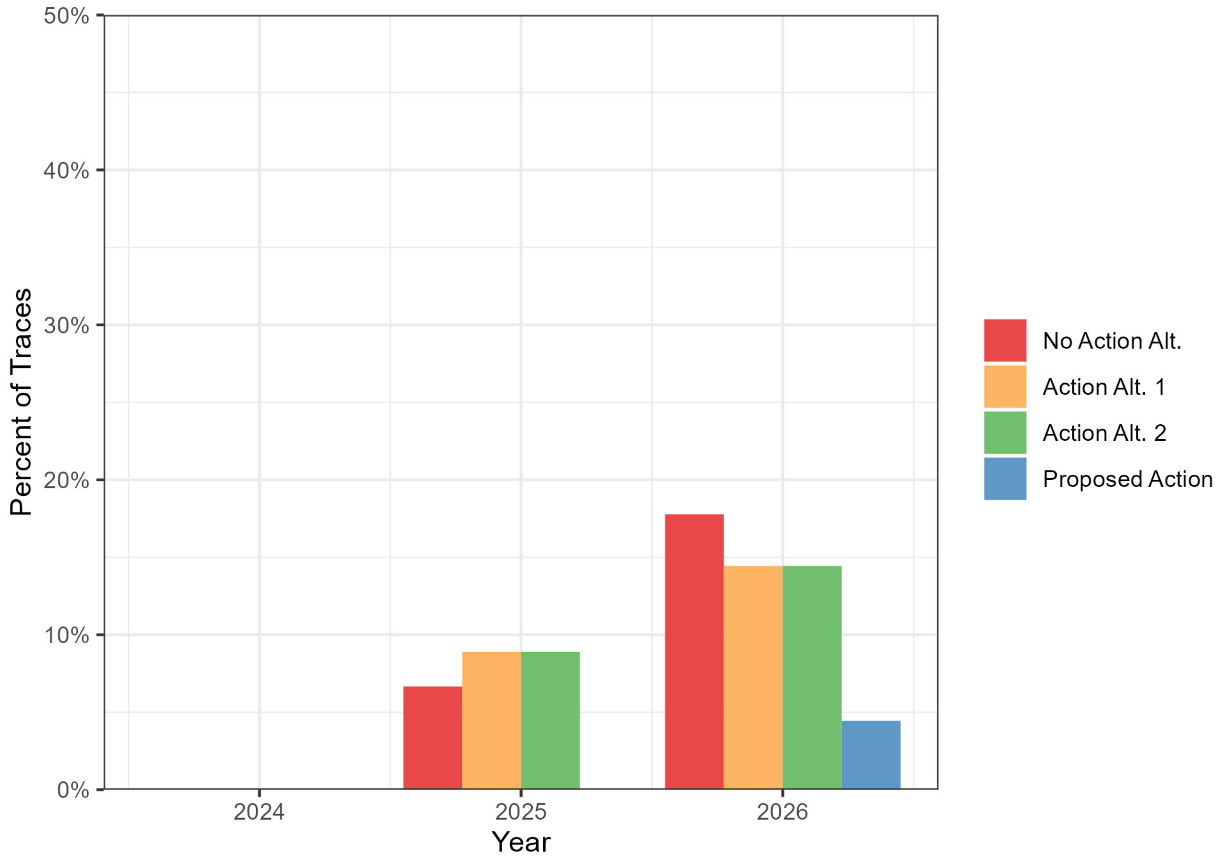
Percentages of Traces below Critical Elevations

Figure B-9 shows the percentage of modeled traces that fall below a Lake Mead elevation of 1,000 feet at any time during a year for the period of analysis. An elevation of 1,020 feet was identified as a critical elevation in the 2019 DCPs.

In **Figure B-9**, no alternatives have modeled traces falling below a Lake Mead elevation of 1,020 feet in 2024. In 2025, all alternatives except the Proposed Action have similar percentages of modeled traces falling below 1,020 feet; the No Action Alternative has approximately 7 percent, Action Alternatives 1 and 2 have the highest percentage at 9 percent, and the Proposed Action has the fewest traces at 0 percent. Over the period of analysis, the percentage of traces falling below an elevation of 1,020 feet increases under all alternatives. In 2026, the No Action Alternative has 18

[2] SEIS conservation may be a combination of system conservation, creation of ICS, or other water conservation activities that result in system benefits, as outlined in the proposal. Implementation of conservation measures would be subject additional environmental compliance, as appropriate.

Figure B-9
Lake Mead Minimum Calendar Year Elevation, Percentage of Traces Less than Elevation 1,020 Feet



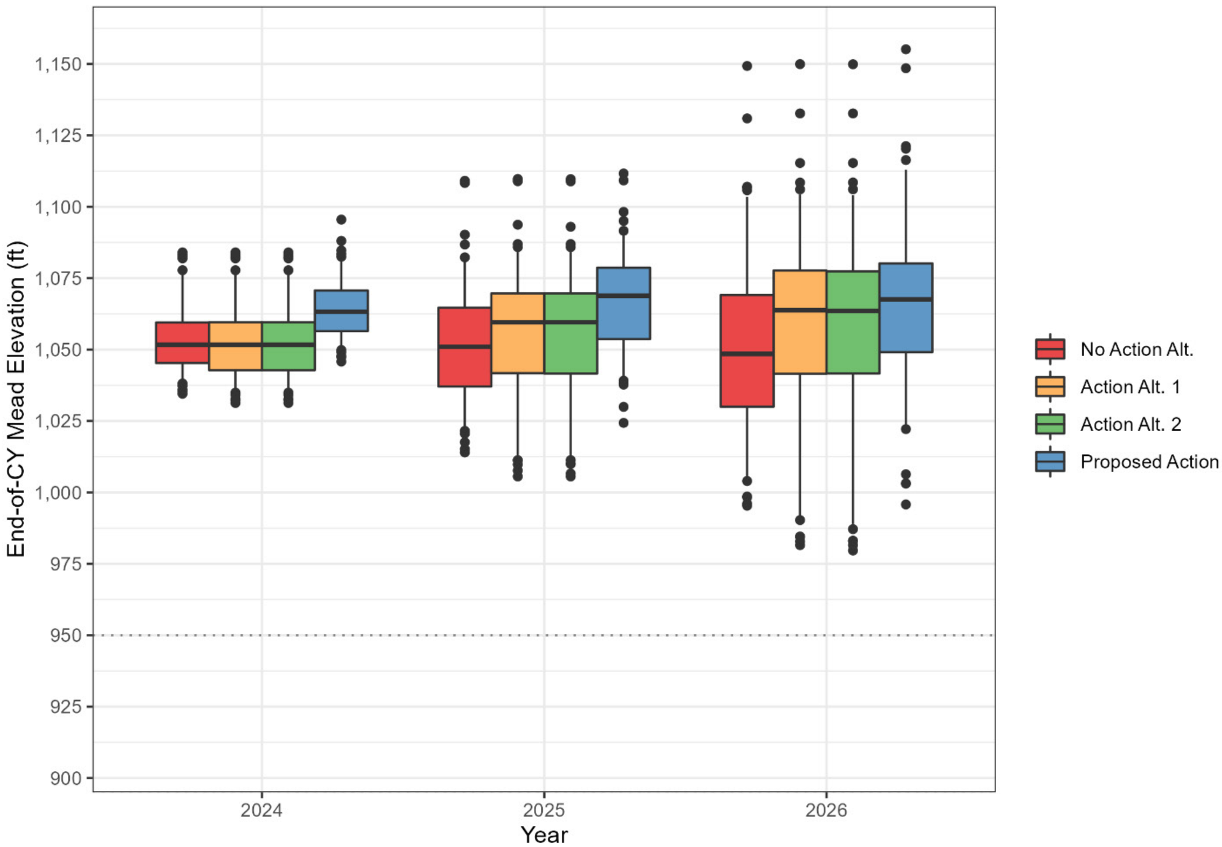
percent of traces falling below 1,020 feet, Action Alternatives 1 and 2 have 14 percent of traces, and the Proposed Action has 4 percent of traces.

Annual Pool Elevations

Figure B-10 shows the distributions of modeled Lake Mead elevations on December 31 in 2024, 2025, and 2026. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines.

The distributions of modeled end-of-calendar-year Lake Mead elevations for the alternatives shown in **Figure B-10** exhibit the same dynamics as those described under **Figure B-8**. The medians of the No Action Alternative decline from 2024 to 2026, and the variability increases. Action Alternatives 1 and 2 display wide ranges in all years, but the medians and ranges consistently shift upward over the period of analysis. Compared with the other alternatives, the Proposed Action has the highest pool elevation at all quantiles from 2024 to 2026.

Figure B-10
Lake Mead End-of-Calendar-Year Pool Elevations

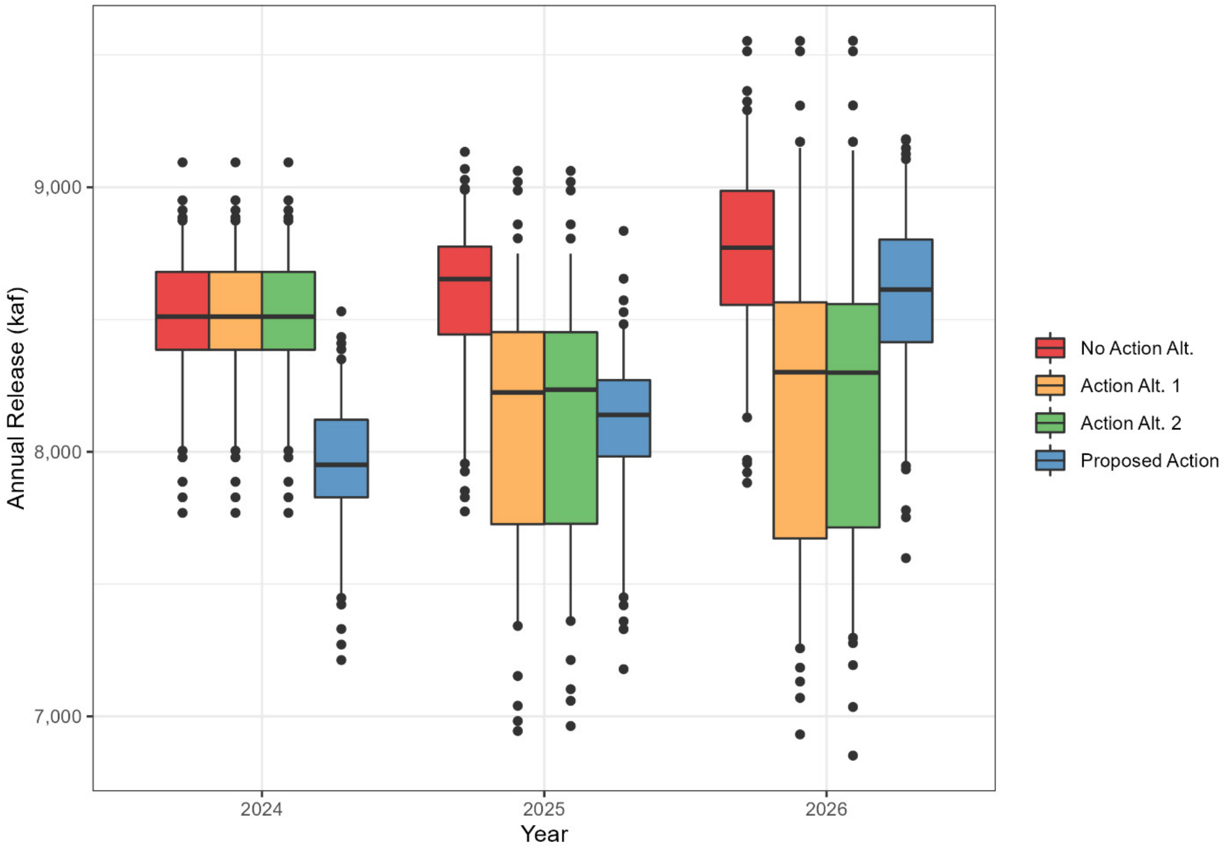


Annual Releases

Figure B-11 shows the distributions of modeled annual releases from Hoover Dam in 2024, 2025, and 2026. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines.

Figure B-11 shows that under the No Action Alternative, the modeled releases from Hoover Dam in 2024 to 2025 have ranges of approximately 1.3 maf, with medians that increase slightly from approximately 8.51 to 8.65 maf. In 2026, the median release again increases slightly to 8.77 maf, while the highest releases increase to above 9.5 maf. In 2024, Action Alternatives 1 and 2 have the same releases as the No Action Alternative. In 2025 and 2026, releases are lower than under the No Action Alternative, and variability increases due to the potential of increased Lower Division State shortage volumes. With a median of 7.95 maf, the Proposed Action has lower releases than the other alternatives in 2024. In 2025, the release increases but is still lower than it is under Action Alternatives 1 and 2 at the median. In 2026, the Proposed Action release is higher at the median at 8.61 maf and has less variability than under Action Alternatives 1 and 2; however, the median is still lower than it is under the No Action Alternative.

Figure B-11
Hoover Dam Calendar Year Releases



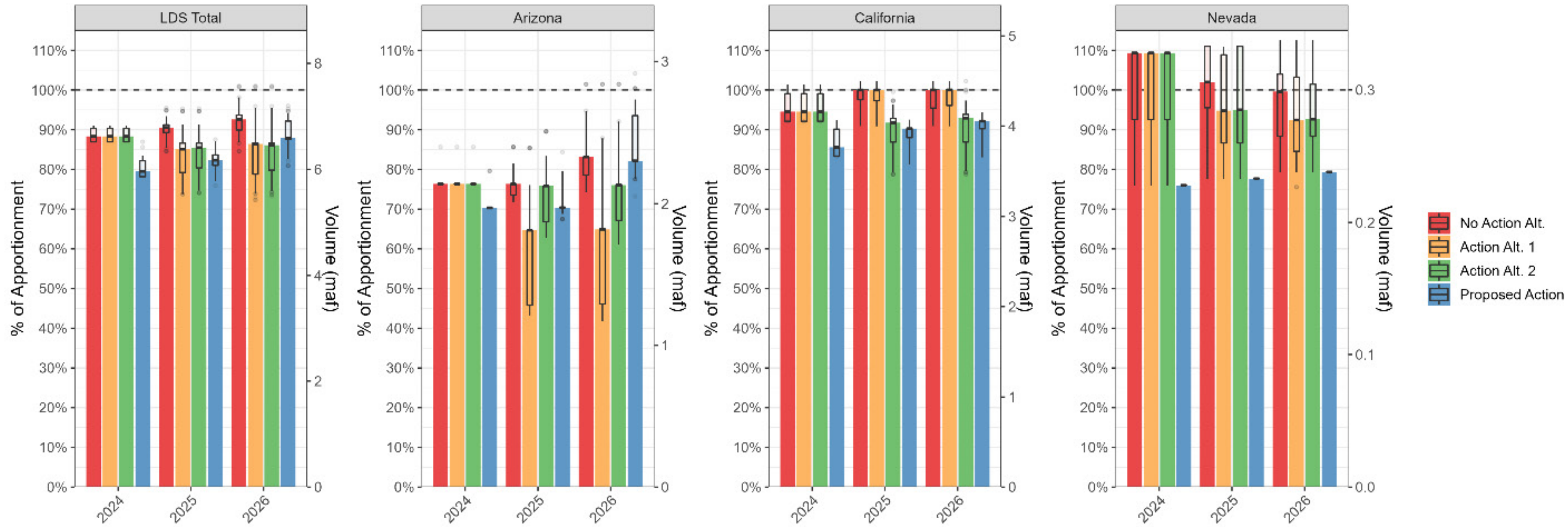
B.3.3 Shortage Sharing and Water Delivery

Lower Division Depletions by State

Figure B-11 shows the distribution of modeled Lower Division States' depletions represented as a percentage of the state's apportionment and by volumes in 2024, 2025, and 2026. The median depletions are represented by the colored bar and the mid-line of each box. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled depletions, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines. From left to right, the four panels display depletions for the Lower Division States (the total), Arizona, California, and Nevada, respectively. The figure is oriented to facilitate the comparison of a state's modeled depletions across each alternative over the period of analysis.

Figure B-12 reports the distributions of modeled Lower Division States' depletions that would occur after adjustments to demands based on shortages, DCP contributions, ICS delivery or creation, and system conservation.

Figure B-12
Lower Division States' Modeled Depletions



The left panel of **Figure B-12** shows a comparison of how total modeled Lower Division States' depletions were affected by the different alternatives. In 2024, the No Action Alternative and Action Alternatives 1 and 2 show the same median depletions at 88 percent of apportionment; this is because no additional shortages are applied in 2024 for Action Alternatives 1 and 2. The Proposed Action depletion for 2024 is lower than for the other alternatives at 80 percent of apportionment; this is because an additional Lower Division State system conservation was modeled. In 2025 and 2026, the medians for Action Alternatives 1 and 2 decline, and the variability increases due to additional shortages taking effect. The median for the No Action Alternative is the highest among the alternatives in 2025 and 2026. The Proposed Action results in lower use than the other alternatives in 2025 and slightly higher depletions than Action Alternatives 1 and 2 in 2026.

In the second panel of **Figure B-12**, Arizona's modeled annual 2025 and 2026 depletions are lowest under Action Alternative 1. Under Action Alternative 1, shortages are applied based exclusively on the concept of priority, so Arizona's junior users are significantly affected. The No Action Alternative and Action Alternative 2 have similar depletions in 2025; this is due to additional shortages and a reduction in system conservation modeled in Action Alternative 2. The No Action Alternative and Proposed Action have higher depletions in 2026 than Action Alternatives 1 and 2 since no additional shortages are applied in those alternatives.

In the third panel of **Figure B-12**, modeled annual depletions for California are highest under the No Action Alternative and Action Alternative 1 throughout the period of analysis; this is because there are no additional shortages applied to California due to high-priority users under those alternatives. In 2025 and 2026, Action Alternative 2 and the Proposed Action have similar median depletions, with a larger range in Action Alterative 2. Action Alternative 2 has additional shortage applied to California when shortage volumes are distributed based on each user's consumptively used water, while the Proposed Action includes system conservation.

The fourth panel of **Figure B-12** shows the modeled annual depletions for Nevada. In 2024, median depletions for all alternatives except the Proposed Action are approximately 109 percent of apportionment. This is a result of how the ICS accumulation space[3] sharing is modeled for these alternatives. An ICS accumulation space-sharing agreement allows states to share ICS accumulation space up to the total capacity of 2.7 maf. In 2024, some model traces show the ICS accumulation at capacity. Since Nevada is using more than the state's individual maximum ICS accumulation, Nevada is modeled to vacate the ICS so another state can create ICS. When this occurs, it is assumed that Nevada takes delivery of Nevada's vacated ICS up to the state's maximum delivery, which results in depletions above Nevada's apportionment. This also occurs in 2025 and 2026. The Proposed Action does not have depletions above Nevada's apportionment since it is assumed that Nevada converts vacated ICS to system water instead of taking delivery of the volume. Due to this assumption, the depletions under the Proposed Action are substantially lower than they are under the other alternatives.

[3] In accordance with the Lower Basin DCP, the maximum total amount of Extraordinary Conservation ICS, Binational ICS, and DCP ICS that may be accumulated by the Lower Division States is 2.7 maf.

Annual Shortage and DCP Contribution Volumes by State

Figure B-13 shows the distributions of modeled shortages plus DCP contributions to Lower Division States represented as a percentage of apportionment and volumes in 2024, 2025, and 2026. The volumes represent water required to meet DCP contributions, 2007 ROD shortages, and additional proposed shortages during a year. The median reductions are represented by the colored bar and the mid-line of each box. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines. From left to right, the four panels display shortage and DCP contributions for Lower Division States (the total), Arizona, California, and Nevada, respectively.

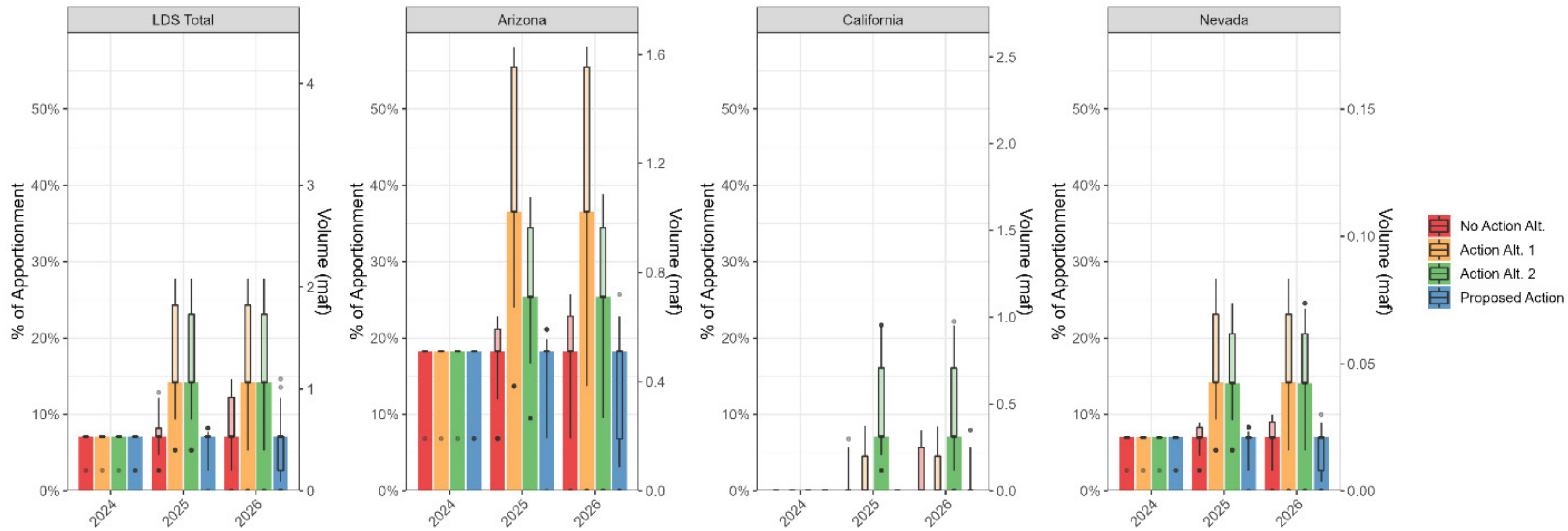
The left panel in **Figure B-13** shows that 2024 Lower Division States' total shortages and DCP contributions are the same across all alternatives since the alternatives have the same 2024 Lake Mead operating condition. In 2025 and 2026, Lower Division States' total shortages and DCP contributions for the No Action Alternative and Proposed Action are similar at the median with 7 percent of apportionment. Also, Action Alternatives 1 and 2 are similar at the median with 14 percent of apportionment. The range of shortages and DCP contributions in 2025 and 2026 for Action Alternatives 1 and 2 is larger than it is for the other alternatives due to the wider range of potential shortages.

The distributions of modeled Arizona shortages and DCP contributions shown in the second panel of **Figure B-13** reflect dynamics between alternatives that have been observed in previous figures and discussions. The No Action Alternative and Proposed Action have lower shortages and DCP contributions than Action Alternatives 1 and 2. Delivery reductions under Action Alternative 1 are higher than they are under Action Alternative 2; this is because Action Alternative 1 distributes shortage volumes based on the concept of priority, as opposed to using the same percentage across all Lower Basin water users to distribute shortages.

The third panel in **Figure B-13** shows the same dynamics in modeled distributions of California's shortages and DCP contributions that were described for Arizona, except the relative higher and lower magnitudes between Action Alternatives 1 and 2 are reversed. Distributing shortages based fully or largely on proportionality results in higher reductions for California under Action Alternative 2; using the priority system as a basis for Action Alternative 1 results in lower delivery reduction volumes for California.

With respect to modeled shortages and DCP contributions assigned to Nevada, the right panel of **Figure B-13** shows that distributing shortages based on the concept of priority versus using the same percentages across all Lower Basin water users is not as strong of a determinant of magnitudes as it is for Arizona and California. Action Alternatives 1 and 2 have the same shortages and DCP contributions at the median, with Action Alternative 1 having a slightly higher maximum shortage compared with Action Alternative 2. Consistent with the other states, the No Action Alternative and Proposed Action have the same shortages and DCP contributions.

Figure B-13
Distribution of Lower Division Shortages and DCP Contributions



Annual Shortage, DCP Contribution, and System Conservation Volumes by State

Figure B-14 shows the distributions of modeled shortages, DCP contributions, and system conservation to Lower Division States represented as a percentage of apportionment and volumes in 2024, 2025, and 2026. The figure reflects **Figure B-13** with the addition of system conservation volumes. The median reductions are represented by the colored bar and the mid-line of each box. The top and bottom of each box capture the 25th and 75th percentile, respectively, of the modeled elevations, and the whiskers extend to the 5th and 95th percentiles. The outliers are represented as dots beyond these lines. From left to right, the four panels display the total shortages, DCP contributions, and system conservation for Lower Division States (the total), Arizona, California, and Nevada, respectively.

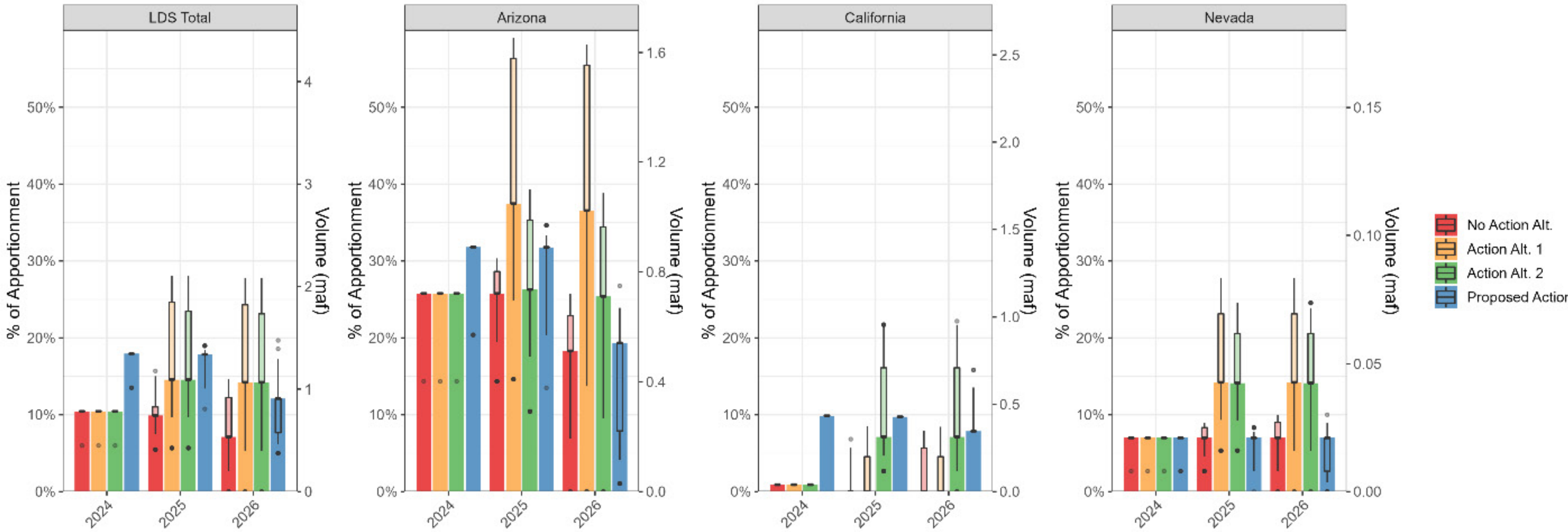
The left panel in **Figure B-14** reflects the difference in system conservation between the alternatives. In 2024 and 2025, the Proposed Action has more system conservation than the other alternatives, resulting in higher volumes that are approximately at 18 percent of Lower Division States' apportionment at the median. Compared with Action Alternatives 1 and 2, under the Proposed Action the assumed system conservation in 2025 results in larger shortages, DCP contributions, and system conservation volumes. In 2026, the Proposed Action has lower volumes than Action Alternatives 1 and 2 since less system conservation is assumed to occur in 2026.

The distributions of modeled Arizona shortages, DCP contributions, and system conservation shown in the second panel of **Figure B-14** reflect the addition of system conservation volumes to **Figure B-13**. The Proposed Action has higher volumes than the other alternatives in 2024. In 2025, Action Alternative 1 has higher volumes at 38 percent of apportionment compared with the Proposed Action, which is 32 percent of apportionment. In 2026, Action Alternatives 1 and 2 have higher volumes than the Proposed Action, which has volumes similar to those under the No Action Alternative at the median.

The third panel in **Figure B-14** shows the Proposed Action has larger total shortages, DCP contributions, and system conservation volumes for California than the other alternatives. In 2024, the Proposed Action results in volumes of 10 percent of apportionment, which are all due to system conservation. The other alternatives have lower volumes at 1 percent of apportionment due to lower assumed system conservation. In 2025 and 2026, Action Alternative 2 has total shortages, DCP contributions, and system conservation volumes only slightly below those of the Proposed Action at the median, while the No Action Alternative and Action Alterative 1 have volumes at 0 percent of apportionment at the median.

With respect to modeled total shortages, DCP contributions, and system conservation volumes assigned to Nevada, the right panel of **Figure B-14** is the same as the panel for Nevada in **Figure B-13**. There is no assumed system conservation for any alternatives in Nevada. The Proposed Action assumes changed assumptions for ICS (see the discussion for **Figure B-12**); this results in different depletions but does not affect the volumes in **Figure B-14**.

Figure B-14
Distribution of Lower Division Shortages, DCP Contributions, and System Conservation



B.4 Summary

At Lake Powell, modeling for the alternatives shows similar monthly and end-of-water-year elevations at the median and high end of the range. Compared with the No Acton Alternative, all three alternatives have higher lower bounds of elevations and a lower incidence of reaching 3,490 feet; this is because they include some protection of elevation 3,500 feet. Action Alternatives 1 and 2 and the Proposed Action show variation over time and are comparable with one another in their distributions of Glen Canyon Dam releases based on whether they include balancing releases below a Lake Powell elevation of 3,575 feet and the volumes of specified releases below 3,575 feet. Action Alternatives 1 and 2 have no balancing below 3,575 feet after 2024; also, their modeled median releases are stable in 2025 and 2026 at 9 maf with ranges that tend to increase over time. The Proposed Action median modeled Glen Canyon Dam releases are lower than they are for the other alternatives by approximately 0.77 maf in 2025 and 2026. The No Action Alternative's medians are similar to the medians of Action Alternatives 1 and 2.

Because of the assumption to protect a Lake Powell elevation of 3,500 feet, there are more modeled traces resulting in 10-year Lees Ferry gage flows less than 82.3 maf in 2026 under Action Alternatives 1 and 2 and the Proposed Action. In 2026, depending on the alternative, 6 to 16 percent of traces fall below 82.3 maf over 10 years under Action Alternatives 1 and 2 and the Proposed Action.

At Lake Mead, the Proposed Action differs from the other alternatives because it includes additional SEIS conservation in 2023 through 2026. Thus, monthly and end-of-calendar-year pool elevations are higher under the Proposed Action for the analysis period. Median pool elevations for Action Alternatives 1 and 2 are higher than they are under the No Action Alternative starting in 2025, which is when additional shortage volumes take effect for Action Alternatives 1 and 2. A combination of increased shortages under Action Alternatives 1 and 2 and decreased Glen Canyon Dam releases under the Proposed Action causes the median modeled Lake Mead elevations under Action Alternatives 1 and 2 to increase up to the elevations for the Proposed Action starting in 2025. At the end of 2026, the elevations under Action Alternatives 1 and 2 are 20 feet below the elevations under the Proposed Action. This dynamic is reflected in the percentage of traces that drop below 1,020 feet at Lake Mead in 2026; the Proposed Action results in 4 percent of traces dropping below 1,020 feet, while Action Alternatives 1 and 2 and the No Action Alternative have 14 and 18 percent of traces, respectively.

Releases from Hoover Dam are significantly lower under Action Alternatives 1 and 2 and the Proposed Action than releases modeled under the No Action Alternative. This is because Action Alternatives 1 and 2 and the Proposed Action apply additional shortages or SEIS conservation. The release medians and ranges for Action Alternatives 1 and 2 are generally consistent in 2025 and 2026, while the releases under the Proposed Action increase through the analysis period based on modeled SEIS conservation and lower shortage volumes.

In terms of shortage sharing and water deliveries to the Lower Division States, three major factors drive the differences among Action Alternatives 1 and 2 and the Proposed Action: (1) additional shortage volumes, (2) how shortages are distributed among users, and (3) assumed system conservation volumes. Overall, Action Alternatives 1 and 2 result in higher modeled shortages (and lower modeled depletions) in 2025 and 2026 than the No Action Alternative. The Proposed Action results in only minor differences in shortages compared with the No Action Alternative. However, when system conservation is considered, reductions are more similar to those under Action Alternatives 1 and 2, though exact volumes vary by year. In 2024, depletions are lower for the Proposed Action than for the other alternatives; however, in 2025 and 2026, depletions are approximately the same as they are for Action Alternatives 1 and 2.

The additional shortages applied to individual states vary among Action Alternatives 1 and 2, which are the only alternatives that assume additional shortages. Action Alternative 1 uses the concept of priority as the basis for distributing additional shortages. This results in the modeled shortages and DCP contributions being relatively higher in Arizona and lower in California, compared with Action Alternative 2. In contrast, Action Alternative 2 bases additional shortage distributions on the proportions of water used by different users; this results in relatively higher magnitudes of reductions in California and lower reductions in Arizona. For Nevada, the two approaches to distributing shortages do not have a strong impact on shortage magnitudes.

When system conservation and additional shortages are both considered, the Proposed Action shows higher reductions for California than any of the other alternatives. For Arizona, the Proposed Action has lower reductions than Action Alternative 1 but higher reductions than Action Alternative 2 in 2025 and reductions similar to the No Action Alternative in 2026. Since Nevada has no assumed system conservation, additional reductions are only due to additional shortages under Action Alternatives 1 and 2. Changes in modeled ICS behavior result in much lower depletions by Nevada under the Proposed Action compared with under the other alternatives.

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Attachment B-1

Action Alternatives 1 and 2 CRMMS Modeling Assumptions

Attachment B-1. CRMMS Modeling Assumptions

This attachment describes the CRMMS modeling assumptions for Action Alternatives 1 and 2. CRMMS modeling assumptions for the No Action Alterative and Proposed Action are detailed in **Appendix D**. The assumptions common to all alternatives in **Appendix D, Section D.6.1** and **Section D.7.1** also apply to Action Alternatives 1 and 2.

B-1.1 Lake Powell Operations under Action Alternatives 1 and 2

The Lake Powell operations under Action Alternatives 1 and 2 are the same. For operating year 2023 and 2024, CRMMS solves for Lake Powell operations as described for the No Action Alternative (**Appendix D, Section D.6.2**). For operating years 2025 and 2026, CRMMS solves for the Lake Powell operating tier and operating year release as follows using the projected physical pool elevation:

- If the projected Lake Powell end-of-calendar-year pool elevation is greater than or equal to the equalization level (**Appendix D**, **Table D-8**), the Equalization Tier operations govern the operating year releases (see **Section D.6.3.1**).
- If the Lake Powell end-of-calendar-year pool elevation is less than the equalization level and greater than or equal to 3,575 feet, the Upper Elevation Balancing Tier governs the operating year releases (see **Section D.6.3.2**).
- If the Lake Powell end-of-calendar-year pool elevation is less than 3,575 feet, the new Lower Elevation Release Tier governs the operating year releases (see **Section D.6.3.3**).

The operating year release calculation for each tier is described below for Action Alternatives 1 and 2.

B-1.1.1 Equalization Tier

The Equalization Tier method for Lake Powell under Action Alternatives 1 and 2 is identical to that under the No Action Alternative (**Appendix D**, **Section D.6.2**).

B-1.1.2 Upper Elevation Balancing Tier

The Upper Elevation Balancing Tier method for Lake Powell under Action Alternatives 1 and 2 is identical to that under the No Action Alternative (**Appendix D**, **Section D.6.2**).

B-1.1.3 Lower Elevation Release Tier

Operating year 2023 operates in the Lower Elevation Balancing Tier, as set by the August 2022 24-Month Study. The calculation of the Lake Powell annual release for operating year 2023 is identical to that for the No Action Alternative (**Appendix D**, **Section D.6.2**). Operating year 2024 also operates consistent with operating year 2024 under the No Action Alternative.

For operating years beyond 2024, the Lower Elevation Release Tier is modeled by first setting the annual release volume to 8.23 maf. Lake Powell resolves with the 8.23-maf annual release for monthly releases and pool elevations. Next, a rule checks the projected Lake Powell end-of-water-year pool elevation (for example, September 30, 2024, when the model is executing in August 2023) and sets the operating year release as follows:

- If the projected Lake Powell end-of-water-year pool elevation is greater than or equal to 3,575 feet, set the operating year release to 8.23 maf.
- If the projected Lake Powell end-of- water-year pool elevation is less than 3,575 feet and greater than or equal to 3,550 feet, set the operating year release to 7.48 maf.
- If the projected Lake Powell end-of-water-year pool elevation is less than 3,550 feet and greater than or equal to 3,525 feet, set the operating year release to 7.00 maf.
- If the Lake Powell end-of-water-year pool elevation is less than 3,525 feet, set the operating year release to 6.00 maf.

B-1.1.4 Protection Level

Action Alternatives 1 and 2 specify a protection level at Lake Powell such that if, in any month, Lake Powell's elevation is below 3,500 feet, the Lake Powell release would be set to maintain or increase the elevation with a maximum release of 6.0 maf. The goal would be to maintain LTEMP minimum flows, subject to run-of-the-river conditions, operational constraints, and prudent operations as determined by Reclamation.

In CRMMS, this is modeled by constraining monthly releases to ensure the pool elevation does not drop below 3,500 feet. If the operating year starts with Lake Powell below 3,500 feet and if the monthly release will cause the elevation to decrease, then the monthly release is decreased to maintain the current elevation. It is also constrained by the river outlet works' capacity. If the monthly outflow results in an increase in pool elevation, the method will try to release any constrained volume from earlier in the operating year while staying above the protection elevation of 3,500 feet.

If Lake Powell is greater than or equal to 3,500 feet at the beginning of the operating year, then all monthly releases are constrained such that the end-of-month pool elevation does not fall below 3,500 feet. The constrained release volume is tracked throughout the operating year. If a release for a given month is above 3,500 feet, then the method will try to release the previously constrained volume such that Lake Powell remains at or above 3,500 feet at the end of the month.

B-1.1.5 Disaggregation from Annual to Monthly Release

Lake Powell operating year releases are disaggregated to monthly releases using the same method used for the No Action Alternative. To assist in the solution of monthly releases, an additional column was added to **Table Attachment D-1** for a 6.0-maf annual release (**Table Attachment B-1**). This monthly distribution is used for modeling purposes only.

Table Attachment B-1
Monthly Distribution of Lake Powell Releases for a 6.0-maf Annual Release (af)

Annual Total	**6,000,000**
October	410,000
November	430,000
December	510,000
January	570,000
February	500,000
March	530,000
April	470,000
May	470,000
June	500,000
July	560,000
August	600,000
September	450,000

B-1.2 Lake Mead Operations under Action Alternatives 1 and 2

In CRMMS, Lake Mead operations are modeled by solving for the Lower Basin condition, Lower Basin and Mexico diversions, and ICS and other conservation activity.

B-1.2.1 Action Alternative 1

The Lake Mead operations and Lower Basin conditions for Action Alternative 1 are similar to those under the No Action Alternative (that is, the shortage and DCP contribution volumes are based on Lake Mead elevations). For operating years 2023 and 2024, CRMMS solves for the Lake Mead operations as described in the No Action Alternative; the physical pool elevation is used to calculate Lake Mead operations and the Lower Basin conditions. For operating years 2025 and 2026, CRMMS solves for the Lake Mead operations and Lower Basin conditions using the physical elevations at Lake Mead with additional shortages applied at different Lake Mead elevations.

Surplus

The surplus model assumptions for the Lower Basin under Action Alternative 1 are identical to those under the No Action Alternative (**Appendix D**, **Section D.7.2**).

Normal Condition

The normal condition model assumptions for the Lower Basin under Action Alternative 1 are identical to those under the No Action Alternative (**Appendix D**, **Section D.7.2**).

Shortage Condition

Under Action Alternative 1, for operating years 2025 and 2026, the Lower Basin is modeled to operate in a shortage condition when the projected Lake Mead end-of-calendar-year pool elevation is at or below 1,090 feet. For 2023 and 2024, operations are identical to those under the No Action Alterative. In CRMMS, a rule solves for the shortage condition in January by comparing Lake

Mead's previous end-of-calendar-year pool elevation with the defined pool elevations in **Table Attachment B-2**; the total Lower Division States' shortage volumes correspond to the shortage condition and operating year in **Table Attachment B-2**. The total shortage is then distributed by priority among the Lower Division States and water users by following the method used in the shortage allocation model for Action Alternative 1 (see **Appendix E**, Shortage Allocation Model Documentation).

Table Attachment B-2
Lower Division States' Shortages and DCP Contributions (1,000 af)

Lake Mead Elevation (feet)	Shortages	DCP Contributions	Additional Shortages under Action Alternatives 1 and 2	Total Combined (Shortages + DCP Contributions)
	2007 Interim Guidelines	2019 DCPs	Additional Shortage in 2025–2026	Action Alts 1 and 2 2025–2026
1,090 to >1,075	0	200	200	400
1,075 to 1050	333	200	533	1,066
<1,050 to >1,045	417	200	617	1,234
1,045 to >1,040	417	450	867	1,734
1,040 to >1,035	417	500	1,166	2,083
1,035 to >1,030	417	550	1,116	2,083
1,030 to 1,025	417	600	1,066	2,083
<1,025	500	600	983	2,083

The distribution of shortages among water users was computed outside CRMMS and is applied in two stages. When distributing shortage volumes by priority using the shortage allocation model method, total reductions include the reductions specified by the 2007 ROD and 2019 DCPs. In Stage 1, Nevada and Arizona users are shorted. Nevada is assigned 4 percent of the total reduction, which is Nevada's apportionment divided by the total Lower Division States' apportionment (that is, 300,000 af/7,500,000 af). The remainder of the total reduction is assigned to Arizona, which is 96 percent of the total reduction. Once Arizona Priority 4 entitlements are fully shorted (that is, water use is set to zero), Stage 2 is entered.

In Stage 2, all Lower Division States' uses are reduced proportionally to the remaining consumptive uses scheduled in CRMMS. Reductions taken by Nevada and Arizona in Stage 1 are subtracted from each state's annual scheduled consumptive use when determining state reductions.

$$Stage2Reduction_n = Stage2Reduction * \left(\frac{ScheduledUse_n - Stage1Reduction_n}{LDSTotalUse - Stage1Reduction}\right)$$

where n is an individual state.

Once the total state reductions are calculated for each Lower Basin shortage condition, total reductions are split into reduction types (that is, 2007 ROD shortage, Action Alternative 1 shortage, and 2019 DCP contributions). The 2019 DCP contributions can be larger than the specified additional shortage based on the modeled application of Action Alternative 1. In this case, the larger volume is applied, which causes larger total reductions than the volumes based on a given elevation range. A summary of the modeled shortage by state and priority for Action Alternative 1 is in **Attachment B-3**, **Table Attachment B-7**, **Table Attachment B-8**, and **Table Attachment B-9**. Tables are provided for 2025 and 2026 separately because CRMMS depletion schedules vary slightly each year, which results in slightly different distributions of shortages.

Within each state, reductions are distrusted by priority, where the lowest-priority users are shorted completely before shorting any higher-priority user. The assumed priorities of CRMMS users are summarized in **Attachment B-3**. Shortages that are assigned to a specific priority are distributed proportionally across users in a priority group based on CRMMS input annual water depletion schedules.

$$MonthlyShortage_i = AnnualShortage_P * \left(\frac{AnnualWaterUse_i}{AnnualWaterUse_P}\right) * \left(\frac{MonthlyWaterUse_i}{AnnualWaterUse_i}\right)$$

where *P* is a group of water users in the same priority within a state, and *i* is the specific water user within the priority group.

Minute 323 High- and Low-Elevation Reservoir Conditions

The Minute 323 model assumptions for the Lower Basin under Action Alternative 1 are identical to those under the No Action Alternative.

DCP and BWSCP

The DCP and BWSCP model assumptions for the Lower Basin under Action Alternative 1 are identical to those under the No Action Alternative.

ICS

The ICS model assumptions for the Lower Basin under Action Alternative 1 are identical to those under the No Action Alternative.

System Conservation

In addition to shortage and DCP contributions based on Lake Mead operations, Lower Basin demands are assumed to be reduced for system conservation after agreements have been finalized. **Table Attachment B-3** shows the system conservation modeled for Action Alternative 1. The volumes in 2023 and 2024 match those under the No Action Alternative.

Table Attachment B-3
System Conservation under Action Alternative 1

Modeled SEIS Conservation	2023	2024	2025	2026	Total
California					
System Conservation					
Palo Verde Irrigation District	58,400	39,800	—	—	98,200
California Total	**58,400**	**39,800**	—	—	**98,200**
Arizona					
System Conservation					
Gila River Indian Community	91,950	125,000	—	—	216,950
Fort McDowell Yavapai Nation	13,933	13,933	—	—	27,866
Central Arizona Project Subcontractors	62,200	42,200	—	—	104,400
Mohave Valley Irrigation and Drainage District	12,819	—	—	—	12,819
Yuma Mesa Irrigation and Drainage District	13,670	—	—	—	13,670
Gabrych Farms	3,240	3,240	—	—	6,480
Arizona Total	**197,812**	**184,373**	—	—	**382,185**
Total Modeled System Conservation	**256,212**	**224,173**	—	—	**480,385**

B-1.2.2 Action Alternative 2

The Lake Mead operations and Lower Basin conditions under Action Alternative 2 are similar to those under the No Action Alternative (that is, shortage and DCP contribution volumes are based on Lake Mead elevations). For operating years 2023 and 2024, CRMMS solves for Lake Mead operations as described in the No Action Alternative; the physical pool elevation is used to calculate Lake Mead operations and the Lower Basin conditions. For operating years 2025 and 2026, CRMMS solves for the Lake Mead operations and Lower Basin conditions using the physical elevations at Lake Mead with additional shortages applied at different Lake Mead elevations.

Surplus

The surplus model assumptions for the Lower Basin under Action Alternative 2 are identical to those under the No Action Alternative.

Normal Condition

The normal condition model assumptions for the Lower Basin under Action Alternative 2 are identical to those under the No Action Alternative.

Shortage Condition

Under Action Alternative 2, the Lower Division States' total shortage volumes are the same as they are under Action Alternative 1 (**Table Attachment B-2**); however, the shortage distribution between states and water users is different. For Action Alternative 2, shortages in addition to the 2007 ROD shortages and 2019 DCP contributions are distributed in the same percentage across all Lower Basin water users based on the 2021 adjusted consumptive use for CRMMS water users. The total shortage distributed among the Lower Division States and water users follows the method used in the shortage allocation model for Action Alternative 2 (see **Appendix D**).

The distribution of shortages to individual water users is performed outside CRMMS. Specific shortage volumes for each water user and the shortage conditions are input into CRMMS. These shortages are computed by determining the percentage reduction for each water user based on the additional shortage's percentage of the total Lower Division States' consumptive use:

$$UserAdditionalShortage_i = \frac{TotalLDSShortage}{7{,}500{,}000} * UserDepletionScheduleUse_i$$

where i is each Lower Division State's water user modeled in CRMMS.

In applying shortages and DCP contributions under Action Alternative 2, first, the 2007 ROD shortages and 2019 DCP contributions are applied to the users identified in these CRMMS modeling assumptions. Then, the additional shortages are applied using the above equation. A rule applies the shortage to water users by spreading the annual shortage over all months proportionally to the users' monthly depletion schedules.

$$MonthlyShortage_i = AnnualShortage_i * \left(\frac{MonthlyWaterUse_i}{AnnualWaterUse_i}\right)$$

where i is an individual water user.

A summary of the modeled shortage by state for Action Alternative 2 is in **Attachment B-3**, **Table Attachment B-9**.

Minute 323 High- and Low-Elevation Reservoir Conditions

The Minute 323 model assumptions for the Lower Basin under Action Alternative 2 are identical to those under the No Action Alternative.

DCP and BWSCP

The DCP and BWSCP model assumptions for the Lower Basin under Action Alternative 2 are identical to those under the No Action Alternative.

ICS

The ICS model assumptions for the Lower Basin under Action Alternative 2 are identical to those under the No Action Alternative.

System Conservation

The system conservation assumptions for the Lower Basin under Action Alternative 2 are identical to those under Action Alternative 1.

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Attachment B-2

CRMMS Lower Basin Water User Priorities

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Attachment B-2. CRMMS Lower Basin Water User Priorities

Table Attachment B-4 through **Table Attachment B-6** list the CRMMS users and the corresponding assumed priorities that are used for purposes of distributing shortages under Action Alternative 1. Water user depletion schedules are summarized in **Appendix D**, **Table Attachment D-2**. The water user names are provided exactly as they show up in CRMMS; abbreviations are not defined.

Table Attachment B-4
CRMMS Water Users by Priority for Arizona

Arizona		
Priority 1 (P1)	**Priority 2, 3 (P2,3)**	**Priority 4 (P4)**
AzPumpersBlwImp P1	CibolaNWR	AzPumpersAbvImp
BrookeWater P1	City of Yuma P3	AzPumpersBlwImp P4
City of Parker P1	DavisDamProject	AzPumpersDvsToPkr
City of Yuma P1	DesertLawnMemorial	BrookeWater P4
Cocopah Indian Res	Gila Monster Farms P2,3	BullheadCity
CRIRAz	HavasuNWR	CAP P4
Ft Yuma	ImperialNWR	CibolaValleyIID
FtMohaveAz	LMNRA Az Mead	City of Parker P4
Gila Monster Farms P1	LMNRA Az Mohave	Ehrenberg
MohaveValleyIID P1	MCAirStation	Gila Monster Farms P4
NGVIDD P1	NGVIDD P 2,3	GoldenShores
UnitB P1	SouthernPacific	LakeHavasuCity
YCWUA P1	UnitB P2,3	MohaveValleyIID P4
	UofA	MohaveWaterConsDist
	WMIDD	
	YAO	
	YCWUA P2,3	
	YID	
	YMIDD	
	YumaProvingGround	
	YumaUnionHighScl	
	CAP P3	

Table Attachment B-5
CRMMS Water Users by Priority for Nevada

Nevada		
Present Perfected Rights (PPRs)	**SNWP Non-PPRs**	**Non-PPRs, Non-SNWP**
FtMohaveNv	BasicManagement	BigBend
LMNRA Mead PPR	BoulderCanyonProject	LMNRA Mohave P2
LMNRA Mohave PPR	City of Henderson	SCE
	LMNRA Mead P2	
	LVWashReturns	
	NvDeptFishGame	
	PacificCoastBuilding	
	SNWADiversion	
	SNWP	

Table Attachment B-6
CRMMS Water Users by Priority for California

California					
Present Perfected Rights (PPRs)	**Priority 1 (P1)**	**Priority 2 (P2)**	**Priority 3 (P3)**	**Priority 4 (P4)**	**No Priority (Pnone)**
CaPumpersDvsToPkr - PPR	PaloVerde P1	YumaProject	Coachella	MWD	CaPumpersAbvImp
Chemehuevi			IID – P3		CaPumpersDvsToPkr-Pnone
CRIRCa					SaltonSea
FtMohaveCa					YumaIsland
FYIR_Ranches					
IID – PPR					
Needles					
PaloVerde PPR					
Winterhaven					
YumaProject					

Attachment B-3

CRMMS Action Alternatives' Shortages and DCP Contributions

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Attachment B-3. CRMMS Action Alternatives' Shortages and DCP Contributions

Table Attachment B-7 through **Table Attachment B-9** include the assumed shortages and DCP contributions by state and priority (for Action Alternative 1) that were computed using the methods described in **Sections B.7.3.3** and **B.7.4.3**. These shortage volumes are imported to CRMMS to model Action Alternatives 1 and 2. Different tables are provided for 2025 and 2026 because CRMMS depletion schedules vary slightly between 2025 and 2026; this causes slightly different distributions of shortages.

Table Attachment B-7
2025 Action Alternative 1 CRMMS Shortages and DCP Contributions Table by State and Priority (values in af)

Lake Mead (feet)	Interim Guidelines Shortages		DCP Contributions			Additional Shortages[1]								Total Reductions			Lower Division States Total
	AZ	NV	AZ	NV	CA	AZ-P4	AZ-P2,3	NV	CA-P4 and CA-Pnone	CA-P3	CA-P2	CA-P1	CA-PPR	AZ	NV	CA	
>1,090	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,090–1,075	0	0	192,000	8,000	0	192,000	0	8,000	0[2]	0[2]	0[2]	0[2]	0[2]	384,000	16,000	0	400,000
1,075–1050	320,000	13,000	192,000	8,000	0	511,360	0	21,640	0[2]	0[2]	0[2]	0[2]	0[2]	1,023,360	42,640	0	1,066,000
1,050–1,045	400,000	17,000	192,000	8,000	0	592,640	0	24,360	0[2]	0[2]	0[2]	0[2]	0[2]	1,184,640	49,360	0	1,234,000
1,045–1,040	400,000	17,000	240,000	10,000	200,000	880,311	32,011	42,389	0[2]	0[2]	0[2]	0[2]	0[2]	1,552,322	69,389	200,000	1,821,711
1,040–1,035	400,000	17,000	240,000	10,000	250,000	880,311	106,320	56,417	122,953	0	0	0	0	1,626,630	83,417	372,953	2,083,000
1,035–1,030	400,000	17,000	240,000	10,000	300,000	880,311	106,320	56,417	72,953	0	0	0	0	1,626,630	83,417	372,953	2,083,000
1,030–1,025	400,000	17,000	240,000	10,000	350,000	880,311	106,320	56,417	22,953	0	0	0	0	1,626,630	83,417	372,953	2,083,000
<1,025	480,000	20,000	240,000	10,000	350,000	800,311	106,320	53,417	22,953	0	0	0	0	1,626,630	83,417	372,953	2,083,000

Footnotes:
[1]AZ-P4 = Arizona Priority 4; AZ-P2,3 = Arizona Priority 2 and Priority 3; CA-P4 = California Priority 4; CA-Pnone = California users with no priority; CA-P3 = California Priority 3; CA-P2 = California Priority 2; CA-P1 = California Priority 1; CA-PPR = California Priority Perfected Right; CRMMS users are categorized by priority in **Table Attachments B-4**, **B-5**, and **B-6**.

[2]In this elevation tier, the 2019 DCP contributions for California exceed what would be required under Action Alternative 1. As a result, no additional shortage is required in this elevation tier for California.

Disclaimer: These modeling inputs (for Action Alternative 1) should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as Reclamation's position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This modeled methodology is not a substitute for the annual process of reviewing water orders and determining which can be filled; the model methodology cannot replicate the precision required of that annual process.

Table Attachment B-8
2026 Action Alternative 1 CRMMS Shortages and DCP Contributions Table by State and Priority (values in af)

Lake Mead (feet)	Interim Guidelines Shortages		DCP Contributions			Additional Shortages[2]								Total Reductions			Lower Division States Total
	AZ	NV	AZ	NV	CA	AZ-P4	AZ-P2,3	NV	CA-P4 and CA-Pnone	CA-P3	CA-P2	CA-P1	CA-PPR	AZ	NV	CA	
>1,090	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,090–1,075	0	0	192,000	8,000	0	192,000	0	8,000	0[1]	0[1]	0[1]	0[1]	0[1]	384,000	16,000	0	400,000
1,075–1050	320,000	13,000	192,000	8,000	0	511,360	0	21,640	0[1]	0[1]	0[1]	0[1]	0[1]	1,023,360	42,640	0	1,066,000
1,050–1,045	400,000	17,000	192,000	8,000	0	592,640	0	24,360	0[1]	0[1]	0[1]	0[1]	0[1]	1,184,640	49,360	0	1,234,000
1,045–1,040	400,000	17,000	240,000	10,000	200,000	880,311	32,519	42,360	0[1]	0[1]	0[1]	0[1]	0[1]	1,552,830	69,360	200,000	1,822,190
1,040–1,035	400,000	17,000	240,000	10,000	250,000	880,311	108,007	56,320	121,363	0	0[1]	0	0[1]	1,628,317	83,320	371,363	2,083,000
1,035–1,030	400,000	17,000	240,000	10,000	300,000	880,311	108,007	56,320	71,363	0	0	0	0	1,628,317	83,320	371,363	2,083,000
1,030–1,025	400,000	17,000	240,000	10,000	350,000	880,311	108,007	56,320	21,363	0	0	0	0	1,628,317	83,320	371,363	2,083,000
<1,025	480,000	20,000	240,000	10,000	350,000	800,311	108,007	53,320	21,363	0	0	0	0	1,628,317	83,320	371,363	2,083,000

Footnotes:
[1]In this elevation tier, the 2019 DCP contributions for California exceed what would be required under Action Alternative 1. As a result, no additional shortage is required in this elevation tier for California.
[2]AZ-P4 = Arizona Priority 4; AZ-P2,3 = Arizona Priority 2 and Priority 3; CA-P4 = California Priority 4; CA-Pnone = California users with no priority; CA-P3 = California Priority 3; CA-P2 = California Priority 2; CA-P1 = California Priority 1; CA-PPR = California Priority Perfected Right; CRMMS users are categorized by priority in **Table Attachments B-4**, **B-5**, and **B-6**.

Disclaimer: These modeling inputs (for Action Alternative 1) should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as Reclamation's position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This modeled methodology is not a substitute for the annual process of reviewing water orders and determining which can be filled; the modeled methodology cannot replicate the precision required of that annual process.

Table Attachment B-9
2025–2026 Action Alternative 2 CRMMS Shortage Volume Table (values in af)

Lake Mead Pool Elevation (feet)	Interim Guidelines Shortages		DCP Contributions			Additional Shortages			Total Shortages			Lower Division States Total
	AZ	NV	AZ	NV	CA	AZ	NV	CA	AZ	NV	CA	
>1,090	0	0	0	0	0	0	0	0	0	0	0	0
1,090–1,075	0	0	192,000	8,000	0	74,666	8,001	117,333	266,666	16,001	117,333	400,000
1,075–1050	320,000	13,000	192,000	8,000	0	198,986	21,321	312,693	710,986	42,321	312,693	1,066,000
1,050–1,045	400,000	17,000	192,000	8,000	0	230,349	24,680	361,971	822,349	49,680	361,971	1,234,000
1,045–1,040	400,000	17,000	240,000	10,000	200,000	323,677	34,681	508,642	963,677	61,681	708,642	1,734,000
1,040–1,035	400,000	17,000	240,000	10,000	250,000	435,307	46,640	684,053	1,075,307	73,640	934,053	2,083,000
1,035–1,030	400,000	17,000	240,000	10,000	300,000	416,640	44,639	654,721	1,056,640	71,639	954,721	2,083,000
1,030–1,025	400,000	17,000	240,000	10,000	350,000	397,974	42,640	625,386	1,037,974	69,640	975,386	2,083,000
<1,025	480,000	20,000	240,000	10,000	350,000	366,988	39,319	576,693	1,086,988	69,319	926,693	2,083,000

Disclaimer: These modeling inputs (for Action Alternative 2) should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as Reclamation's position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This modeled methodology is not a substitute for the annual process of reviewing water orders and determining which can be filled; the modeled methodology cannot replicate the precision required of that annual process.

Appendix C

Original Draft SEIS Action Alternatives 1 and 2

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Appendix C. Original Draft SEIS Action Alternatives 1 and 2

C.1 Introduction

This appendix describes Action Alternatives 1 and 2 from the original Draft SEIS, which was withdrawn after submittal of the Lower Division Proposal.

C.2 Action Alternative 1

This alternative describes a set of actions adopted pursuant to Secretarial authority under applicable federal law. Unlike current operations that were developed, and are being implemented, pursuant to basin-wide consensus (for example, the 2007 Interim Guidelines and the 2019 DCPs), Action Alternative 1 models changes to operations for both Glen Canyon Dam and Hoover Dam as developed by Reclamation. Action Alternative 1 includes assumptions for reduced releases from Glen Canyon Dam and additional Lower Basin shortages based on the concept of priority.[1] Action Alternative 1 models releases between 6.0 maf and 8.23 maf from Lake Powell when it is below 3,575 feet, with potentially lower releases to preserve the elevation of 3,500 feet.[2]

Action Alternative 1 models progressively larger additional shortages as Lake Mead's elevation declines. It also models larger additional shortages in 2025–2026 as compared with 2024. The total shortages and DCP contributions in 2024, as modeled, are limited to 2.083 maf. This is because this is the maximum volume analyzed in the 2007 FEIS, and to analyze shortages greater than 2.083 maf would require additional detailed analysis and stakeholder coordination. Working within this range of previously analyzed impacts will facilitate completing this SEIS process in the time available in advance of the 2024 operating year. Delaying operational decisions to perform additional analyses would not meet the express purpose of and need for this action.

For all operations, including, but not limited to when Lake Powell is approaching 3,500 feet or when Lake Mead is approaching 950 feet, the Secretary reserves the right to operate Reclamation facilities to address extraordinary circumstances, as described in Section 7(D) of the 2007 Interim Guidelines, including "operations that are prudent or necessary for safety of dams, public health and safety,

[1] Priority refers the distribution of Colorado River water in the Lower Division States of Arizona, California, and Nevada as subject to laws, judicial rulings and decrees, contracts, interstate compacts, and operating criteria, known as the "Law of the River," which apportion available water between the states and establish certain priorities in use.
[2] The action alternatives would protect an elevation of 3,500 feet in Lake Powell to provide a buffer above minimum power pool, which is at 3,490 feet.

other emergency situations, or other unanticipated or unforeseen activities arising from actual operating experience."

C.2.1 Shortage Guidelines

Table C-1 shows the Lower Basin shortages under the 2007 Interim Guidelines, contributions under the 2019 DCPs, and additional shortages modeled under Action Alternative 1 in calendar year 2024. Assumptions regarding the breakdown of shortages and contributions by state, according to priority, are shown in **Table C-2**. Reclamation may consider additional shortages in Shortage Condition Year 2025 and 2026 (see **Table C-3**). This consideration would occur as part of the future analysis referenced in **Section 1.2** before the 2025 operating year operating condition determination.

Figure C-1 shows a graphical view of Lower Basin shortages and contributions from the 2007 Interim Guidelines and the 2019 DCPs plus additional shortages modeled under Action Alternative 1.

Whenever Lake Mead's content is projected to be below an elevation of 1,000 feet, based on the January 1 projection or a mid-year review, additional reductions may be needed to protect the minimum power pool (elevation 950 feet) and to reduce the risk of declining to dead pool (elevation 895 feet).

Table C-1
Lower Division States' Shortages and DCP Contributions, Action Alternatives 1 and 2 (2024)*

Lake Mead Elevation (feet)	No Action Alternative			Additional Shortages under Action Alternatives 1 and 2 (2024)	
	2007 ROD Shortages (1,000 af)	2019 DCP Contributions (1,000 af)	No Action Total (1,000 af)	2024 Additional Shortages (1,000 af)	2024 Total Shortages + Contributions (1,000 af)
1,090 – >1,075	0	200	200	200	**400**
1,075 – 1,050	333	200	533	533	**1,066**
<1,050 – >1,045	417	200	617	617	**1,234**
1,045 – >1,040	417	450	867	867	**1,734**
1,040 – >1,035	417	500	917	1,166	**2,083**
1,035 – >1,030	417	550	967	1,116	**2,083**
1,030 – 1,025	417	600	1,017	1,066	**2,083**
<1,025 – 1,000	500	600	1,100	983	**2,083**
<1,000 – 975	500	600	1,100	983	**2,083**
<975 – 950	500	600	1,100	983	**2,083**
<950	500	600	1,100	983	**2,083**

* This table only shows combined Lower Division State shortage volumes and DCP contributions. In addition to the volumes shown in this table, the analysis for each alternative includes water delivery reductions to Mexico under low-elevation reservoir conditions and Mexico's savings that contribute to the Binational Water Scarcity Contingency Plan, in accordance with Minute 323 to the 1944 Water Treaty.

Table C-2
Lower Division States' Shortages and DCP Contributions by State, Action Alternative 1 (2024)

Lake Mead Elevation (feet)	2007 ROD Shortage + 2019 DCP Contributions (1,000 af)				2024 Action Alternative 1 Additional Shortage* (1,000 af)				2024 Total Shortages + Contributions (1,000 af)			
	AZ	NV	CA	Total	AZ	NV	CA	Total	AZ	NV	CA	Total
1,090 – >1,075	192	8	0	200	192	8	0	200	384	16	0	400
1,075 – 1,050	512	21	0	533	511	22	0	533	1,023	43	0	1,066
<1,050 – >1,045	592	25	0	617	593	24	0	617	1,185	49	0	1,234
1,045 – >1,040	640	27	200	867	1,025	42	0**	1,067	1,665	69	200	1,734***
1,040 – >1,035	640	27	250	917	1,098	56	12	1,166	1,738	83	262	2,083
1,035 – >1,030	640	27	300	967	1,098	56	0**	1,154	1,738	83	300	2,083***
1,030 – 1,025	640	27	350	1,017	1,098	56	0**	1,154	1,738	83	350	2,083***
<1,025 – 1,000	720	30	350	1,100	1,018	53	0**	1,071	1,738	83	350	2,083***
<1,000 – 975	720	30	350	1,100	1,018	53	0**	1,071	1,738	83	350	2,083***
<975 – 950	720	30	350	1,100	1,018	53	0**	1,071	1,738	83	350	2,083***
<950	720	30	350	1,100	1,018	53	0**	1,071	1,738	83	350	2,083***

*The additional shortage volumes decrease at elevation 1,025 feet because the shortages under the 2007 Interim Guidelines increase by the same amount. Therefore, the additional shortage amounts necessary to get to the 2.083 maf total are lower.
**In this elevation tier, the 2019 DCP contributions for California exceed what would be required under Action Alternative 1. As a result, no additional shortage is required in this elevation tier for California.
***Because the 2019 DCP contributions for California exceed the 2024 total shortage and contribution volume as modeled by the Action Alternative 1 Shortage Allocation Model, the sum of the three state totals exceeds the total shortage and contribution volume. While the total amount of the three states' total shortage and contribution volume exceeds 2.083 maf in the elevation tiers below elevation 1,035 feet, the ROD would not exceed a total shortage and contribution volume of 2.083 maf in calendar year 2024.

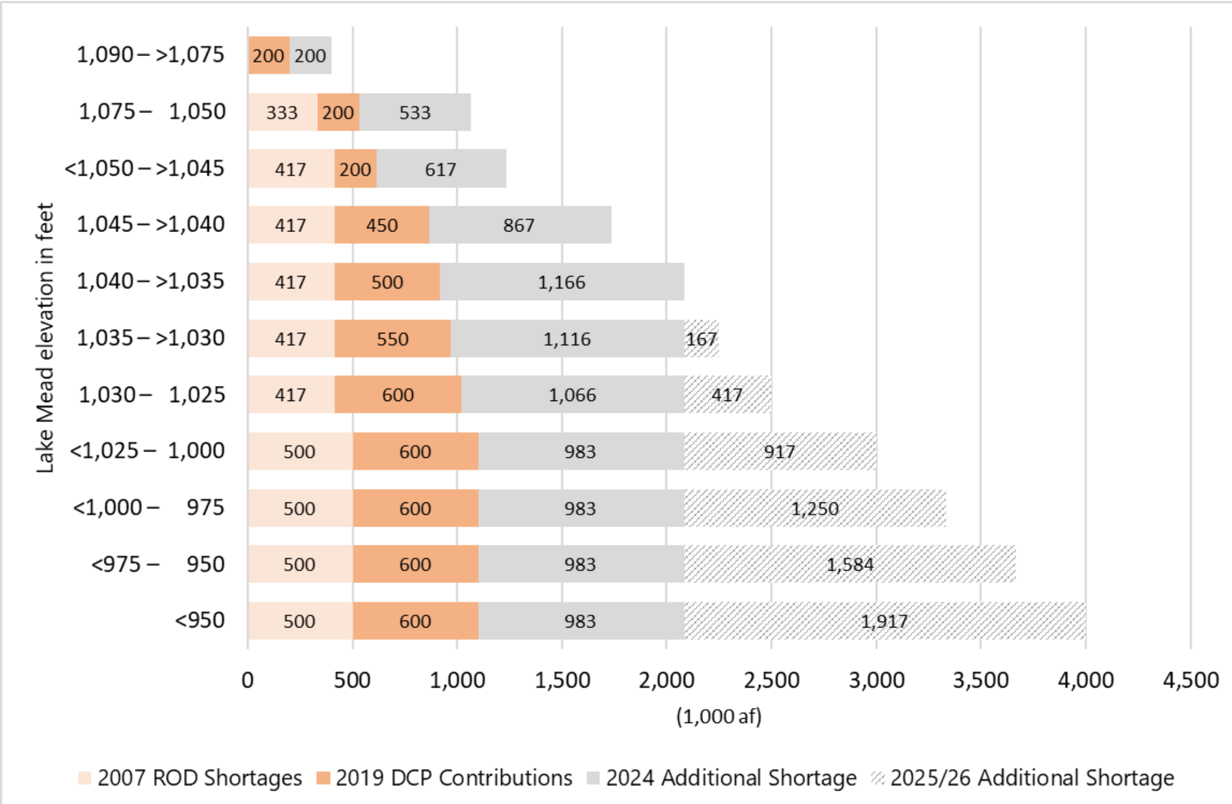
Table C-3
Lower Division States' Shortages and DCP Contributions, Action Alternatives 1 and 2 (2025–2026)*

Lake Mead Elevation (feet)	No Action Alternative			Additional Shortages under Action Alternatives 1 and 2 (2025–2026)	
	2007 ROD Shortage (1,000 af)	2019 DCP Contributions (1,000 af)	No Action Total (1,000 af)	2025–2026 Additional Shortage** (1,000 af)	2025–2026 Total Shortages + Contributions (1,000 af)
1,090 – >1,075	0	200	200	200	**400**
1,075 – 1,050	333	200	533	533	**1,066**
<1,050 – >1,045	417	200	617	617	**1,234**
1,045 – >1,040	417	450	867	867	**1,734**
1,040 – >1,035	417	500	917	1,166	**2,083**
1,035 – >1,030	417	550	967	1,283	**2,250**
1,030 – 1,025	417	600	1,017	1,483	**2,500**
<1,025 – 1,000	500	600	1,100	1,900	**3,000**
<1,000 – 975	500	600	1,100	2,233	**3,333**
<975 – 950	500	600	1,100	2,567	**3,667**
<950	500	600	1,100	2,900	**4,000**

* This table only shows combined Lower Division State shortage volumes and DCP contributions. In addition to the volumes shown in this table, the analysis for each alternative includes water delivery reductions to Mexico under low-elevation reservoir conditions and Mexico's savings that contribute to the Binational Water Scarcity Contingency Plan, in accordance with Minute 323 to the 1944 Water Treaty.

The scope of this NEPA analysis, including potential actions in 2025–2026, is discussed further in **Sections 1.2 and **1.5**.

Figure C-1
Modeled Lower Basin Shortages and DCP Contributions, Action Alternatives 1 and 2



C.2.2 Coordinated Reservoir Operations

Under Action Alternative 1, the annual Lake Powell release is based on the volume of water in storage or the corresponding elevation of Lake Powell and Lake Mead, as described in the operational tiers below (see **Table C-4**). The Equalization and Upper Elevation Balancing Tiers are the same as under the No Action Alternative. The Mid-Elevation Release Tier and Lower Elevation Balancing Tier are combined into a single Lower Elevation Release Tier, and a Protection Level is also included. The applicable operational tier is based on the August 24-Month Study projections of the January 1 system storage and reservoir water surface elevations for the following operating year.

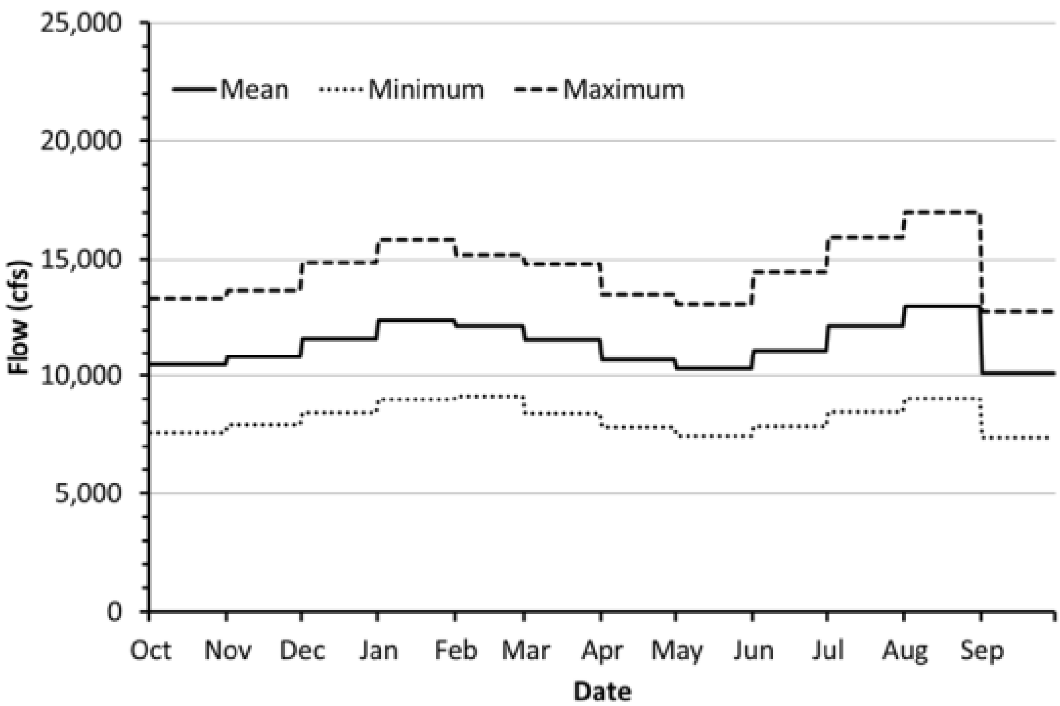
Hourly, daily, and monthly releases from Lake Powell for coordinated operations would be consistent with the parameters of the ROD for the LTEMP EIS (Reclamation and NPS 2016). Monthly releases from Glen Canyon Dam would be distributed proportionally across months for annual releases below 7.0 maf (see **Figure C-2** for monthly distributions in a year when the annual release is 8.23 maf). If annual flows were adjusted mid-year, they would be distributed to meet the goals of the LTEMP, including potential distribution across monthly or experimental flow patterns, and including the unique resource considerations specific to any mid-year annual adjustments.

Table C-4
Lake Powell Operational Tiers, Action Alternatives 1 and 2

Lake Powell Operational Tiers (subject to April adjustments or mid-year review modifications)		
Lake Powell Elevation (feet)	**Lake Powell Operational Tier**	**Lake Powell Active Storage*** (maf)
3,700	**Equalization Tier** Equalize, avoid spills, or release 8.23 maf	**23.31**
3,636–3,666 (see Table 2.3-1 in the 2007 FEIS)	**Upper Elevation Balancing Tier** Release 8.23 maf; if Lake Mead <1,075 feet, balance contents with a minimum/maximum release of 7.0/9.0 maf	**14.65–18.36** (2008–2026)
3,575	**Lower Elevation Release Tier** Set initial release: 6.0 maf; adjust releases based on the April Lake Powell end-of-water-year elevation projection: ≥3,575 feet, release 8.23 maf <3,575 feet AND ≥3,550 feet, release 7.48 maf <3,550 feet AND ≥3,525 feet, release 7.0 maf <3,525 feet AND ≥3,500 feet, maintain release of 6.0 maf <3,500 feet, then reduce releases (gains equals losses) such that Lake Powell ends the operating year at 3,500 feet	**8.90**
3,500	**Protection Level** <3,500 feet, in any month, reduce releases (gains equals losses) such that Lake Powell ends the operating year at 3,500 feet	**4.22**
3,370		**0**

*Active storage values have been updated from 2007 based on the 2018 bathymetry.

Figure C-2
Mean, Minimum, and Maximum Monthly Flows under LTEMP in an 8.23-maf Year



Hourly and daily releases would follow LTEMP parameters, so long as sufficient water is available from the annual release. If sufficient water is not available from the annual release to meet hourly and daily LTEMP release parameters, hourly and daily releases would follow the base operation daily and nightly minimum flows (8,000 cubic feet per second [cfs] and 5,000 cfs, respectively), for as long as possible. If sufficient water is not available from the annual release to support the base operation nightly minimum flow of 5,000 cfs, hourly and daily releases would be consistent with the run of the river[3] to match Lake Powell inflows consistent with protecting an elevation of 3,500 feet at Lake Powell.

Lower Elevation Release Tier

When the projected January 1 Lake Powell elevation is below 3,575 feet, an initial annual release in the amount of 6.0 maf would be set from Lake Powell. Adjustments to the annual release may then be made based on the April 24-Month Study, as outlined below.

- If the April 24-Month Study projects the end-of-water-year elevation to be at or above 3,575 feet, an adjustment would be made to release 8.23 maf from Lake Powell.

[3] In a general sense, "run of the river" means the inflow equals the outflow, adjusted for operational considerations, such as evaporation, seepage, and release capacity.

- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,575 feet and at or above 3,550 feet, an adjustment would be made to release 7.48 maf from Lake Powell.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,550 feet and at or above 3,525 feet, an adjustment would be made to release 7.0 maf from Lake Powell.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,525 feet and at or above 3,500 feet, the release of 6.0 maf from Lake Powell would be maintained.
- If the April 24-Month Study projects the end-of-water-year elevation to be below 3,500 feet, the dam would be operated to maintain an elevation of at least 3,500 feet. Additionally, up to 6.0 maf would be released over the year with a goal of maintaining LTEMP minimum flows subject to run-of-the-river conditions, operational constraints, and prudent operations as determined by Reclamation.

Protection Level

If, in any month, Lake Powell's elevation is below 3,500 feet, the Lake Powell release would be set to maintain or increase the elevation with a maximum release of 6.0 maf; the goal would be to maintain LTEMP minimum flows subject to run-of-the-river conditions, operational constraints, and prudent operations as determined by Reclamation.

C.2.3 Implementation of Guidelines

The provisions for a mid-year review are the same as those under the No Action Alternative except revisions to shortages associated with Lake Mead elevation determinations in the mid-year review can be revised to allow for either further reduced deliveries or additional deliveries.

C.3 Action Alternative 2

This alternative describes a set of actions adopted pursuant to Secretarial authority under applicable federal law. Unlike current operations that were developed, and are being implemented, pursuant to basin-wide consensus (for example, the 2007 Interim Guidelines and the 2019 DCPs), Action Alternative 2 models changes to operations for both Glen Canyon Dam and Hoover Dam as developed by Reclamation. Action Alternative 2 models releases between 6.0 maf and 8.23 maf from Lake Powell when it is below 3,575 feet, with potentially lower releases to preserve an elevation of 3,500 feet and assumes additional inflow to Lake Powell pursuant to the 2019 DCPs.

Action Alternative 2 includes assumptions for reduced releases from Glen Canyon Dam and additional Lower Basin shortages that are not based exclusively on the concept of priority. While both the 2007 Interim Guidelines and the 2019 DCPs encompass reductions that reflect the priority system, the additional reductions identified in Action Alternative 2 for the remainder of the interim period would be distributed in the same percentage across all Lower Basin water users.[4] [5] Total additional shortage volumes for the Lower Basin are the same under Action Alternative 2 as under Action Alternative 1.

As under Action Alternative 1, Action Alternative 2 models progressively larger Lower Basin reductions as Lake Mead's elevation declines and models larger Lower Basin reductions in 2025–2026 as compared with 2024. The total shortages and DCP contributions in 2024, as modeled, are limited to 2.083 maf; this is because this is the maximum volume analyzed in the 2007 FEIS. Working within this range of previously analyzed impacts will facilitate completing this SEIS process in the time available in advance of the 2024 operating year. Delaying operational decisions to perform additional analyses would not meet the express purpose of and need for this action.

This alternative includes actions and modeling assumptions that have precedent in actions previously undertaken by Reclamation under applicable federal law in both the Upper Basin (2021–2022) and Lower Basin (see the 1964 Determination by Secretary Udall to impose equivalent percentile reductions in light of reduced flows from Glen Canyon Dam). The goal is to operate Colorado River system reservoirs in a manner that ensures continued operations in a prudent manner throughout a range of projected future hydrologic conditions.

For all operations, including, but not limited to when Lake Powell is approaching 3,500 feet or when Lake Mead is approaching 950 feet, the Secretary reserves the right to operate Reclamation facilities to address extraordinary circumstances, as described in Section 7(D) of the 2007 Interim Guidelines, including "operations that are prudent or necessary for safety of dams, public health and safety, other emergency situations, or other unanticipated or unforeseen activities arising from actual operating experience."

C.3.1 Shortage Guidelines

As stated above, total additional shortage volumes for the Lower Basin are the same under Action Alternative 2 as under Action Alternative 1. The additional shortage volumes identified in **Table C-1** and **Table C-3** for calendar years 2024 and 2025–2026, respectively, would be achieved by a reduction of available Lower Basin annual consumptive use, distributed in the same percentage across all Lower Basin water users at the specified Lake Mead elevations. The distribution of reductions as modeled in Action Alternative 2 is based on each user's consumptively used water in 2021, as reported in Reclamation's final Colorado River Accounting and Water Use Report: Arizona, California, and Nevada prepared pursuant to Article V of the Supreme Court's Decree in *Arizona v. California* (as adjusted for conservation).

[4] Entities holding an entitlement to Mainstream water under (a) the Consolidated Decree, (b) a water delivery contract with the United States through the Secretary, or (c) a reservation of water by the Secretary.

[5] For example, if the additional shortage amount is 1 maf, the percentage of additional shortage volume is calculated by dividing 1 maf by 7.5 maf, which equals 13 percent. Then, a 13 percent additional reduction is modeled for each Lower Basin water user based on current water use.

Table C-5 displays the percentage of the additional shortage volumes at specified Lake Mead elevations and the distribution for each Lower Division State as modeled in Action Alternative 2. Reclamation may consider additional shortages in Shortage Condition Years 2025 and 2026 (see **Table C-3**). This consideration would occur as part of the future analysis referenced in **Section 1.2** before the 2025 operating year operating condition determination.

Figure C-1 shows a graphical view of Lower Basin shortages and contributions from the 2007 Interim Guidelines and 2019 DCPs plus additional shortages modeled under Action Alternative 2.

Like Action Alternative 1, whenever Lake Mead's content is projected to be below an elevation of 1,000 feet, based on the January 1 projection or a mid-year review, additional reductions may be needed to protect the minimum power pool (elevation 950 feet) and to reduce the risk of declining to dead pool (elevation 895 feet).

Table C-5
2024 Lower Division States' Shortages and DCP Contributions by State, Action Alternative 2 (2024)

Lake Mead Elevation (feet)	2007 ROD Shortages + 2019 DCP Contributions (1,000 af)				2024 Additional Shortage* (1,000 af)					2024 Total Shortage + Contributions (1,000 af)			
	AZ	NV	CA	Total	Percentage Additional Reduction**	AZ	NV	CA	Total	AZ	NV	CA	Total
1,090 – >1,075	192	8	0	200	2.67%	75	8	117	200	267	16	117	400
1,075 – 1,050	512	21	0	533	7.11%	199	21	313	533	711	42	313	1,066
<1,050 – >1,045	592	25	0	617	8.23%	230	25	362	617	822	50	362	1,234
1,045 – >1,040	640	27	200	867	11.56%	324	35	509	867	964	62	709	1,734
1,040 – >1,035	640	27	250	917	15.55%	435	47	684	1,166	1,075	74	934	2,083
1,035 – >1,030	640	27	300	967	14.88%	417	45	655	1,116	1,057	72	955	2,083
1,030 – 1,025	640	27	350	1,017	14.21%	398	43	625	1,066	1,038	70	975	2,083
<1,025 – 1,000	720	30	350	1,100	13.11%	367	39	577	983	1,087	69	927	2,083
<1,000 – 975	720	30	350	1,100	13.11%	367	39	577	983	1,087	69	927	2,083
<975 – 950	720	30	350	1,100	13.11%	367	39	577	983	1,087	69	927	2,083
<950	720	30	350	1,100	13.11%	367	39	577	983	1,087	69	927	2,083

*The additional shortage volumes decrease at elevation 1,025 feet because the shortages under the 2007 Interim Guidelines increase by the same amount. Therefore, the additional shortage amounts necessary to get to the 2.083 maf total are lower.
**Percentage of 2021 consumptive use

C.3.2 Coordinated Reservoir Operations

The modifications to annual Lake Powell releases and operational tiers are the same as those under Action Alternative 1.

C.3.3 Implementation of Guidelines

The provisions for a mid-year review are the same as those under Action Alternative 1.

Appendix D
CRMMS Model Documentation

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Contents

Tables

Figure

Attachments

Appendix D. CRMMS Model Documentation

D.1 Introduction

Reclamation's CRMMS for the Basin is a Basin-wide operations model used to evaluate future system conditions for out to 5 years into the future. Specifically, the September 2022 CRMMS version is used for hydrologic modeling for this SEIS. This appendix provides a detailed overview of the model and its components, as well as the reservoir operations simulated in the model.

Reclamation uses two primary Basin-wide modeling and decision support tools: CRMMS and the Colorado River Simulation System (CRSS). CRMMS is run in two modes, the 24-Month Study Mode and the Ensemble Mode. The CRMMS 24-Month Study Mode is used to produce the 24-Month Study and the Annual Operating Plan. The 24-Month Study is an operational model with a 2-year outlook that uses a single most probable inflow forecast (updated monthly) provided by the National Weather Service's Colorado Basin River Forecast Center (CBRFC). The 24-Month Study is limited in its ability to incorporate hydrologic uncertainty because future reservoir operations must be input manually. Additionally, CRMMS can be run in Ensemble Mode to produce 1- to 5-year probabilistic projections of Basin conditions. CRMMS uses the CBRFC's Ensemble Streamflow Prediction (ESP) forecast (updated monthly) to provide more information about the risk and uncertainty for operations.

CRSS, which is used in long-term planning studies (for example, the 2007 FEIS) and the Colorado River Basin Water Supply and Demand Study), is a planning model that simulates Basin conditions decades into the future. Although CRSS accounts for hydrologic uncertainty in its ability to simulate hundreds of future hydrologic scenarios, it is limited in its ability to incorporate real-time forecasts and operations.

The CRMMS Ensemble Mode (referred to as CRMMS for the remainder of the appendix) provides probabilistic information about the uncertainty associated with Basin reservoir operations and future states of the system in the 1- to 5-year time frame. By supplementing the most probable projection of Basin conditions developed in the 24-Month Study, CRMMS provides a wider range of information for planning, risk analysis, and operational decision-making in the short- to mid-term planning horizons.

D.2 Overview

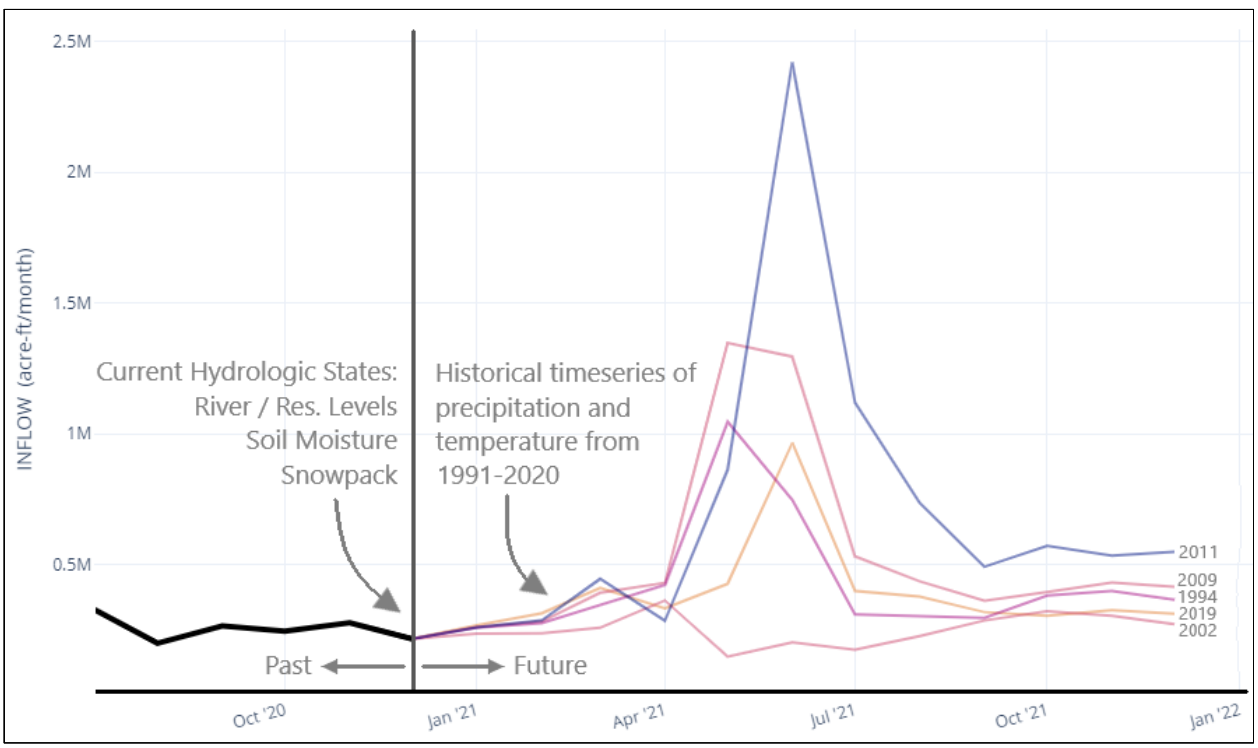
CRMMS is implemented in the commercial river modeling software called RiverWare™ developed by the Center for Advanced Decision Support for Water and Environmental Systems at the University of Colorado Boulder. Reclamation's Upper and Lower Basin Regions update and maintain the models continually, including review of model outputs.

The Basin-wide model simulates the operation of the major reservoirs on the Colorado River system and provides information regarding the projected future state of the system on a monthly basis. Output variables include the volume of water in storage, reservoir elevations, releases from the dams, energy generation, streamflow, and diversions to and return flows from water users throughout the system. Input data include physical parameters (such as individual reservoir storage capacity, evaporation rates, and reservoir release capabilities), initial reservoir conditions, and the depletion schedules for entities in the Lower Division States and for the United Mexican States (Mexico).

Upper Basin depletion schedules are not explicitly modeled in CRMMS; this is because the unregulated streamflow forecasts provided by the CBRFC include the impact of most Upper Basin depletions, except for three diversions: Gunnison Tunnel, Azotea Tunnel, and the Navajo Indian Irrigation Project (NIIP), which are individually input. These simulations use a mass balance (or water budget) calculation, which accounts for all water entering, stored in, and leaving the system. CRMMS contains a modeling "rule set," which simulates how water is released and delivered under various hydrologic conditions with the aim of simulating actual operations.

CRMMS provides information about risk and uncertainty for operations within a 1- to 5-year planning horizon. CRMMS uses an ensemble of unregulated streamflow forecasts developed by the CBRFC using ESP forecasts. **Figure D-1** depicts an example of ESP forecasts of future potential hydrologic inflows.

Figure D-1
Process for Developing ESP Forecasts



Source: Reclamation 2022e

D.2.1 Model Simulations

CRMMS simulates the operations of nine reservoirs in the Upper Basin, three reservoirs in the Lower Basin, river flows, energy generation, and diversions throughout the Basin. A description of each reservoir, the drivers of operation, and how reservoir operations are modeled in CRMMS are discussed in **Sections D.5** through **D.8**.

In understanding how CRMMS simulates operations, it is helpful to first understand the modeling process used to produce the 24-Month Study, which CRMMS attempts to replicate. To produce the 24-Month Study, Reclamation modelers first manually set releases for the reservoirs at the Upper Basin headwaters (**Table D-1**). Once operations are set for reservoirs farthest upstream, operations for the next downstream reservoirs can be entered. Information about upstream reservoir operations is required before operations can be set for the downstream reservoirs; this is because a full year of projected regulated inflow is needed to plan the reservoir releases at those downstream reservoirs. Additionally, operations for Lake Powell and Lake Mead are frequently set in an iterative manner, as Lake Powell and Lake Mead operations are coordinated based on their respective releases and resulting elevations and storages.

To simulate operations in CRMMS in a manner similar to the manual process used in producing the 24-Month Study, CRMMS takes advantage of a RiverWare feature called "run cycles." By using run cycles, RiverWare has the capability of cycling through the simulation (from the first time step to the last time step) multiple times during the run. With the aid of rule logic, CRMMS uses four run cycles to solve or "operate" the reservoirs from the Upper Basin headwaters downstream through the Lower Basin. **Table D-1** shows which reservoirs and outflows are solved within each run cycle. To initiate the model run for each year of the model run duration, Lower Basin depletion schedules are set with a default assumption of "normal condition" so that the entire Basin will solve when the rule logic solves for Lake Powell. Lower Basin Shortage and Surplus are assessed and applied in later run cycles; this is similar to the iterative process completed manually in the production of the 24-Month Study.

Table D-1
How Run Cycles Solve Reservoir Operations in CRMMS

Run Cycle	Operations Solved
1	Upper Basin headwater reservoirs: Taylor Park, Vallecito, and Fontenelle; Initial Lower Basin diversions and Lake Mead outflow
2	Additional Upper Basin reservoirs: Flaming Gorge, the Aspinall Unit, and Navajo
3	Lake Powell, Lake Mead, and the remainder of the Lower Basin (initial Lake Mead outflow was solved in run cycle 1; the flood control, surplus, shortage, and hydrologic demand variability are first solved in run cycle 3)
4	Lake Powell, Lake Mead, and the remainder of the Lower Basin may resolve again (Lake Powell releases are fine tuned to achieve balancing when appropriate, and Lower Basin operations are adjusted, if necessary, after Lake Powell releases have been modified)

An additional feature of CRMMS is that the model run duration period changes depending on the model run's initial time step. The model run duration ranges from 60 to 68 months in an ensemble run. Extending the length of the model run is required in the months of February through September to complete Lake Powell operations for the entire operating year (October through September) in the last year of the model run. Each model run's duration is specified in **Table D-2**. The modeling analysis for the SEIS uses the September 2022 version of CRMMS, but it limits the analysis period to September 2022–December 2026.

Table D-2
Model Run Duration for Ensemble Model Runs

Initial Time Step (Month)	Ensemble Run Duration (Months)
January	60
February	68
March	67
April	66
May	65
June	64
July	63
August	62
September	61
October	60
November	60
December	60

D.2.2 Model Uncertainty

CRMMS projections are subject to multiple sources of uncertainty. One source is the model, which is a simplified representation of a complex system. Another component of uncertainty is the need to estimate physical processes, such as reservoir evaporation and transpiration from plants. The most impactful source of uncertainty is the future itself; models rely on assumptions about how the hydrology, water demand, and policy and operations will unfold. Reclamation works with stakeholders and scientists to develop the best modeling practices and most appropriate assumptions in light of the purpose of the model. It is important to understand the purpose, approach, and assumptions associated with projections and their inherent uncertainty to properly interpret the information they provide.

Projections are most sensitive to assumptions about future hydrology, and future flows are highly uncertain. Assumptions about future hydrology can produce very different pictures of risk. Using ESP, CRMMS generates a wide range of hydrologic possibilities based on an assumption that the future precipitation and temperature will be similar to those experienced during the recent 30 years (1991–2020); this allows an evaluation of the Proposed Action under a wide range of future flows.

Projections farther in the future have more uncertainty. This is apparent when comparing the different ranges of possible conditions in the next 1 to 5 years. As time horizons extend and uncertainty increases, projections of statistics-based measures, such as risks of certain system conditions, become less reliable as representations of the true probabilities that specific events may occur. All statistics calculated reflect the hydrologic scenarios and other assumptions used in modeling for this SEIS; the statistics are not intended to suggest actual probabilities of any events occurring. However, it is meaningful to compare statistics across alternatives to differentiate performance.

D.3 Hydrology

To simulate reservoir operations for up to 5 years, a hydrologic forecast of 60–68 months at 12 Upper Basin forecast points and 7 Lower Basin forecast points must be input into the model. The Upper Basin hydrology inputs are unregulated inflow forecasts for each forecast point. Unregulated flow is the forecasted flow that would arrive at a specific point if there were no dams upstream of that point. The total unregulated inflow for each forecast point includes the entire flow from the Basin upstream from that point. In other words, each downstream forecast point reflects the sum of the unregulated inflows from all forecast points above it in the Upper Basin.

Reclamation develops the Lower Basin hydrology inputs and generates them using 30 years of calculated historical intervening flows. The 30-year period of historical flows matches the CBRFC's 30-year calibration period (currently 1991 through 2020) to provide consistency in the periods of record used to produce flow assumptions for the Upper and Lower Basin portions of the model. Historical, intervening flows in the Lower Basin are calculated based on a mass balance approach, as discussed in **Section D.3.2**. Intervening flows for this purpose are defined as the amount of flow entering the system between the upstream point and the downstream point.

D.3.1 Upper Basin Hydrology

The CBRFC provides ESP forecasts at 12 Upper Basin forecast points (**Table D-3**). The ESP method generates multiple time series (that is, traces) of forecasted streamflows. Forecasts are created using the Sacramento Soil Moisture Accounting hydrologic model, which is initialized with current Basin conditions for soil moisture and snowpack and forced with a set of historical time series of precipitation and temperature that match the model calibration period (currently 1991 through 2020). This process results in a 30-member ensemble for monthly streamflow forecasts based on current Basin conditions and temperature and precipitation that match the 1991–2020 climatological period.

Table D-3
Upper Basin Forecast Points

Fontenelle Inflow
Flaming Gorge Unregulated Inflow
Yampa River Inflow
Taylor Park Inflow
Blue Mesa Unregulated Inflow
Crystal Unregulated Inflow
Morrow Point Unregulated Inflow
Gains Crystal to Grand Junction
Vallecito Unregulated Inflow
Animas River Inflow
Navajo Unregulated Inflow
Powell Unregulated Inflow

D.3.2 Lower Basin Hydrology

For modeling purposes in CRMMS, the Lower Basin is the portion of the model below the Lees Ferry gage. Although the intervening flows between Glen Canyon Dam and the Lees Ferry gage are physically located in the Upper Basin above the Lee Ferry Compact Point, the methodology used to project these flows matches the methodology used to project the Lower Basin inflows; therefore, flows at the Lees Ferry gage are included in this section. The hydrologic inputs for the Lower Basin are intervening flows (**Table D-4**), which may be positive, representing a gain in the reach, or negative, representing a loss in the reach.

Table D-4
Lower Basin Intervening Flow Points

Glen Canyon Dam to Lees Ferry
Lees Ferry to the USGS gage at Grand Canyon
USGS gage at Grand Canyon to Hoover Dam
Hoover Dam to Davis Dam
Davis Dam to Parker Dam
Parker Dam to Imperial Dam
Imperial Dam to Northerly International Boundary with Mexico

The intervening inflows are the estimated volumes calculated by Reclamation's Lower Colorado Gain-Loss Model. This method calculates the intervening inflows using a mass balance approach. CRMMS uses the calculated intervening inflow values from the same 30-year period for which the CBRFC produces forecast traces (1991 through 2020).

Just as the model rotates through Upper Basin inflow traces corresponding to a particular year in the 30-year calibration period, the model also rotates through intervening flows in the Lower Basin corresponding to the same year. For example, the Upper Basin inflow forecast corresponding to the

1991 trace is generated from the temperature and precipitation from 1991 through 1995. In this 1991 trace, the intervening inflows for all seven reaches below Glen Canyon Dam are the historical, calculated, intervening inflows from 1991 through 1995.

D.3.3 Hydrology Used in CRMMS SEIS Modeling

The hydrologic scenarios used in the SEIS are derived from the June 2023 ESP Upper Basin forecast and associated Lower Basin intervening flows. Three sets of ESPs are used in the SEIS modeling:

- 100 percent ESP: There is no adjustment to the streamflow forecasts.
- 90 percent ESP: Streamflow forecasts are reduced by 10 percent.
- 80 percent ESP: Streamflow forecasts are reduced by 20 percent.

ESP forecasts are adjusted at each forecast location by reducing the monthly streamflow forecast by the desired percentage. The following equation was used to reduce each month's streamflow forecast:

$$AdjustedMonthlyStreamflow_i = MonthlyStreamflow_i - |MonthlyStreamflow_i| \times PercentReduction$$

where, *PercentReduction* is the percent reduction (i.e., 0.1 or 0.2 for the 90 percent ESP and 80 percent ESP, respectively), and i is a single forecast location for all locations described in **Sections D.3.1** and **D.3.2**.

The equation allows for the adjustment of both negative and positive forecasts.

The three sets of ESPs—100 percent ESP, 90 percent ESP, and 80 percent ESP—are combined into a 90-member hydrologic scenario for SEIS analysis purposes. The three sets of ESPs allow for an analysis of a wider range of low-flow hydrologic scenarios beyond those experienced during the recent 30 years (1991–2020). It is possible, however, that future flows may include periods of wet or dry conditions that are outside the 90-member scenario sequences analyzed.

D.4 Initial Reservoir Conditions

CRMMS was initialized with the observed May 2023 end-of-month reservoir conditions shown in **Table D-5**.

Table D-5
End-of-Month Reservoir Conditions Used as Initial Conditions

Reservoir	Elevation (feet above mean sea level [msl])	Storage (af)
Fontenelle	6,494.66	249,866
Flaming Gorge	6,020.21	2,917,394
Taylor Park	9,316.35	80,454
Blue Mesa	7,491.44	588,968

Reservoir	Elevation (feet above mean sea level [msl])	Storage (af)
Morrow Point	7,153.72	111,993
Crystal	6,751.16	16,449
Vallecito	7,651.55	90,920
Navajo	6,063.70	1,340,268
Powell	3,561.42	7,887,844
Mead	1,054.28	7,995,261
Mohave	641.83	1,666,824
Havasu	446.26	547,344

D.5 Reservoirs Upstream of Lake Powell

Nine Upper Basin reservoirs are simulated in CRMMS. Each of the nine Upper Basin reservoirs included in the model has an individual operation plan. Some facilities are operated to meet storage or elevation targets, while others feature environmentally regulated, controlled, consistent releases. Within the model, each reservoir has a set of rules to guide the specific operations. The model solves by using the logic in those operating rules. The following briefly describes the various Upper Basin reservoirs along with a high-level description of the logic in RiverWare for simulating operations within the Upper Basin. The operations of the Upper Basin reservoirs above Lake Powell are modeled the same for the No Action Alternative and the Proposed Action.

In a rule-based model, such as CRMMS in Ensemble Mode, general assumptions must be made for the model to solve. The rules developed for CRMMS are, ideally, the best representation of operations that can be projected. In practice, however, there are sometimes differences between the projected operations produced by the model and actual operations. For example, many reservoirs in the Upper Basin are operated following the principles of adaptive management. As such, operations may be altered to meet various objectives of the reservoirs' adaptive management work groups on an ad hoc or experimental basis. Such ad hoc or experimental operations cannot be known in advance, within the 5-year model outlook. As such, CRMMS Ensemble Mode projections may differ from actual operations, even under similar hydrologic conditions.

D.5.1 Fontenelle Reservoir

Fontenelle Reservoir is on the Green River about 24 miles southeast of La Barge, Wyoming. Fontenelle Reservoir is operated to meet various target elevations throughout the year while staying within practical and authorized limits.

D.5.2 Flaming Gorge Reservoir

Flaming Gorge Reservoir is on the Green River about 32 miles downstream of the Utah-Wyoming border and upstream of the confluence with the Yampa River. The operations of Flaming Gorge Reservoir meet the requirements detailed in the 2006 Record of Decision for the Operation of Flaming Gorge Dam Final Environmental Impact Statement (2006 Flaming Gorge ROD; Reclamation 2006a) that were designed to achieve the authorized purposes of the Colorado River Storage Project Act, while addressing environmental requirements. The 2006 Flaming Gorge ROD outlines the operational guidelines of Flaming Gorge and implements, to the extent possible, recommendations to assist in the recovery of four endangered fish species, outlined in the 2000 Flow and Temperature Recommendations for Endangered Fish in the Green River Downstream of Flaming Gorge Dam (Muth 2000).

Flaming Gorge operations are governed by the April through July unregulated inflow into the reservoir, which determines the corresponding hydrologic classification, spring peak, and base flow targets from the 2006 Flaming Gorge ROD (Reclamation 2006a) for the year. The April through July releases are modeled at the daily time step in CRMMS to approximate the sub-monthly component of the spring peak targets. The model logic determines typical daily operations from April through July before summing to a monthly release. During the March to April transition period, Flaming Gorge operations try to achieve a May 1 storage target. Actual annual operations at Flaming Gorge are determined in a consultation process with other agencies. The CRMMS Ensemble Mode cannot model these adaptive management decisions; therefore, model results do not include possible future adaptive management decision changes to the logic described above.

D.5.3 Taylor Park Reservoir

Taylor Park Reservoir is on the Taylor River, a tributary of the Gunnison River on the western slope of Colorado's Rocky Mountains. Taylor Park Reservoir is operated with a rule curve to meet various target elevations throughout the year, while staying within practical and authorized limits.

D.5.4 Aspinall Unit Reservoirs – Blue Mesa, Morrow Point, and Crystal

The Aspinall Unit consists of three reservoirs—Blue Mesa, Morrow Point, and Crystal—in series along the Gunnison River in western Colorado. The operations of the Aspinall Unit meet the requirements detailed in the April 2012 Record of Decision for the Aspinall Unit Operations Final Environmental Impact Statement (2012 Aspinall ROD; Reclamation 2012) and the decree quantifying the Federal Reserved Water Right for the Black Canyon of the Gunnison, which specify the spring peak outflow hydrographs and base flows for the rest of the year based on the hydrologic conditions upstream of Blue Mesa Reservoir. The 2012 Aspinall ROD provides specifications to avoid jeopardizing the continued existence of fish listed under the Endangered Species Act and to ensure the dam's operations do not result in the destruction or adverse modification of critical habitat in the Gunnison River.

Aspinall Unit operations are governed by the April through July unregulated inflow into the reservoir, which determines spring peak and base flow targets for the rest of the year based on the hydrologic conditions above Blue Mesa Reservoir. CRMMS approximates daily flow targets in the 2012 Aspinall ROD and Federal Reserved Water Right for the Black Canyon of the Gunnison by first modeling typical daily operations for both the spring and baseflow periods and then summing to a monthly release. Morrow Point and Crystal Reservoirs are modeled to maintain elevation targets of 7,153.73 and 6,753.04 feet, respectively.

D.5.5 Vallecito Reservoir

Vallecito Reservoir is on the Pine River, which flows into the San Juan River. The reservoir is 18 miles northeast of Durango, Colorado. Vallecito Reservoir is operated with a rule curve to meet various target elevations throughout the year, while staying within practical and authorized limits.

D.5.6 Navajo Reservoir

Navajo Reservoir is on the San Juan River above the confluence with the Animas River. The reservoir is operated to meet environmental requirements outlined in the July 2006 Record of Decision for the Navajo Reservoir Operations, Navajo Unit-San Juan River New Mexico, Colorado, Utah Final Environmental Impact Statement (Reclamation 2006b). Navajo Reservoir also provides for the diversion of NIIP water from Navajo Reservoir, and other municipal and industrial uses throughout the San Juan Basin. The minimum active storage at Navajo Reservoir is at 5,990 feet; at that point, the NIIP can no longer divert water.

Navajo Reservoir operations are modeled to first meet the environmental baseflow requirements at downstream gages stated in the July 2006 Record of Decision for the Navajo Reservoir Operations, Navajo Unit-San Juan River New Mexico, Colorado, Utah Final Environmental Impact Statement (Reclamation 2006b); because of the CRMMS spatial scale, it is assumed that all flow targets are for the San Juan River near Farmington, New Mexico. If available additional water is released as a spring peak, a spring release pattern is selected to bring Navajo Reservoir closest to the September 30 storage target, while staying within practical and authorized limits, including maintaining NIIP diversions. If the reservoir pool elevation is projected to go below 5,990 feet, the minimum elevation for NIIP diversions, the outflow, and NIIP diversions are proportionally reduced.

D.5.7 DROA Year 2022 Contribution Assumptions

The CRMMS modeling assumes no DROA releases, which is consistent with the June 2023 CRMMS simulation. The DROA releases from Flaming Gorge totaled 463,000 af for May 2022 through March 2023.[1] Starting March 2023, recovery of DROA releases began. By June 2023, 178,000 af had been recovered at Flaming Gorge, which was reflected in the initial reservoir conditions. CRMMS modeling does not include any assumptions regarding future DROA releases. Reclamation will attempt to maximize DROA recovery in the Upper Initial Units in water year 2023 and through April 2024.

D.6 Lake Powell Operation

Lake Powell is the most downstream reservoir in the Upper Basin; it is impounded by Glen Canyon Dam. Near Page, Arizona, Glen Canyon Dam is 17 miles upstream of Lee Ferry, the delineation point between the Upper and Lower Basins.

In CRMMS, Lake Powell operations logic calculates the annual operating year release, followed by disaggregating the annual release to monthly releases. The sections below summarize these operations. **Section D.6.1** describes modeling assumptions common to all alternatives. **Section D.6.2** describes model assumptions for Lake Powell operating tiers used in the No Action Alternative and the Proposed Action.

[1] The projected 500,0000 af DROA release was reduced on March 7, 2023, and recovery began in March 2023.

D.6.1 Assumptions Common to All Alternatives

CRMMS solves for Lake Powell operating tiers in CRMMS run cycles 3 and 4. CRMMS solves for the following rules in run cycles 3 and 4. In August, operations of Lake Powell are set for the entire following operating year (that is, October through September). An initial operating year release of 8.23 maf is used to solve for the end-of-calendar-year pool elevation, which is used to determine the operating tier and annual operating year release volume. The annual release is then disaggregated into monthly releases using the Long-term Experimental and Management Plan release patterns. The Lake Powell assumed monthly releases for CRMMS are in **Attachment D-1**.

The monthly releases solved using **Table Attachment D-1** can be constrained due to physical limitations at Glen Canyon Dam. Water can be released through the powerplant turbines until the pool elevation drops below 3,490 feet. Once Lake Powell is below 3,490 feet, releases are made through the river outlet works. There are four river outlet works at Glen Canyon Dam. The capacity of the river outlet works varies with the elevation of Lake Powell; the higher the pool elevation, the higher the potential release through the river outlet works. CRMMS computes the maximum monthly release based on the Lake Powell elevation using **Table D-6** and interpolates for the capacity between elevations listed in **Table D-6**. For the SEIS modeling, three out of four river outlet works are assumed available for use at any given time; this is because of the need for periodic inspections and any associated maintenance activities. Reclamation believes this is a reasonable estimation given the historical and future operations and maintenance requirements for the river outlet works.

Table D-6
CRMMS Modeled River Outlet Works' Capacity by Lake Powell Elevation

Lake Powell Elevation	Capacity (1 river outlet work)		Capacity (3 river outlet works)	
feet	cfs	af/month*	cfs	af/month*
3,490	3,660	225,045	10,980	675,134
3,480	3,620	222,585	10,860	667,755
3,470	3,520	216,436	10,560	649,309
3,460	3,380	207,828	10,140	623,484
3,450	3,140	193,071	9,420	579,213
3,440	2,860	175,855	8,580	527,564
3,430	2,560	157,408	7,680	472,225
3,420	2,200	135,273	6,600	405,818
3,410	1,760	108,218	5,280	324,655
3,400	1,200	73,785	3,600	221,355
3,390	800	49,190	2,400	147,570
3,380	400	24,595	1,200	73,785
3,370	0	0	0	0

* Computed using 31 days per month

D.6.2 No Action Alternative

Lake Powell operating tiers are determined based on the projected end-of-calendar-year pool elevation at Lake Powell. For operating year 2023, the August 2022 24-Month Study projected the

January 1, 2023, effective[2] pool elevation to be less than 3,525 feet, which results in 2023 operations being governed by the Lower Elevation Balancing Tier. CRMMS rules are then used to solve for the 2023 annual release in the Lower Elevation Balancing Tier.

For operating years beyond 2023, CRMMS will solve for the Lake Powell operating tier and annual release for the entire operating year in August. The first step of solving for the Lake Powell operating tier is to set the annual release to 8.23 maf. This allows CRMMS to solve for Lake Powell releases for the entire operating year and to solve for storage and other parameters, since CRMMS solves for the inflow in run cycle 2. This includes the end-of-calendar-year pool elevation, which is used to set the Lake Powell operating tier.

CRMMS solves for the Lake Powell operating tier and operating year release as follows using the projected end-of-calendar-year pool elevation:

- If the projected Lake Powell end-of-calendar-year pool elevation is greater than or equal to the equalization level (**Table D-7**), the Equalization Tier operations govern the operating year releases.
- If the projected Lake Powell end-of-calendar-year pool elevation is less than the equalization level and greater than or equal to 3,575 feet, the Upper Elevation Balancing Tier governs the operating year releases.
- If the projected Lake Powell end-of-calendar-year pool elevation is less than 3,575 feet and greater than or equal to 3,525 feet, the Mid-Elevation Release Tier governs the operating year releases.
- If the projected Lake Powell end-of-calendar-year pool elevation is less than 3,525 feet, the Lower Elevation Balancing Tier governs the operating year releases.

The annual release for each tier is described below for the No Action Alternative. The last section describes how Lake Powell operating year releases are disaggregated to a monthly scale.

Table D-7
Lake Powell Equalization Level Table

Year	Equalization Elevation (feet)
2023	3,662
2024	3,663
2025	3,664
2026	3,666

[2] The reduction of releases from Lake Powell from 7.48 to 7.00 maf in operating year 2022 resulted in a reduced release volume of 0.48 maf that normally would have been released from Glen Canyon Dam to Lake Mead as part of a 7.48-maf annual release volume, consistent with routine operations under the 2007 Interim Guidelines. The reduction of releases from Glen Canyon Dam in operating year 2022 (resulting in increased storage in Lake Powell) did not affect the operation determination for 2023; it was accounted for "as if" this volume of water had been delivered to Lake Mead, which is referred to as "effective" pool elevation. In April 2023, Reclamation removed the operational neutrality of the 0.48 maf that was retained in Lake Powell under the May 2022 action, such that 2023 balancing releases are based on the projected end-of-water-year physical contents of Lake Powell and Lake Mead.

D.6.2.1 Equalization Tier

Under the No Action Alternative, the equalization of storage between Lake Powell and Lake Mead is modeled with a rule that first calculates how much water would be released to equalize Lakes Powell and Mead. The release for equalization is computed by taking half of the difference between the predicted end-of-water-year volumes of Lake Powell and Lake Mead. Evaporation and bank storage losses at Lake Powell and Lake Mead are estimated in the calculation. The equalization release is then constrained by choosing the minimum of the equalization release, the release to take Lake Mead to 1,105 feet, and the release to take Lake Powell to 20 feet below the equalization level. The rule then sets the Lake Powell operating year release to the maximum of the constrained equalization volume and an 8.23-maf release. Monthly releases from Lake Powell are then calculated for the operating year using **Table Attachment D-1**.

After Lake Powell and Lake Mead have both resolved, a higher-priority rule refines the equalization release. This rule is also used to refine the Upper Elevation Balancing Tier equalization releases. The rule calculates the volume deviation of the end-of-water-year storage at Lake Powell and Lake Mead from target levels (that is, equalization to achieve Lake Mead at 1,105 feet or to achieve Lake Powell 20 feet below the equalization level). The deviation volume then adjusts Lake Powell's release to achieve the end-of-water-year target, subject to a minimum release of 8.23 maf. This rule is allowed to iterate so that end-of-water-year target elevations are achieved to within a specified tolerance.

D.6.2.2 Upper Elevation Balancing Tier

Once it is determined that Lake Powell is starting the year in the Upper Elevation Balancing Tier, the projected end-of-water-year pool elevation at the end of the next operating year (for example, September 30, 2024, when the model has set the operating tier in August 2023) is used to determine how much water is released.

If the projected Lake Powell end-of-water-year pool elevation is above the equalization level, then an April switch to equalization is modeled, and the operating year release is set based on equalization logic (described in the previous section) and constrained to a minimum of 8.23 maf. Otherwise, if Lake Powell's projected end-of-water-year pool elevation is less than or equal to the equalization level, Lake Powell's releases are modeled consistent with the Upper Elevation Balancing constraints and depend on Lake Mead's end-of-water-year pool elevation:

- If the Lake Mead end-of-calendar-year pool elevation is greater than or equal to 1,075 feet, the operating year release necessary to balance Lake Powell and Lake Mead's end-of-water-year storage is calculated but constrained to be within the range of 8.23 to 9.0 maf.
- If the Lake Mead end-of-calendar-year pool elevation is greater than 1,075 feet, and the Lake Powell end-of-water-year pool elevation is less than or equal to 3,575 feet, the operating year release is 8.23 maf.
- If the Lake Mead end-of-calendar-year pool elevation is less than 1,075 feet, the operating year release necessary to balance Lake Powell and Lake Mead end-of-water-year storage is calculated but constrained to be within the range of 7.0 to 9.0 maf.

D.6.2.3 Mid-Elevation Release Tier

The Mid-Elevation Release Tier is modeled by first checking Lake Mead's projected end-of-calendar-year pool elevation. If the Lake Mead end-of-calendar-year pool elevation is greater than or equal to 1,025 feet, Lake Powell's operating year release is set to 7.48 maf. Otherwise, the operating year release is set to 8.23 maf.

D.6.2.4 Lower Elevation Balancing Tier

For operating years 2023 and 2024, the Lower Elevation Balancing Tier operations are modeled in a way that protects critical elevations at Lake Powell. This is done by assessing potential balancing releases in April 2023 and limiting any balancing releases (with a minimum of 7.00 maf) to protect Lake Powell from declining below an elevation of 3,525 feet at the end of December of the following year. For operating years 2025 and 2026, balancing releases are not limited to protect Lake Powell from declining below critical elevations.

In CRMMS, the Lower Elevation Balancing Tier is modeled by first setting the Lake Powell operating year release to 7.0 maf, which causes Lake Powell to resolve for monthly releases and pool elevations. Next, Lower Elevation Balancing Tier releases are calculated with different constraints, which depend on the operating year, as previously described.

- In operating years 2023 and 2024:
    - If the Lake Powell end-of-water-year pool elevation is greater than the protection threshold of 3,535 feet,[3] two potential annual releases are calculated: (1) the operating year release necessary to balance Lake Powell and Lake Mead's end-of-water-year storage; the release is calculated but constrained to be within the range of 7.0 to 9.5 maf.; and (2) the release needed so that Lake Powell's end-of-water-year pool elevation is 3,535 feet. The minimum of these two releases is used to set Lake Powell's annual release. If the end-of-water-year Lake Powell pool elevation is less than the protection threshold of 3,535 feet with a 7.0 maf release, the release is not adjusted.
- In operating years 2025 and beyond:
    - The operating year release necessary to balance Lake Powell and Lake Mead's end-of-water-year storage is calculated but constrained to be within the range of 7.0 to 9.5 maf.

D.6.2.5 Disaggregation from Annual to Monthly Release

Lake Powell operating year releases are disaggregated to monthly releases anytime the operating year release volume is set for Lake Powell. The operating year volume is used to select the closest operating year release pattern from **Table Attachment D-1**; for operating year releases between set values, the monthly releases are interpolated between the two columns with the closest operating year release. Except for certain circumstances, as noted below, the water year volume is preserved when interpolating monthly releases.

There are a few special cases where the monthly releases are not interpolated directly from **Table Attachment D-1**. If there is an equalization outflow in the Upper Elevation Balancing Tier, then the

[3] The protection threshold of 3,535 feet was used for modeling purposes since it is the end-of-water-year elevation needed during an average year to achieve an end-of-calendar-year elevation of 3,525 feet (or higher).

outflows from October until March follow a path of a 9.0-maf release and then will be either the maximum powerplant release or the remaining amount of volume to meet the equalization annual release volume. The April through September releases are calculated to attempt to release the remainder operating year release volume, while constraining releases to the powerplant capacity. If the operating year release volume is less than 8.23 maf, the release pattern is set to the 7.48-maf pattern for October through December. For January through September, the remainder of the operating year release volume is released proportional to **Table Attachment D-1**.

The disaggregated monthly releases are further constrained so that the monthly releases do not exceed what can be moved through the river outlet works. If a monthly release is constrained, the volume is tracked and is attempted to be released later in the operating year to maintain the desired operating year release, if possible.

D.6.3 Proposed Action

CRMMS solves for Lake Powell operations as described for the No Action Alternative, except for a protection-level provision described in **Section D.6.3.5**.

D.6.3.1 Equalization Tier

The Equalization Tier method for Lake Powell under the Proposed Action is identical to that under the No Action Alternative.

D.6.3.2 Upper Elevation Balancing Tier

The Upper Elevation Balancing Tier method for Lake Powell under the Proposed Action is identical to that under the No Action Alternative.

D.6.3.3 Mid-Elevation Release Tier

The Mid-Elevation Release Tier method for Lake Powell under the Proposed Action is identical to that under the No Action Alternative, except when additional adjustments are necessary to protect an elevation of 3,500 feet. See **Section D.6.3.5** for additional details on these additional adjustments.

D.6.3.4 Lower Elevation Balancing Tier

The Lower Elevation Balancing Tier method for Lake Powell under the Proposed Action is identical to that under the No Action Alternative, except when additional adjustments are necessary to protect an elevation of 3,500 feet. See **Section D.6.3.5** for additional details on these additional adjustments.

D.6.3.5 Protection Level

The Proposed Action specifies a protection level of 3,500 feet at Lake Powell such that Reclamation can make a mid-year adjustment to reduce the operating year release no less than 6.0 maf, if Lake Powell is projected to drop below 3,500 feet in the next 12 months.

In CRMMS, this is modeled by checking Lake Powell pool elevations from April through the end of the water year when Lake Powell is operating in the Mid-Elevation Release Tier or Lower Elevation Balancing Tier. If the Lake Powell pool elevation is projected to drop below 3,500 feet or is already below 3,500 feet, monthly releases will be adjusted for April through September. The monthly release will be decreased such that the Lake Powell pool elevation is maintained at or above 3,500 feet; however, it is subject to the following constraints: the minimum water year release is 6.0 maf, and the monthly releases will release a volume not less than the volume necessary to meet the minimum daily LTEMP release. If releases are adjusted in April through September and Lake Powell pool elevation increases above 3,500 feet, monthly releases can be increased to release up to the original annual release volume for the given Lake Powell operating tier.

If the protection of 3,500 feet is triggered in April, Lake Powell's release can be adjusted to protect 3,500 feet during the following water year. The same logic applies to the second water year, but releases can be adjusted starting at the beginning of the water year.

D.6.3.6 Disaggregation from Annual to Monthly Release

Lake Powell operating year releases are disaggregated to monthly releases using the same method as under the No Action Alternative.

D.7 Lake Mead Operation

Lake Mead is the uppermost reservoir in the Lower Basin. Located 35 miles southeast of Las Vegas, the 726-foot-high Hoover Dam impounds Lake Mead. In CRMMS, Lake Mead operations are modeled by solving for the Lower Basin condition, Lower Basin and Mexico diversions, and intentionally created surplus (ICS) and other conservation activity. **Section D.7.1** describes modeling assumptions common to all alternatives. **Sections C.7.2** and **C.7.3** describe Lake Mead operations for the No Action Alternative and Proposed Action, respectively.

D.7.1 Assumptions Common to All Alternatives

CRMMS solves for the Lower Basin operating condition in CRMMS run cycles 3 and 4. In August, operations of Lake Powell are set for the entire following operating year (that is, October through September). Once Lake Powell releases are set for the entire operating year, the Lower Basin condition can be solved, which occurs in the January time step. After the condition is set, depletion schedules for the Lower Division States and Mexico may be modified in accordance with the requirements of the operating condition for the entire calendar year, based on the 2007 Interim Guidelines, 2019 DCPs, Minute 323, and system conservation agreements. Assumed ICS activity may also affect the water user depletions. Once demands below Lake Mead are calculated, Lake Mead's release is set to meet downstream demands.

For Lower Division States and Mexico use, in the first year of the model run, depletion schedules use water orders that reflect shortage conditions, Lower Basin DCP contributions, reductions under low-elevation reservoir conditions, Binational Water Scarcity Contingency Plan (BWSCP) contributions per Minute 323, and signed system conservation agreements. For the remaining years in the model run, depletion schedules reflect "normal" schedules, and represent near-term historical trends in water use. All additional reductions (2007 Interim Guidelines shortages, DCP reductions, and reductions under low-elevation reservoir conditions and BWSCP contributions per Minute 323) reduce these "baseline/normal" depletion schedules. Depletion schedules for CRMMS water users that were used in the June 2023 CRMMS modeling are summarized in **Attachment D-2**.

D.7.1.1 Lake Mead/Hoover Dam Flood Control

The Lake Mead flood control logic in CRMMS is based on the 1984 Field Working Agreement between Reclamation and the United States Army Corps of Engineers. Three flood control procedures are in effect for different times of the year. The first procedure is in effect throughout the year. Its objective is to maintain a minimum space of 1.5 maf in Lake Mead, primarily for extreme storm events. This space is referred to as exclusive flood control space and is represented by the space above elevation 1,219.6 feet. The second procedure is used during the period from January to July. The objective during this period is to route the maximum inflow forecast through the reservoir system using specific rates of Hoover Dam outflow, assuming that Lake Mead will fill to elevation 1,219.6 feet at the end of July. The third procedure is used during the space-building or drawdown period of August through December. The objective during this period is to gradually draw down the reservoir system, to meet the total system space requirements in each month in anticipation of the next year's runoff.

This logic matches the logic used in the 2007 FEIS. Given the June 2023 conditions and inflow forecast ensemble, there were no instances of simulating flood control operations in the SEIS modeling through 2026.

D.7.2 No Action Alternative

Lake Mead operations and Lower Basin conditions are modeled based on projected end-of-calendar-year pool elevation at Lake Mead.

D.7.2.1 Surplus

The Lower Basin operates in a Surplus Condition if the Lake Mead elevation is above 1,145 feet and below an elevation that would trigger space-building or flood control releases pursuant to the 1984 Field Working Agreement between Reclamation and the US Army Corps of Engineers (described in **Section D.7.1.1**).

The 2007 Interim Guidelines define two levels of Surplus. A Domestic Surplus is determined if the Lake Mead elevation is above 1,145 feet and below the elevation that triggers a Quantified Surplus. Under a Domestic Surplus, depletion schedules are modified in the Lower Division States consistent with the 2007 Interim Guidelines Section 2.B.2. A Quantified Surplus is determined if water needs to be delivered to reduce the risk of potential reservoir spills based on the 70R Strategy (see 2007 FEIS, Appendix A, Section A.6.2.4). Under a Quantified Surplus, depletion schedules are modified in the Lower Division States consistent with the 2007 Interim Guidelines Section 2.B.3.

D.7.2.2 Normal Conditions

The Lower Basin operates in a Normal Condition if the Lake Mead elevation is above 1,075 feet and below 1,145 feet. If the model determines that a Normal Condition exists, the model retains the default Normal schedules initially assigned in run cycle 1. Depletion schedules might be modified due to ICS creation or delivery logic or for DCP contributions. An ICS Surplus Condition is a type of Normal Condition that is determined when Lake Mead's elevation is above 1,075 feet and below 1,145 feet, and there is an ICS creation plan in place for at least one Lower Basin entity.

D.7.2.3 Shortage Conditions

A Lower Basin Shortage Condition is modeled if the Lake Mead elevation is less than or equal to 1,075 feet. A rule solves for the Shortage Condition in January by comparing Lake Mead's end-of-calendar-year pool elevation to defined pool elevations, as shown in **Table D-8**.

Once the Shortage Condition is set, shortage volumes (**Table D-8**) are assigned to users proportionally to a user's monthly and annual scheduled water use:

$$MonthlyShortage_i = AnnualShortage_i * \left(\frac{MonthlyWaterUse_i}{AnnualWaterUse_i}\right)$$

where i is an individual water user.

Diversions for water users are then adjusted with the user's monthly shortage. In Nevada, Southern Nevada Water Project (SNWP) users incur the entire shortage volume; in Arizona, the entire shortage volume is modeled to be incurred by the Central Arizona Project.

Table D-8
Lower Division State Shortage Volumes

Lake Mead Elevation (feet)	Arizona Shortage (af)	Nevada Shortage (af)	Total Shortage (af)
>1,075	0	0	0
1,075 to 1,050	320,000	13,000	333,000
<1,050 to 1,025	400,000	17,000	417,000
<1,025	480,000	20,000	500,000

D.7.2.4 Minute 323 High- and Low-Elevation Reservoir Conditions

Minute 323 defines reductions to Mexico under low-elevation reservoir conditions based on the projected Lake Mead end-of-calendar-year pool elevation. **Table D-9** shows Mexico's reductions. Adjustments to Mexico's delivery assume the same method to disaggregate the annual reduction to a monthly reduction as the adjustments due to shortage in the Lower Division States (**Section D.7.2.3**).

Table D-9
Mexico Minute 323 Reductions

Lake Mead Elevation (feet)	Mexico Reduction (af)
>1,075	0
1,075 to 1,050	50,000
<1,050 to 1,025	70,000
<1,025	125,000

Distribution of flows to Mexico under high-elevation reservoir conditions are modeled in accordance with Minute 323 Section II, when the Lake Mead end-of-calendar-year pool elevation is at or above 1,145 feet.

D.7.2.5 2019 DCPs and BWSCP

CRMMS models the 2019 DCP contributions in accordance with Exhibit 1 to the Lower Basin DCP agreement and the Minute 323 BWSCP. The contribution volumes (**Table D-10**) are based on the projected Lake Mead end-of-calendar-year pool elevation, similar to the Shortage Condition. For modeling purposes, DCP contributions can be made through conversion of existing ICS, simultaneous ICS creation and conversion to DCP-ICS, and/or reducing depletions to create system water. Additional CRMMS ICS assumptions are described in **Section D.7.2.6**.

As previously mentioned, in the first year of the model run, depletion schedules use water orders that reflect shortage conditions, Lower Basin DCP contributions, and Minute 323 reductions and contributions. These first-year depletion schedules reflect more guidance and input from states, water users, and Mexico than exist for the subsequent modeled years. In the subsequent years, model assumptions are developed with states, water users, and Mexico to provide a reasonable assumption for how DCP and BWSCP contributions might be made, as described below.

Table D-10
2019 DCP and Minute 323 BWSCP Contribution Volumes

Lake Mead Elevation (feet)	DCP (1,000 af) Arizona	DCP (1,000 af) Nevada	DCP (1,000 af) California	Minute 323 BWSCP (1,000 af)
>1,090	0	0	0	0
1,090 – 1,075	192	8	0	41
1,075 – 1,050	192	8	0	30
<1,050 – >1,045	192	8	0	34
1,045 – >1,040	240	10	200	76
1,040 – >1,035	240	10	250	84
1,035 – >1,030	240	10	300	92
1,030 – 1,025	240	10	350	101
<1,025	240	10	350	150

In Nevada, the DCP contribution is generally made by converting extraordinary conservation (EC)-ICS to DCP-ICS. If there is not enough EC-ICS available to meet the full DCP contribution, Nevada simultaneously creates EC-ICS and converts it to DCP-ICS in the year it is required. If insufficient ICS accumulation limit[4] space exists to create DCP-ICS, then contributions are made via system water.

In California, the agreement between the Metropolitan Water District of Southern California (MWD) and Coachella Valley Water District (Coachella) is modeled in CRMMS; however, the entire DCP-ICS balance in CRMMS is tracked in the MWD's ICS account. This means that CRMMS decreases Coachella's water use schedule by 7 percent of California's DCP contribution. Then, the MWD makes 100 percent of the DCP contribution by converting EC-ICS to DCP-ICS, and can then take delivery of the unused water created by Coachella. If the MWD's EC-ICS balance is insufficient to meet the full DCP contribution, the MWD simultaneously creates EC-ICS and

[4] In accordance with the Lower Basin DCP, the maximum total amount of EC-ICS, Binational ICS, and DCP-ICS that may be accumulated by the Lower Division States is 2.7 maf.

converts it to DCP-ICS in the year it is required. If there is 2.7 maf of accumulated ICS, and/or there is insufficient EC-ICS to meet the entire DCP contribution, then the MWD creates non-ICS water (that is, system water) to meet the DCP contribution.

In Arizona, the DCP contributions are assumed to be made through simultaneous creation of EC-ICS and conversion to DCP-ICS in the year it is required, and through non-ICS water. If there is 2.7 maf of accumulated ICS, then Central Arizona Water Conservation District (CAWCD) makes the entire DCP contribution through non-ICS water.

In Mexico, BWSCP contributions are assumed to be made through reductions to Mexico's delivery (that is, via system water), unless Mexico provides other input and assumptions.

D.7.2.6 ICS Assumptions

ICS may be created through various mechanisms, including EC, tributary conservation, system efficiency projects, importation of non-Colorado River water, and transfer of Mexico's Water Reserve to Binational ICS. For modeling purposes in CRMMS, ICS creation and delivery is a combination of inputs and logic.

In CRMMS, ICS is modeled in multiple steps. First, non-junior priority ICS accounts are solved. Second, the preliminary ICS for junior priority accounts is solved. Preliminary ICS represents the ICS creation or delivery volumes that each junior priority entity would like under their ideal scenario. Using the preliminary ICS values, CRMMS then solves the ICS accumulation space sharing. ICS accumulation space sharing, per the agreements signed in 2020 and 2021, allows Lower Division States to take advantage of the full 2.7 maf of ICS storage through a sharing mechanism. Following the ICS accumulation space sharing, the model then adjusts the preliminary ICS accounts appropriately to finalize ICS creation, deliveries, and balances. Finally, water users' diversions are adjusted to reflect ICS creation and deliveries.

D.7.2.6.1 Constants

Table D-11 list the ICS-related assumptions used in CRMMS.

Table D-11
Annual Creation and Delivery Limits

State	Maximum Annual Creation (1,000 af)	Maximum Annual Delivery (1,000 af)
Arizona	100	300
California	400	400
Nevada	125	300

CRMMS models the ICS accumulation space sharing agreements from 2020 and 2021. Therefore, the accumulation limits (**Table D-12**) reflect volumes that differ somewhat from those specified in the 2007 Interim Guidelines and Lower Basin DCP. Additionally, there is logic in CRMMS that allows one or more states to exceed their maximum accumulation limit as long as the total Lower Basin ICS accumulation as defined in the Lower Basin DCP (i.e., sum of EC-ICS, DCP-ICS, and Binational ICS) is less than or equal to 2.7 maf. A state may be required to vacate ICS and/or not create ICS if the ICS accumulation is at 2.7 maf and the state has exceeded its individual accumulation limit. If a state is required to vacate ICS, it will take the following actions until the required volume has been vacated: (1) convert DCP-ICS to system water, (2) take delivery of Tributary ICS and Imported ICS (Nevada only), (3) take delivery of EC-ICS, and (4) take delivery of Binational ICS. Annual ICS assessments for evaporation depend on the entity and year (**Table D-13**).

Table D-12
Accumulation Limits by Entity in CRMMS

Accumulation Limit (af)	Arizona			California			Nevada
	CAWCD	Tribal	Total	IID	MWD	Total	Total
	300,000	300,000	**600,000**	50,000	1,600,000	**1,650,000**	**450,000**

Table D-13
Annual ICS Assessments (percentages)

Entity	Year 1	Year 2	Year 3
Arizona	10	—	—
IID[1]	5	3	3
MWD	10	—	—
Nevada	10	—	—

[1] After the year of creation, a 3 percent evaporation assessment is applied in all non-shortage years.

D.7.2.6.2 Arizona ICS Assumptions

In general, information about the ICS creation is provided to Reclamation by the state, and CRMMS logic is used to model the future ICS delivery and type of ICS created.

Reclamation generally inputs ICS creation volumes for all entities in Arizona based on existing and anticipated ICS creation plans (**Table D-14**). CRMMS allows CAWCD's DCP contribution to be made through creation of ICS and non-ICS water. A default creation volume is input, and rule logic determines whether CAWCD's ICS creation is EC-ICS or DCP-ICS based on the operating condition of the current year.

Table D-14
Assumed ICS Creation and Delivery Volumes in Arizona

		2023	2024	2025	2026
CAWCD	EC-DCP Creation (af)	60,000	60,000	60,000	0
	Binational Creation (af)	9,092	0	0	9,092
	System Efficiency Creation (af)	0	0	0	0
	Default Delivery[1] (af)	80,000	0	0	0
GRIC	EC Creation (af)	0	0	0	0
	Delivery (af)	0	0	0	0

[1]CAWCD delivers an additional 60,000 af when the operating condition is between 1,075 and 1,025 feet for mitigation purposes. Starting in 2026, CAWCD is assumed to also try to take delivery of its remaining ICS by 2036, based on the operating condition.

Reclamation also inputs the assumed ICS delivery volumes for all entities in Arizona, except CAWCD and the GRIC. Assumed delivery volumes for CAWCD incorporate a default assumption provided by CAWCD plus an assumed delivery for mitigation water. Starting in 2026, CAWCD is modeled to try to take delivery of its remaining ICS by 2036, based on the operating condition. Assumed ICS delivery volumes for GRIC are based on the Arizona Firming Agreement and are assumed to start in 2027. There are no ICS deliveries when Lake Mead is projected to decline below elevation 1,025 feet on January 1.

D.7.2.6.3 California ICS Assumptions

CRMMS includes ICS assumptions in California for the IID and MWD (**Table D-15**). Creation volumes of Binational ICS (assumed conversion from Mexico's Water Reserve pursuant to Minute 323) for the IID and MWD, and System Efficiency ICS for the MWD are input into CRMMS.

Table D-15
Assumed ICS Creation Volumes by IID and MWD (af)*

		2023	2024	2025	2026
MWD	**EC-ICS Creation (af)**	**209,000**	—	—	—
	Binational ICS Creation (af)	9,092	0	0	9,092
	System Efficiency ICS Creation (af)	0	0	0	0
IID	Binational ICS Creation (af)	9,092	0	0	9,092

* The 2023 MWD EC-ICS creation is a static volume. For 2024–2026, EC-ICS creation or delivery volumes are dynamic and based on the Sacramento River Water Year Classification (SRWYC; see **Table D-16**).

In general, IID tries to keep its ICS accumulation at its capacity (50,000 af). As such, approximately 1,500 af of EC-ICS can be created in normal, ICS surplus, and domestic surplus years. This volume is enough to keep the EC-ICS accumulation at capacity and cover the annual evaporative assessment (**Table D-13**).

There is no logic to create additional EC-ICS by IID above the 1,500 af lost to evaporation during normal and surplus years. Therefore, if the EC-ICS balance decreases more than 1,500 af due to the assumed behavior in flood control surplus conditions, that ICS balance is not currently replenished in the year(s) following the flood control release.

There is currently no assumed delivery of Binational ICS or EC-ICS by IID.

For the MWD, EC-ICS creation and ICS delivery volumes are based on the annual SRWYC. The SRWYC index is obtained at http://cdec.water.cC.gov/cgi-progs/iodir/WSIHIST and then resampled using the index sequential method, for use with each inflow trace scenario, consistent with the year the Lower Basin hydrology input is from. Other constraints are described below.

EC-ICS will be created per **Table D-16** in Normal and Shortage conditions, subject to ICS accumulation and annual creation limits. ICS creation is also limited to make sure the MWD's annual diversion does not fall below its specified annual minimum diversion of 500,000 af. No creation occurs during surplus or flood control conditions.

Table D-16
EC-ICS Creation and Delivery Volumes by SRWYC

SRWYC	Creation (af)	Delivery (af)
Wet	300,000	0
Above Normal	150,000	0
Below Normal	0	0
Dry	0	100,000
Critical	0	200,000

If a DCP contribution is needed, the MWD converts EC-ICS to meet its contribution. If not enough EC-ICS is available to meet the full DCP contribution, the MWD simultaneously creates EC-ICS and converts it to DCP-ICS in the year it is required. If insufficient ICS accumulation space exists to create DCP-ICS, then contributions are made via system water.

D.7.2.6.4 Nevada ICS Assumptions

Creation of Tributary Conservation, Imported ICS, and Binational ICS are all inputs in CRMMS (**Table D-17**).

If a DCP contribution is needed, the SNWP converts EC-ICS to meet its contribution. If there is not enough EC-ICS available to meet the full DCP contribution, the SNWP simultaneously creates EC-ICS and converts it to DCP-ICS in the year it is required. If insufficient ICS accumulation space exists to create DCP-ICS, then contributions are made via system water.

EC-ICS is assumed to be created from Nevada's unused apportionment as long as there is ICS accumulation space available. The SNWP's unused apportionment equals the SNWP's apportionment minus shortages and DCP contributions, if EC-ICS was not converted in that year, minus SNWP's annual normal demand.

Table D-17
Assumed ICS Creation Volumes by the SNWP

	2023	2024	2025	2026
Tributary Conservation (af)	30,000	30,000	30,000	30,000
Imported ICS creation (af)	0	0	0	0
Binational ICS creation (af)	9,092	0	0	9,092

ICS can be used to meet the SNWP's water demands; however, it is typically only used when the demands exceed apportionment, or to offset delivery reductions resulting from shortages. In the 5-year modeling period of the June 2023 CRMMS run, the demands do not exceed the SNWP's apportionment.

D.7.2.7 System Conservation

In addition to shortage and DCP contributions based on Lake Mead operations, Lower Basin demands are assumed to be reduced for system conservation after these agreements have been finalized. **Table D-18** shows the system conservation modeled for the No Action Alternative.

Table D-18
No Action Alternative Modeled System Conservation Volumes (af)

Modeled System Conservation	2023	2024	2025	2026	Total
California					
Palo Verde Irrigation District	58,400	39,800	—	—	98,200
California Total	**58,400**	**39,800**	—	—	**98,200**
Arizona					
Gila River Indian Community	91,950	125,000	125,000	—	341,950
Fort McDowell Yavapai Nation	13,933	13,933	13,933	—	41,799
Central Arizona Project subcontractors	62,200	42,200	42,200	—	146,600
Mohave Valley Irrigation and Drainage District	12,819	—	—	—	12,819
Yuma Mesa Irrigation and Drainage District	13,670	—	—	—	13,670
Gabrych Farms	3,240	3,240	3,240	—	9,720
Arizona Total	**197,812**	**184,373**	**184,373**	—	**566,558**
Total Modeled System Conservation	**256,212**	**224,173**	**184,373**	—	**664,758**

[1] These model assumptions reflect projected volumes as of June 2023 from executed agreements, and are subject to change. These system conservation volumes are modeling assumptions; they do not represent mandatory shortages, and they do not commit specific water users to these reductions in use.

D.7.3 Proposed Action

The Lake Mead operations and Lower Basin conditions for the Proposed Action are similar to those under the No Action Alternative (that is, shortage and DCP contribution volumes are based on Lake Mead elevations).

D.7.3.1 Surplus

The surplus model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative.

D.7.3.2 Normal Conditions

The normal condition model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative.

D.7.3.3 Shortage Condition

The shortage condition model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative.

D.7.3.4 Minute 323 High- and Low-Elevation Reservoir Conditions

The Minute 323 model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative.

D.7.3.5 DCP and BWSCP

The DCP and BWSCP model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative.

D.7.3.6 ICS Assumptions

The ICS model assumptions for the Lower Basin under the Proposed Action are identical to those under the No Action Alternative, except for the following updates:

- MWD's 2023 EC-ICS creation volume is set to 216,000 af. The No Action Alterative assumes 209,000 af of ICS creation (see **Table D-17**).
- SNWA's 2023 tributary ICS creation was converted to system water due to the ICS accumulation limit.
- The assumed behavior of a state's ICS activity when the ICS accumulation capacity is full was updated. If a state is required to vacate ICS (as described in **Section D.7.2.6.1** for the No Action Alternative), a state will convert EC-ICS and tributary ICS (Nevada only) to system water instead of taking delivery of the ICS volume.

C.7.3.6 System Conservation

The Proposed Action includes additional system conservation beyond the volumes included under the No Action Alternative. **Table D-19** reports the assumed system conservation modeled for this SEIS.

Table D-19
Proposed Action Modeled SEIS Conservation Volumes (af)

Modeled SEIS Conservation	2023	2024	2025	2026	Total
California					
Coachella Valley Water District	35,000	45,000	45,000	—	125,000
Quechan Indian Tribe	13,000	13,000	13,000	13,000	52,000
Palo Verde Irrigation District	78,000	120,000	120,000	83,000	401,000
Bard Water District	—	6,000	—	—	6,000
Imperial Irrigation District	50,000	250,000	250,000	250,000	800,000
California Total	**176,000**	**434,000**	**428,000**	**346,000**	**1,384,000**
Arizona					
Gila River Indian Community	91,950	145,000	145,000	20,000	401,950
Fort McDowell Yavapai Nation	13,933	13,933	13,933	—	41,799
San Carlos Apache Tribe	23,275	—	—	—	23,275
Colorado River Indian Tribes	37,000	23,000	23,000	—	83,000
Central Arizona Project Subcontractors	143,800	129,800	128,800	—	402,400
Mohave Valley Irrigation and Drainage District	12,819	12,819	12,819	—	38,457
Yuma Mesa Irrigation and Drainage District	13,670	13,670	13,670	—	41,010
Gabrych Farms	3,240	3,240	3,240	—	9,720
Wellton-Mohawk Irrigation and Drainage District	9,000	12,000	12,000	9,000	42,000
Arizona Total	**348,687**	**353,462**	**352,462**	**29,000**	**1,083,611**
Total Modeled SEIS Conservation	**524,687**	**787,462**	**780,462**	**375,000**	**2,467,611**

[1] These model assumptions reflect projected volumes as of June 2023 from executed agreements, agreements that are under development, and planned operations; these assumptions are subject to change. These SEIS conservation volumes are modeling assumptions; they do not represent mandatory shortages, and they in no way commit specific water users to these reductions in use.

D.8 Lake Mohave and Lake Havasu Operations

Lake Mohave and Lake Havasu are operated to meet user-specified target storages at the end of each month. These operations remain consistent for both alternatives. The storage targets and the corresponding elevations for Lake Mohave and Lake Havasu are presented in the following sections.

D.8.1 Lake Mohave/Davis Dam

Lake Mohave is operated to meet monthly elevation targets (**Table D-20**). These elevation targets are based on effective storage space targets set by the US Army Corps of Engineers for Lower Basin flood control purposes, as well as for endangered species operations developed in conjunction with the Fish and Wildlife Service.

Table D-20
Lake Mohave Monthly Elevation and Storage Targets

Month	Lake Mohave Target Elevation (feet)	Lake Mohave Target Storage (1,000 af)
January	641.8	1,666
February	641.8	1,666
March	642.5	1,685
April	643.0	1,699
May	643.0	1,699
June	643.0	1,671
July	642.0	1,658
August	642.0	1,658
September	640.0	1,617
October	630.5	1,371
November	635.0	1,486
December	638.7	1,583

D.8.2 Lake Havasu/Parker Dam

Lake Havasu is operated to meet monthly elevation targets (**Table D-21**). These elevation targets are based on effective storage space targets set by the US Army Corps of Engineers for Lower Basin flood control purposes, as well as for seasonal needs to meet downstream water demands.

Table D-21
Lake Havasu Monthly Elevation and Storage Targets

Month	Lake Havasu Target Elevation (feet)	Lake Havasu Target Storage (1,000 af)
January	446.5	552
February	446.5	552
March	446.7	555
April	448.7	593
May	448.7	593
June	448.7	593
July	448.0	580
August	447.5	571
September	447.5	571
October	447.5	571
November	447.5	571
December	446.5	552

D.9 Energy Generation

RiverWare™ includes a variety of methods that can be chosen to compute electrical power generation and estimate generation capacity. All methods compute power and energy on a monthly basis. These results can be used to estimate revenue and total economic value. The following sections describe the methods used to compute power at Glen Canyon Dam, Hoover Dam, Davis Dam, and Parker Dam.

D.9.1 Glen Canyon Dam

While CRMMS includes a RiverWare™ method to compute electrical power generated from Glen Canyon Dam, the power generation data used in **Section 3.15** are computed using Generation Transmission Maximization Model (GTMax) Lite.

If the previous month's elevation is less than 3,490 feet, there is no power or energy generated for the current month. This elevation reflects the minimum power pool elevation at Lake Powell.

D.9.2 Hoover Dam

The method that computes power and energy generated at Hoover Dam, which is the same method used in CRSS for the 2007 FEIS, assumes two levels of power generation. The lower level of generation occurs at base flow, while the upper level occurs at peak flow. The method computes the fraction of the month that the powerplant is operated at peak flow and base flow. The peak flow is the most efficient flow through the turbines for the current operating head, while the base flow represents the minimum flow through the turbines to produce energy.

The base flow and corresponding power generation are based on the outflow for the current month. The peak flow must be computed through an iterative procedure using operating head, tailwater elevation, and turbine release. The initial turbine release is assumed to be that corresponding to maximum power production. Tailwater elevation at Hoover Dam is computed as a function of Lake Mohave elevation and Hoover Dam release.

The monthly Hoover Dam release volume at the base flow is computed by applying the base flow over the month. The monthly release volume at the peak flow is computed as:

$$PeakFlowVolume = TurbineReleaseVolume - BaseFlowVolume$$

Next, the number of hours required for operation at base and peak flows are computed as:

$$PeakHours = \frac{PeakFlowVolume}{(PeakFlow - BaseFlow) * 3600}$$

$$BaseHours = \frac{SecondsInMonth}{3600} - PeakHours$$

where 3,600 is the amount of seconds per hour.

If the peak hours are greater than the length of the month, the peak hours' value is set equal to the length of the month, and the base hours value is set to zero. The peak and base hours are then multiplied by the powerplant capacity at each level and added together to obtain the total energy produced for the month. Power is computed as the energy divided by the length of the month in hours.

The algorithm described above allows power generation at elevations below approximately 950 feet, which is the minimum power pool at Lake Mead. According to the algorithm, power is generated as long as the minimum operating head of 304 feet is available, corresponding to an elevation of about 950 feet. Because there is no operating experience at these elevations, it is impossible to verify whether CRMMS mimics the actual turbine performance at such low heads. It is, therefore, critical to view energy results from CRMMS in a relative manner and not in a strict numeric sense.

Power capacity is the power that could be generated if the flow is directed through the penstock turbine(s) with a given operating head. This is computed to distinguish between actual power production and the power that could be produced.

D.9.3 Davis Dam

The method that computes power and energy generations at Davis Dam uses an empirical relationship as a function of flow, operating head, plant efficiency, and user-specified power coefficients. This empirical relationship is estimated by Reclamation and was last updated in 2019 using January 2012–September 2018 historical data. Energy is computed using this empirical relationship as:

$$Energy\ (MWH) = \left(C_1 * \frac{62.4}{737.5} * Outflow\ (1000\ cfs) * HoursInMonth * \frac{OperatingHead\ (ft)}{1000} - C_2\right) * eff * 1000$$

where 62.4 is the unit weight of water in pounds per cubic foot; 737.5 represents foot-pounds per second per kilowatt; C_1 is estimated to be 0.88 based on historical data; C_2 is estimated to be 0; and eff is set to 1.0. C_1 and eff are representations of the efficiency of the powerplant, where C_1 must be a static value through the entire simulation; eff can vary (by month and/or year). C_2 represents any energy consumed within the powerplant, and is set to 0 because Reclamation does not have necessary data to determine C_2.

This energy method is different from the method used in CRSS for the 2007 FEIS; this is because the analysis of energy methods in RiverWare indicated the new method simulates historical energy generation better than the method previously used in CRSS. This new method does not currently estimate the power capacity at Davis Dam, which was computed by the method used for the 2007 FEIS.

D.9.4 Parker Dam

The method that computes power and energy generation at Parker Dam is the same method used for Davis Dam, except C_1 is set to 1.0; C_2 is estimated to be 0; and eff varies by month, as shown in **Table D-22**. The monthly efficiency coefficients are based on an analysis of historical data from PO&M reports (January 2000–April 2021).

Table D-22
Parker Dam Monthly Efficiency Coefficients

Month	Coefficient
January	0.8192
February	0.8583
March	0.8645
April	0.8732
May	0.8705
June	0.8703
July	0.8658
August	0.8631
September	0.8588
October	0.8636
November	0.8369
December	0.7710

In June 2022, this energy method was implemented in CRMMS for Parker Dam after performing analyses of different methods in RiverWare and comparing the simulated energy to actual energy as reported in historical reports. The new method was shown to outperform the previous method (used in the 2007 FEIS), particularly at higher flow and generation levels.

D.10 References

Muth, R. T., L. W. Crist, K. E. LaGory, J. W. Hayse, K. R. Bestgen, T. P. Ryan, J. K. Lyons, et al. 2000. Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam. September 2000. Internet website: https://www.waterrights.utah.gov/meetinfo/m20090820/flaminggorgeflowrecs.pdf.

Reclamation (Bureau of Reclamation). 2006a. Record of Decision for the Operation of Flaming Gorge Dam Final Environmental Impact Statement. February 2006. Internet website: https://www.usbr.gov/uc/envdocs/rod/fgFEIS/final-ROD-15feb06.pdf.

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Western Water Assessment. 2020. Colorado River Basin Climate and Hydrology State of the Science. Western Water Assessment. Chapter 3 Primary Planning Tools. April 2020. Internet website: https://wwa.colorado.edu/sites/default/files/2021-06/ColoRiver_StateOfScience_WWA_2020_Chapter_3.pdf

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Attachment D-1

CRMMS Lake Powell Assumed Monthly Releases

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Attachment D-1. CRMMS Lake Powell Assumed Monthly Releases

Table Attachment D-1
CRMMS Lake Powell Assumed Monthly Releases
(Values in af)

Annual Total	October	November	December	January	February	March	April	May	June	July	August	September
0	0	0	0	0	0	0	0	0	0	0	0	0
7,000,000	480,000	500,000	600,000	664,000	587,000	620,000	552,000	550,000	577,000	652,000	696,000	522,000
7,480,000	480,000	500,000	600,000	723,000	639,000	675,000	601,000	599,000	628,000	709,000	758,000	568,000
8,230,000	643,000	642,000	715,000	763,000	675,000	713,000	635,000	632,000	663,000	749,000	800,000	600,000
9,000,000	643,000	642,000	715,000	857,000	758,000	801,000	713,000	710,000	745,000	842,000	900,000	674,000
9,500,000	643,000	642,000	715,000	919,000	813,000	858,000	764,000	761,000	798,000	902,000	963,000	722,000
10,000,000	643,000	642,000	715,000	980,000	870,000	920,000	810,000	810,000	850,000	960,000	1,030,000	770,000
10,500,000	643,000	642,000	715,000	1,041,000	921,000	973,000	866,000	862,000	905,000	1,022,000	1,091,000	819,000
11,000,000	643,000	642,000	715,000	1,102,000	975,000	1,030,000	917,000	913,000	958,000	1,082,000	1,156,000	867,000
11,500,000	643,000	642,000	715,000	1,160,000	1,030,000	1,090,000	970,000	960,000	1,010,000	1,140,000	1,220,000	920,000
12,000,000	643,000	642,000	715,000	1,225,000	1,083,000	1,145,000	1,020,000	1,014,000	1,064,000	1,202,000	1,284,000	963,000
12,500,000	643,000	642,000	715,000	1,290,000	1,140,000	1,200,000	1,070,000	1,060,000	1,120,000	1,260,000	1,350,000	1,010,000
13,000,000	643,000	642,000	715,000	1,347,000	1,192,000	1,259,000	1,121,000	1,116,000	1,171,000	1,322,000	1,413,000	1,059,000
13,500,000	643,000	642,000	715,000	1,410,000	1,250,000	1,320,000	1,170,000	1,170,000	1,220,000	1,380,000	1,480,000	1,100,000
14,000,000	643,000	642,000	715,000	1,470,000	1,300,000	1,373,000	1,223,000	1,217,000	1,277,000	1,443,000	1,537,000	1,160,000
14,500,000	643,000	642,000	715,000	1,530,000	1,350,000	1,430,000	1,270,000	1,270,000	1,330,000	1,500,000	1,600,000	1,220,000
15,000,000	643,000	642,000	715,000	1,590,000	1,410,000	1,490,000	1,320,000	1,320,000	1,380,000	1,560,000	1,670,000	1,260,000
15,500,000	650,000	650,000	750,000	1,650,000	1,450,000	1,540,000	1,370,000	1,370,000	1,420,000	1,620,000	1,730,000	1,300,000
16,000,000	650,000	650,000	800,000	1,720,000	1,490,000	1,590,000	1,410,000	1,420,000	1,480,000	1,670,000	1,780,000	1,340,000
16,500,000	650,000	650,000	800,000	1,770,000	1,550,000	1,650,000	1,470,000	1,460,000	1,530,000	1,730,000	1,850,000	1,390,000
17,000,000	650,000	650,000	800,000	1,840,000	1,600,000	1,700,000	1,510,000	1,510,000	1,590,000	1,790,000	1,920,000	1,440,000
17,500,000	650,000	650,000	800,000	1,900,000	1,650,000	1,760,000	1,560,000	1,570,000	1,640,000	1,850,000	1,980,000	1,490,000
18,000,000	650,000	650,000	800,000	1,960,000	1,710,000	1,820,000	1,620,000	1,620,000	1,690,000	1,910,000	2,040,000	1,530,000
20,000,000	800,000	800,000	1,000,000	2,000,000	1,760,000	1,880,000	1,980,000	2,040,000	1,980,000	2,040,000	2,040,000	1,680,000
30,000,000	1,600,000	1,600,000	1,900,000	2,500,000	1,900,000	2,500,000	2,500,000	2,800,000	3,100,000	3,400,000	3,400,000	2,800,000
50,000,000	2,666,667	2,666,667	3,166,667	4,166,667	3,166,667	4,166,667	4,166,667	4,666,667	5,166,667	5,666,667	5,666,667	4,666,667
75,000,000	4,000,000	4,000,000	4,750,000	6,250,000	4,750,000	6,250,000	6,250,000	7,000,000	7,750,000	8,500,000	8,500,000	7,000,000

Footnote:
Releases from 7.0 to 14.0 maf are from LTEMP; releases outside this range are interpolated from LTEMP patterns for modeling purposes.

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Attachment D-2

CRMMS Lower Basin Water User Depletion Schedules

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Attachment D-2. CRMMS Lower Basin Water User Depletion Schedules

Table Attachment D-2
CRMMS Input Annual Lower Basin Water User Depletion Schedules (Values in af)

State	CRMMS Water User	2023	2024	2025	2026
Arizona	AzPumpersAbvImp	5,742	5,678	5,678	5,678
	AzPumpersBlwImp	8,984	8,984	8,984	8,984
	AzPumpersDvsToPkr	949	949	949	949
	BrookeWater	318	327	327	327
	BullheadCity	8,246	8,799	8,799	8,799
	CAP	851,619	1,524,366	1,524,366	1,524,366
	CibolaNWR	14,329	14,264	14,264	14,264
	CibolaValleyIID	12,761	13,090	13,090	13,090
	City of Parker	386	418	418	418
	City of Yuma	14,747	15,151	15,151	15,151
	Cocopah Indian Res	1,770	1,822	1,822	1,822
	CRIRAz	352,860	360,641	360,641	360,641
	DavisDamProject	2	2	2	2
	DesertLawnMemorial	27	27	27	27
	Ehrenberg	263	260	260	260
	Ft Yuma	3,123	3,123	3,123	3,123
	FtMohaveAz	39,285	44,280	44,280	44,280
	Gila Monster Farms	4,221	4,833	4,833	4,833
	GoldenShores	287	287	287	287
	HavasuNWR	2,924	3,564	3,564	3,564
	ImperialNWR	3,567	3,799	3,799	3,799
	LakeHavasuCity	8,850	9,052	9,052	9,052
	LMNRA Az Mead	69	68	68	68
	LMNRA Az Mohave	219	218	218	218
	MCAirStation	1,173	1,265	1,265	1,265
	MohaveValleyIID	17,279	22,815	22,815	22,815
	MohaveWaterConsDist	765	749	749	749
	NGVIDD	8,474	9,486	9,486	9,486
	SouthernPacific	29	29	29	29
	UnitB	13,980	12,220	12,220	12,220
	UofA	832	897	897	897
	WMIDD	253,149	278,000	278,000	278,000
	YAO	206	206	206	206
	YCWUA	260,208	277,259	277,259	277,259
	YID	35,774	38,958	38,958	38,958
	YMIDD	97,109	108,402	108,402	108,402
	YumaProvingGround	457	486	486	486
	YumaUnionHighScl	138	150	150	150

State	CRMMS Water User	2023	2024	2025	2026
Nevada	BasicManagement	0	0	0	0
	BigBend	4,080	4,704	4,704	4,704
	BoulderCanyonProject	300	300	300	300
	City of Henderson	0	0	0	0
	FtMohaveNv	3,666	4,623	4,623	4,623
	LMNRA Mead	1,241	1,500	1,500	1,500
	LMNRA Mohave	394	500	500	500
	LVWashReturns	234,967	222,204	222,204	222,204
	NvDeptFishGame	0	0	0	0
	PacificCoastBuilding	889	928	928	928
	SCE	0	0	0	0
	SNWADiversion	436,780	509,772	509,772	509,772
California	CaPumpersAbvImp	53	53	53	53
	CaPumpersDvsToPkr	414	414	414	414
	Chemehuevi	183	183	183	183
	Coachella	370,647	394,000	399,000	404,000
	CRIRCa	4,380	4,380	4,380	4,380
	FtMohaveCa	8,197	8,994	8,994	8,994
	FYIR_Ranches	2,331	2,332	2,332	2,332
	IID	2,580,442	2,612,800	2,607,800	2,607,800
	MWD	802,932	875,507	875,507	797,400
	MWDDiversion	805,543	878,107	878,107	800,000
	MWDReturns	2,611	2,600	2,600	2,600
	Needles	1,403	1,605	1,605	1,605
	PaloVerde	388,784	362,104	362,104	362,104
	SaltonSea	0	0	0	0
	Winterhaven	58	58	58	58
	YumaIsland	1,463	1,463	1,463	1,463
	YumaProject	44,844	48,668	48,668	48,668
Mexico	MexicoSched	1,404,713	1,500,000	1,500,000	1,500,000
	MexicoBypass	123,169	117,192	117,192	117,192
	MexicoExcess	35,781	28,963	28,963	28,963
	MexicoTJ	2,348	0	0	0

Footnotes:

Water user names in the table reflect the water user names in the June 2023 CRMMS. Water user names may have been updated in the Lower Basin Water Accounting Reports, and/or they may not match the Lower Basin Water Accounting Reports.

Appendix E

Shortage Allocation Model Documentation

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Contents

Tables

Attachments

E-1 Reclamation's September 14, 2022 letter notifying interested parties of a Tier 2 Shortage Condition and required DCP contributions in operational year 2023

E-2 Reclamation's September 28, 2022 letter to the Central Arizona Water Conservation District announcing the operational year 2023 Available CAP Supply

E-3 Exhibit 5.3.4.1 to the Tohono O'odham Settlement Agreement, *Secretary's Approach for Determining the Amount of Water Available to the Nation During a Time of Shortage Under 1980 Contract*

Acronyms and Abbreviations

Acronyms and Abbreviations	Full Phrase
2007 FEIS	2007 Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead Final Environmental Impact Statement
2007 ROD	Record of Decision for the adoption of Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead
ADWR	Arizona Department of Water Resources
af/AF	acre-foot/feet
AFY	acre-feet per year
AOP	Annual Operating Plan
AWSA	2004 Arizona Water Settlements Act
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CRBPA	Colorado River Basin Project Act of 1968
CRMMS	Colorado River Mid-term Modeling System
CU	Consumptive Use
CVWD	Coachella Valley Water District
DCP	2019 Lower Basin Drought Contingency Plan
ICS	Intentionally Created Surplus
Interim Guidelines	2007 Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead
KAF	thousand acre-feet
LCWSP	Lower Colorado Water Supply Project
LMNRA	Lake Mead National Recreation Area
Lower Division States	Arizona, California, and Nevada
M&I	Municipal and Industrial (priority)
maf	million acre-feet
MWD	The Metropolitan Water District of Southern California
NIA	Non-Indian Agricultural (priority)
PABCO	Pacific Coast Building Products, Inc.
PPR	Present Perfected Right
QSA	Quantification Settlement Agreement
Reclamation	Bureau of Reclamation

Secretary	Secretary of the Interior
SEIS	Supplemental Environmental Impact Statement
SNWA	Southern Nevada Water Authority

Appendix E. Shortage Allocation Model Documentation

This appendix describes the Shortage Allocation Model and assumptions that were used to allocate shortages to water users in the States of Arizona, California, and Nevada (Lower Division States) as part of the analysis of alternatives in this Draft SEIS. Similar material was contained within Appendix G, Table of Sensitive Species, to the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead – Final Environmental Impact Statement (2007 FEIS).

E.1 Introduction

In order to help assess the general effects of changes in the quantity of Colorado River water supplies available to water users in the Lower Division States[1] under the alternatives analyzed in this Draft SEIS, the Bureau of Reclamation developed a Shortage Allocation Model and documented the specific modeling assumptions in this appendix. This work is a supplement to a 2007 Shortage Allocation Model developed as part of the 2007 FEIS, reflecting the current conditions of Colorado River water use in the Lower Division States and the operating guidelines under review in this Draft SEIS.

E.2 Background and Purpose

The Shortage Allocation Model was created to estimate the quantity of Colorado River water that would be available to water entitlement holders or water users under shortage conditions on the mainstream lower Colorado River over a specified range of shortage volumes. A shortage condition would exist during a year when the Secretary of the Department of the Interior (Secretary), as documented in the Annual Operating Plan (AOP), determines that there is less than 7.5 million acre-feet (maf) of water available to the Lower Division States.

The Shortage Allocation Model, which is described in detail in the following sections, requires certain modeling assumptions with regard to how shortages may be allocated. Reclamation acknowledges there may be other interpretations of how shortages could be distributed. These modeling assumptions are not intended to represent current or future policy with respect to shortage sharing or to limit Secretarial discretion to distribute shortages. The Shortage Allocation Model is not a substitute for the annual process of reviewing water orders and determining annual water

[1] The US will conduct all necessary and appropriate discussions regarding the proposed federal action and implementation of the 1944 Water Treaty with Mexico through the International Boundary and Water Commission in consultation with the Department of State.

availability for each water entitlement holder on the lower Colorado River and, as such, cannot replicate the precision required for that process.

The Shortage Allocation Model simulates shortage allocations and adjusts deliveries of Colorado River water in accordance with the priority of entitlements within each of the Lower Division States' apportionments. Entitlement holders are all persons or entities authorized to beneficially use Colorado River water pursuant to: 1) a right decreed by the United States Supreme Court, 2) a contract for the delivery of Colorado River water through the Secretary, or 3) a Secretarial reservation. For a current list of each state's Colorado River water entitlement holders, please see: https://www.usbr.gov/lc/region/g4000/contracts/entitlements.html. The Shortage Allocation Model for this Draft SEIS only reflects the application of the priority system over a limited range of shortage volumes representing current commitments pursuant to the 2007 Interim Guidelines and 2019 Lower Basin Drought Contingency Plan (DCP).

For the purposes of this SEIS, shortages implemented through operational decisions are referred to as "shortages", whereas shortages incurred as a result of unplanned or unforeseen hydrologic events and when water delivery requirements cannot be met are referred to as "system shortages". The Shortage Allocation Model cannot represent the effect of potential system shortages or physical limitations on access to water due to low river stage.

The Shortage Allocation Model developed for this Draft SEIS is not intended as an implementation tool, and it should only be used for decision support as part of this Draft SEIS.

E.3 Shortage Allocation Model Assumptions

The alternatives describe the continued implementation of existing agreements that control operations of Glen Canyon and Hoover Dams. These include the 2007 Interim Guidelines for the remainder of the interim period (through the 2026 operating year) and the 2019 DCPs. The Shortage Allocation Model is a set of Microsoft Excel worksheets that simulate shortages and distribute available water first among the Lower Division States based on the 2007 ROD and 2019 DCP and then among the entitlement holders within each state based on priority or as otherwise provided by the 2019 DCP.

The discrete volumes of total shortage to the Lower Division States considered in the Shortage Allocation Model comprise the 2007 Interim Guidelines shortage reductions and 2019 DCP water savings contributions, based on Lake Mead elevations. These volumes (in AF) are:

- 200,000
- 533,000
- 617,000
- 867,000
- 917,000
- 967,000

- 1,017,000
- 1,100,000

E.3.1 Distribution Among States

The Shortage Allocation Model distributes shortages among states based on state reductions specified in the 2007 Interim Guidelines. The Shortage Allocation Model also simulates water savings contributions that were distributed among states as agreed to in the 2019 DCP. For the purpose of analyzing the impacts of alternatives considered in this Draft SEIS, DCP contributions are assumed to represent reductions in deliveries, although parties retain flexibility in how to meet those contribution commitments.

Table E-1 below shows a distribution of shortage among the Lower Division States (which consists of both 2007 Interim Guidelines shortages and 2019 DCP water savings contributions) and corresponding volumes of water available to each Lower Division State.

Table E-1
Summary of Shortage Volumes by Lower Division State Under the Shortage Allocation Model

Total Lower Division States Shortage Volumes (AF)	Arizona Shortage Volume (AF)	Arizona Available Water (AF)	California Shortage Volume (AF)	California Available Water (AF)	Nevada Shortage Volume (AF)	Nevada Available Water (AF)
(200,000)	(192,000)	2,608,000	-	4,400,000	(8,000)	292,000
(533,000)	(512,000)	2,288,000	-	4,400,000	(21,000)	279,000
(617,000)	(592,000)	2,208,000	-	4,400,000	(25,000)	275,000
(867,000)	(640,000)	2,160,000	(200,000)	4,200,000	(27,000)	273,000
(917,000)	(640,000)	2,160,000	(250,000)	4,150,000	(27,000)	273,000
(967,000)	(640,000)	2,160,000	(300,000)	4,100,000	(27,000)	273,000
(1,017,000)	(640,000)	2,160,000	(350,000)	4,050,000	(27,000)	273,000
(1,100,000)	(720,000)	2,080,000	(350,000)	4,050,000	(30,000)	270,000

E.3.2 Distribution Within States

E.3.2.1 Introduction

In accordance with Section II(B)(3) of the Consolidated Decree and Section 301(b) of the CRBPA, the Secretary has the authority to declare and allocate shortages to the Lower Division States. Some explicit guidance is given by the Supreme Court and Congress with regard to how shortages would be allocated according to priority, and additional detail is based on interpretation of intra-state priority systems and water delivery contracts executed on behalf of the Secretary in accordance with Section 5 of the Boulder Canyon Project Act.

To estimate the impacts of given levels of shortage, assumptions were made with regard to how shortages might be shared. These assumptions are made to facilitate analysis of the potential impacts and they are not intended to represent current or future policy with respect to shortage allocation. The Shortage Allocation Model is not designed to replicate some of the annual processes that must be undertaken in determining the quantity of water that can be approved for diversion by specific users.

E.3.2.2 General State Assumptions

- Each state is using its entire apportionment each year.
- For the purpose of analyzing the impacts of alternatives considered in this Draft SEIS, DCP contributions are assumed to represent reductions in deliveries, although parties retain flexibility in how to meet those contribution commitments.
- Because state apportionments are quantified in terms of consumptive use, unquantified and diversionary entitlements were estimated in terms of an equivalent consumptive use. For diversionary entitlements, the consumptive use to diversion ratios for calculating consumptive use equivalent entitlements were derived from the 2021 *Colorado River Accounting and Water Use Report: Arizona, California, and Nevada*[2] or equivalent source data for each entitlement holder (with the exception of Present Perfected Rights (PPRs) for which the Supreme Court estimated both a diversion and consumptive use). Unquantified entitlements were modeled at their level of consumptive use in 2021, including conservation activities; this should not be taken as a limit on the future exercise of those entitlements.
    - As of the date the Shortage Allocation Model was prepared for this Draft SEIS, Reclamation's determination of a 2024 Shortage Condition was forthcoming, including documentation of the 2022 published water accounting data that will affect contractual determinations of Colorado River water availability in 2024. This Appendix E therefore uses 2021 water accounting data to remain consistent with Attachments E-1 and E-2, the most current available official documentation of some of the shortage calculations referenced in this document.
- Entitlement holders with multiple priorities are assumed to divert their highest-priority water first, until it is fully utilized, although specific geographic restrictions may exist for the actual use of various priorities.
- Entitlements are used as the basis for distributing the available water supply to individual users.
- With the exception of PPRs, entitlement holders within a priority or sub-priority share in a pro-rata distribution of available water on the basis of entitlement, unless another distribution is prescribed by contract or other determination. Within priorities other than PPRs, priority dates are not considered except as they pertain to grouping entitlements by priority.
- Current and/or future paybacks of overruns or underruns under the Inadvertent Overrun and Payback Policy, creation or use of Intentionally Created Surplus (ICS), or interstate storage and release are not considered in the Shortage Allocation Model.

[2] Internet website: https://www.usbr.gov/lc/region/g4000/4200Rpts/DecreeRpt/2021/2021.pdf, also known as "Decree Accounting".

- PPRs (on a consumptive use or equivalent basis) are not included in the distribution of shortage within each state; they are subtracted from the water calculated to be available to each state, which water is then distributed in satisfaction of non-PPR entitlements, and the PPRs are accounted for in a separate PPR worksheet. A fill order is assumed for PPRs (see **Section E.3.3**), although no shortages are modeled to invoke that fill order.
- Individual entitlements are assigned to one of three categories (domestic, irrigation, or Tribal) by their primary use or intended benefit, for the purpose of generalizing shortage impacts. No attempt is made to pro-rate shared irrigation and domestic entitlements by actual use. The current proportions of irrigation and domestic use of these entitlements may change in a shortage condition due to contract-specific terms and conditions and/or the discretion of the entitlement holder.

E.3.2.3 Nevada Assumptions

- Nevada has eight water delivery priorities as established in the Robert B. Griffith Water Project Contract No. 7-07-30-W0004, as amended, for delivery of Colorado River water between the US and the State of Nevada; the contract also provides for the Southern Nevada Water Authority (SNWA) to divert the balance of any remaining un-allocated, unused, and surplus water in Nevada. **Table E-2** summarizes that priority system, which is also available at https://www.usbr.gov/lc/region/g4000/contracts/entitlements.html.
- Deliveries to Nevada are no longer assumed to be constrained by Lake Mead surface elevation as assumed in the 2007 FEIS; however, the Shortage Allocation Model does not reflect the effect of potential system shortages or physical limitations on access to water.
- The Shortage Allocation Model calculates shortage to Nevada entitlement holders relative to their consumptive use entitlement (or equivalent); however, the discrete volumes of total shortage considered in the Shortage Allocation Model pursuant to the 2007 Interim Guidelines and 2019 DCP do not result in priority system-based reductions to Nevada parties other than SNWA. The SNWA member agencies may make further arrangements for the distribution of water amongst themselves during a Shortage Condition.

Table E-2
Framework for Priority-Based Distribution of Available Water Within Nevada

Priority	Entitlement Holder	Contract No.	Priority Date	Use	Entitlements: Diversion (AFY)	Entitlements: CU or Estimated Equivalent (AFY)[1]	Entitlements: Cumulative CU (AFY)
9thth	Any contracts dated after 3-2-1992, SNWA Contract						
8thth – Balance & Surplus	Southern Nevada Water Authority	2-07-30-W0266	3/2/1992	M&I	balance + surplus	93,975	
	TOTAL					93,975	291,303
8thth	Big Bend Water District	2-07-30-W0269	3/2/1992	M&I	10,000	4,718	
	Robert B. Griffith Project Sub. to City of Boulder City (8,918af) Sub. to City Henderson (27,021af) Sub. to City of North Las Vegas (26,635af) Sub. to Las Vegas Valley Water District (232,426af)	7-07-30-W0004	3/2/1992	M&I	308,000	146,342	
	TOTAL				**318,000**	151,060	197,327
7th	Southern Nevada Water Authority (Formerly Boy Scouts of America)[2]	9-07-30-W0011	11/8/1978	M&I	10	5	
	Bureau of Reclamation (includes Sportsman Park)	Secretarial Res.	11/9/1998	M&I	300	168	
	Nevada Dept. of Wildlife (formerly Nevada Dept. of Fish & Game)	14-06-300-2405	10/18/1972	M&I		25	
	US Air Force (4,000af) (Delivery from SNWA)[2]	F26600-78-DOO11, amended by F-26600-01-D-A111 (Included in 07-07-30-W0004 in P8)	1/23/1978, amended 5/1/2000		4,000	1,901	
	TOTAL				**4,310**	2,099	46,267
6th	Las Vegas Valley Water District[2]	14-06-300-2130	9/22/1969	M&I	15,407	7,320	
	TOTAL				**15,407**	7,320	44,169
5th	Lakeview Company (Hacienda Casino)	14-06-300-1523	2/12/1965	M&I	0	0	
	Pacific Coast Building Products, Inc. (PABCO)	5-07-30-W0089	6/19/1985	M&I	928	928	
	TOTAL				**928**	928	36,848

Priority	Entitlement Holder	Contract No.	Priority Date	Use	Entitlements		
					Diversion (AFY)	CU or Estimated Equivalent (AFY)[1]	Cumulative CU (AFY)
4th	Basic Water Company (formerly Basic Management, Inc.)	14-06-300-2083	9/18/1969	M&I	8,208	8,208	
	City of Henderson	0-07-30-W0246	9/18/1969	M&I	15,878	14,503	
	Southern Nevada Water Authority (From Basic Water Company)[2]	2-07-30-W0266	9/18/1969	M&I	14,950	7,103	
	TOTAL				**39,036**	29,814	35,920
3rd	Boulder City[3]	14-06-300-978	5/15/1931	M&I	5,876	5,876	
	TOTAL				5,876	5,876	6,106
2nd	Lake Mead National Recreation Area[4], Executive Order No. 5339	1964 Decree	4/25/1930	M&I	Unquantified, estimated ~1,500	230	
	TOTAL				**1,500**	230	230
NEVADA TOTALS					385,057	291,303	

Note: CU means Consumptive Use. All units are in acre-feet per year. The Cumulative CU column is included as a reference for the estimated amount of water that would need to be available to Nevada priorities two through eight to fulfill a given priority on this table.

Subcontracts are displayed below the Entitlement Holder and indented five spaces.

In a shortage, PPRs are delivered water in order of priority date regardless of state lines. PPRs are not included in this table and they are accounted for in a separate PPR worksheet.

[1]2021 Decree Accounting values and Diversion/CU conversion ratios were used to estimate not specified and unquantified entitlements.

[2]Water for this entitlement is delivered through the Robert B. Griffith Project. 2021 Decree Accounting for the Robert B. Griffith Project and Las Vegas Wash return flows were used to estimate the consumptive use equivalent for these diversions.

[3]Though Boulder City's entitlement is delivered through the Robert B. Griffith Project, there are no return flows from Boulder City, so its consumptive use was assumed to be equivalent to diversion.

[4]This unlimited entitlement is estimated based on 2021 use, minus the Lake Mead National Recreation Area PPR.

E.3.2.4 California Assumptions

- Entitlements shown in **Table E-3** for California priorities one through three exclude the full volume of PPR entitlements held by those same parties, which are subject to a separate priority system (see **Section E.3.3**).
- Reclamation recognizes that the Quantification Settlement Agreement (QSA) and related agreements help California parties meet the water needs of PPRs by agreeing that certain parties to the Seven Party Agreement would make water available to satisfy the requirements of the PPR holders while keeping the priorities within the Seven Party Agreement intact. In addition, the QSA helped quantify entitlements in the Seven Party Agreement, which is necessary to model shortages.
    - The quantified entitlements in the QSA for the Imperial Irrigation District and the Coachella Valley Water District were modeled in the Shortage Allocation Model.
    - QSA transfers and exchanges were not modeled in the Shortage Allocation Model since the shortage levels simulated do not trigger QSA shortage provisions.
- Although the Metropolitan Water District of Southern California (MWD) has a fourth priority Seven Party Agreement entitlement of 550,000 af, MWD's consumptive use equivalent entitlement is calculated (for modeling purposes) to equal the balance of California's apportionment after full use of higher priority entitlements. During a shortage, MWD may acquire a minimum of 25,000 af from the Palo Verde Irrigation District, though this is not modeled in the Shortage Allocation Model.
- The Shortage Allocation Model attributes 93% of California DCP contributions to MWD and 7% of California DCP contributions to Coachella Valley Water District pursuant to a May 20, 2019 DCP Implementation Agreement Between Metropolitan Water District of Southern California and Coachella Valley Water District. No shortages from the 2007 Interim Guidelines are applicable to California.
- Entitlements associated with each California entitlement holder are available at: https://www.usbr.gov/lc/region/g4000/contracts/entitlements.html.
- Shortage to California entitlement holders, in this case comprised solely of DCP contributions, is calculated relative to their consumptive use entitlement (or equivalent).

Table E-3
Framework for Priority-Based Distribution of Available Water Within California

Priority	Entitlement Holder	Contract No.	Priority Date	Use	Diversion (AFY)	CU Entitlement (AFY)	Entitlements	
							CU or Estimated Equivalent (AFY)	Cumulative CU (AFY)
4th	The Metropolitan Water District of Southern California (MWD) (4)	I1r-645	1930, 1931	M&I		550,000	429,852	**1,705,724**
	TOTAL				**0**	**550,000**	**429,852**	
3rd	Palo Verde Irrigation District (3b) – Lower Palo Verde Mesa Lands[1]	PVID20733C_P5	1933	Ag	≤16,000 acres	Unquantified	4,156	
	Coachella Valley Water District (CVWD) Total (3a)	I1r-781	1934			330,000	330,000	
	Imperial Irrigation District (IID) (3a)[2]	I1r-747	1932			615,000	615,000	
	TOTAL[3]					**945,000**	**949,156**	**1,275,872**
2nd	Yuma Project, Reservation Division (Bard Unit Only – Indian Unit Under PPRs)[4]	Water Certificates	1905	Ind./Ag	≤25,000 acres		3,459	
	TOTAL				**0**	**0**	**3,459**	**326,716**
1st	Palo Verde Irrigation District – Valley Lands (1)[5]	PVID20733C_P2	1933	Ag	≤104,500 acres	Unquantified	323,258	
	TOTAL				**0**	**0**	**323,258**	**323,258**
	CALIFORNIA TOTALS						**1,705,724**	

Notes: CU means Consumptive Use; all units are in AFY (acre feet per year). The Cumulative CU column is included as a reference for the estimated amount of water that would need to be available to California priorities one through four to fulfill a given priority on this table.

Priorities are based on the California Seven Party Agreement, modified for the PPRs identified by the Consolidated Decree (which are accounted for in the PPRs tab).

Unless otherwise noted, 2021 Decree Accounting values and Diversion/CU conversion ratios were used to estimate not specified and unquantified entitlements.

PPRs are not included in this table and they are accounted for in a separate PPR worksheet.

[1]PVID Lower Palo Verde Mesa Lands' 2022 Diversion of 9,134 af was assumed to be more representative of future conditions than the 2021 Diversion. The CU/Diversion ratio of about 0.455 for the entire PVID, based on 2021 accounting, was used to estimate the CU equivalent.

[2]Non-Colorado River water is pumped from the Lower Colorado Water Supply Project (LCWSP) wellfield and discharged into the All-American Canal for delivery to IID. IID forbears the consumptive use of an equivalent amount of Colorado River, up to a maximum of 10,000 af per year, to make such water available, via exchange, to the LCWSP beneficiaries (includes MWD and the City of Needles and its subcontractors). For purposes of the Shortage Allocation Model, the 10,000 af is included in IID's estimated CU equivalent; if the LCWSP was non-operational, that water would be diverted from the Colorado River by IID.

[3]QSA transfers and exchanges are not modeled in the Shortage Allocation Model since shortages to California are not triggered at the modeled shortage levels.

[4]The Yuma Project CU Estimated Equivalent is based on the 2021 CU from the Bard Unit, plus the amount conserved by the Bard Unit that was made available to MWD, minus the CU from PPR 28, which is accounted for in the PPRs tab. The Yuma Project Reservation Division Indian Unit is not accounted for here, since its use is fully satisfied by PPR 23, also listed in the PPRs tab.

E.3.2.5 Arizona Assumptions

- In 2007, consumptive use schedules were provided by the Arizona Department of Water Resources (ADWR) for use in the Shortage Allocation Model for the period 2008 through 2060. ADWR and Reclamation have not undertaken a process to update those schedules; shortage to Arizona entitlement holders is instead assessed relative to recent available data as described below for each priority.
- Central Arizona Project (CAP) excess and unused water contracts and mainstream unused apportionment or surplus (fifth and/or sixth priority) entitlements are not available in shortage and they are assumed to bear the remainder of any shortage not assigned to other parties within Arizona; they are assumed to be out of priority in all levels of shortage and they are not itemized.
- The Shortage Allocation Model does not attempt to redistribute water that may be available within a priority but is unordered by any specific entitlement holder.
- Entitlements associated with each Arizona entitlement holder are available at: https://www.usbr.gov/lc/region/g4000/contracts/entitlements.html.

Water available to entitlement holders in Arizona is distributed through each priority according to the following assumptions. These assumptions do not necessarily reflect operational procedure, but they are necessary to produce a general approximation of the effect of shortages on specific priorities and entitlement holders for the purpose of comparing alternatives in this Draft SEIS.

E.3.2.5.1 Arizona Priority Two and Three Assumptions

Arizona priority two is for Secretarial Reservations and Perfected Rights established or effective prior to September 30, 1968. Arizona priority three is for entitlements pursuant to contracts between the US and water users in the State of Arizona executed on or before September 30, 1968. The second and third priorities are coequal.

Water supply to the Arizona second and third priorities is not projected to be affected at the specified levels of shortage and DCP contributions contemplated in the Shortage Allocation Model, because the Arizona fourth priority is not projected to be fully reduced. Thus it is unnecessary to analyze the relative priority of individual entitlements within the second and third priorities for purposes of assessing impacts within those priorities in this Appendix E; however, because information on the Arizona second and third priorities is included in the Shortage Allocation Model worksheets and second and third priority entitlements are enumerated in summary tables in this Appendix, modeling assumptions are described below.

The available supply to Arizona priorities two and three is calculated as the available supply to Arizona minus an average of the 4 highest of the last 5 years (2017–2021) of use by the first priority (PPR), or 519,154 AF. That supply is divided between priorities two and three in proportion to the sum of the consumptive use (or equivalent) entitlements within each priority: about 10 percent to priority two and about 90 percent to priority three. The 2007 Shortage Allocation Model did not distinguish between priority two and three supplies. The following assumptions for distribution within those priorities are intended to improve the accuracy of estimated impacts by considering contract-specific priority language.

Shortage is measured by the difference between water available to an entitlement during shortage and the 2021 adjusted consumptive use of that entitlement. Shortage is assumed to begin for priorities two and three when available supply is less than total 2021 adjusted consumptive use for both priorities, not reflecting the potential difference between orders and use. In addition, distributions of available water on the basis of entitlement may result in a shortage to certain entitlements and no shortage to others. The Shortage Allocation Model does not contain data for estimated orders in this priority or attempt to redistribute water that may be available, but unordered.

Water available to priority two is distributed among its five entitlements in proportion to their consumptive use (or equivalent) entitlement relative to the total for priority two.

Water available to priority three is distributed among its 28 entitlements in six groups according to project and/or division or pertinent contract terms. The alphanumeric sub-priority naming conventions for the six groups (shown in **Table E-4** below) are not operational or contractual designations, and they are only used as an organizational tool specific to this analysis. Five of the six groups are assumed to be coequal within priority three, and they are distributed water in proportion to the sum of the consumptive use (or equivalent) entitlements within each group, relative to the total for all five groups. They are discussed in detail in the sections that follow.

Table E-4
Framework for Priority-Based Distribution of Available Water Within Arizona Priorities 2 and 3

Priority	Water Allocation % by Priority	Sub-Priority	Project	Division	Water Allocation % by Project/Division	Entitlement Holder	Contract No.	Priority Date	Use	Entitlements: Diversion (AFY)	Entitlements: CU or *Estimated Equivalent* (AFY)
2nd	9.94%	N/A	N/A	N/A	N/A	Cibola National Wildlife Refuge	Secretarial Res.	8/21/1964	M&I	34,500	16,793
						Lake Mead National Recreation Area	Consolidated Decree	4/25/1930	M&I	unquantified	*306*
						Bureau of Reclamation – Davis Dam	Secretarial Res.	4/26/1941	M&I	100	*3*
						Imperial National Wildlife Refuge	Consolidated Decree	2/14/1941	M&I	28,000	23,000
						Havasu National Wildlife Refuge	Consolidated Decree	1/22/1941	M&I	41,839	37,399
										P2 Total	**77,501**
3rd	90.06%	3b	Boulder Canyon		Remainder	City of Yuma	14-06-W-106	11/12/1959	M&I		48,522
										Project/Division Subtotal	**48,522**
		3a5 Subordinate	Gila	Yuma Mesa	33.03%	Union Pacific Railroad (formerly Southern Pacific Co.)	14-06-303-1524	12/21/1959	M&I	48	*29*
						Kaman, Inc.	14-06-303-1555	12/2/1959	M&I	2	0
						Department of the Navy, MCAS	14-06-300-937	1/1/1959	M&I	3,000	*3,000*
						City of Yuma (cemetery)	14-06-303-1078	5/1/1956	M&I	60	0
						Yuma Mesa Fruit Growers' Association	14-06-303-1196	10/1/1956	M&I	15	0
						Desert Lawn Memorial Park Association	14-06-300-1079	5/1/1956	M&I	200	*140*
						Sturges, Harold	I76R-733	1/1/1952	Ag	335	*0*
						Sturges, Irma	I76R-735	1/1/1952	Ag	385	*0*
		3a5				**Yuma Mesa Irrigation & Drainage District (10,000af M&I)**	5-07-30-W0095	5/26/1956	M&I/Ag		141,519
						Yuma Irrigation District (5,000af M&I)	5-07-30-W0093	7/23/1962	M&I/Ag		67,278
						North Gila Valley Irrigation and Drainage District (2,500af M&I)	5-07-30-W0094	5/12/1953	M&I/Ag		*3,920*
										Project/Division Subtotal	***215,886***
		3a4	Gila	Wellton-Mohawk	42.53%	**Wellton-Mohawk Irrigation and Drainage District (12,000af M&I)**	1-07-30-W0021	3/4/1952	M&I/Ag		278,000
										Project/Division Subtotal	***278,000***
		3a3	Various		11.73%	Ak-Chin Indian Community	1985 Settlement Contract	1/1/1956	M&I/Ag	50,000	*50,000*
						Chandler (Salt River Pima-Maricopa Exchange)	9-07-30-W0235	3/4/1952	M&I	4,278	*4,278*
						Gilbert (Salt River Pima-Maricopa Exchange)	9-07-30-W0241	3/4/1952	M&I	6,762	*6,762*
						Glendale (Salt River Pima-Maricopa Exchange)	9-07-30-W0236	3/4/1952	M&I	3,000	*3,000*
						Mesa (Salt River Pima-Maricopa Exchange)	9-07-30-W0239	3/4/1952	M&I	2,760	*2,760*
						Phoenix (Salt River Pima-Maricopa Exchange)	9-07-30-W0240	3/4/1952	M&I	5,000	*5,000*
						Scottsdale (Salt River Pima-Maricopa Exchange)	9-07-30-W0237	3/4/1952	M&I	100	*100*
						Tempe (Salt River Pima-Maricopa Exchange)	9-07-30-W0238	3/4/1952	M&I	100	*100*
						Department of the Army — Yuma Proving Ground	I76r-696	6/12/1951	M&I	1,129	*1,129*
						Gila Monster Farms (formerly Sturges)	6-07-30-W0337	1/1/1952	Ag	6,285	3,516
										Project/Division Subtotal	***76,645***
		3a2 Subordinate	Yuma		10.69%	Yuma Union High School District	14-06-303-179	1/1/1953	M&I	200	*150*
		3a2				**Yuma County Water Users' Association (14,701af M&I includes YAO)**	14-06-300-621 & Certificates	4/1/1957	M&I/Ag	unquantified	*69,690*
										Project/Division Subtotal	***69,840***
		3a1 Subordinate	Yuma Auxiliary		2.02%	University of Arizona	14-06-300-144	1/1/1954	Ag	1,088	*1,088*
						Camille Allec, Jr. (Formerly Yuma Mesa Grapefruit Company)	14-06-303-528	12/23/1953	Ag	120	0
		3a1				**Unit B Irrigation & Drainage District**	14-06-300-44	12/22/1952	Ag	unquantified	*12,145*
Grand Total	**100.00%**									**Project/Division Subtotal**	**13,233**
										P3a Total	**653,605**
										P3 Total	**702,127**
										P 2 & 3 Grand Total	**779,628**

The Yuma Mesa Division of the Gila Project

Approximately 33 percent of the available priority three water, up to the limit of the sum of the consumptive use (or equivalent) entitlements within the Division, is distributed among the Division's 11 entitlements. That water is first made available to Yuma Mesa Irrigation and Drainage District, Yuma Irrigation District, and North Gila Valley Irrigation and Drainage District coequally in proportion to their consumptive use entitlements.[3]

Any water remaining for the Division after satisfaction of the district contracts is made available to Union Pacific Railroad, Department of the Navy (Marine Corps Air Station), and Desert Lawn Memorial Park Association coequally in proportion to their consumptive use equivalent entitlements.[4]

The Kaman, City of Yuma (Cemetery), Yuma Mesa Fruit Growers Association, Harold Sturges, and Irma Sturges entitlements[5] are assumed to be unexercised and they are not distributed water; they are shown with a consumptive use equivalent entitlement of zero.

The Wellton-Mohawk Division of the Gila Project

Approximately 43 percent of the available priority three water, up to the limit of Wellton-Mohawk Irrigation and Drainage District's consumptive use entitlement, is made available to the District.[4]

The Yuma Project

Approximately 11 percent of the available priority three water is first made available to the Yuma County Water Users Association up to the limit of its consumptive use equivalent entitlement. Any water remaining for the Yuma Project after satisfaction of the Association contract is made available to Yuma Union High School District.[5]

The Yuma Auxiliary Project

Approximately 2.0 percent of the available priority three water, up to the limit of the sum of the consumptive use equivalent entitlements within the Yuma Auxiliary Project, is distributed among the Yuma Auxiliary Project's three entitlements. That water is first made available to Unit B Irrigation and Drainage District up to the limit of its consumptive use equivalent entitlement. Any water remaining for the Yuma Auxiliary Project after satisfaction of the District contract is made available to the University of Arizona.[5] The Camille Allec, Jr. entitlement[5] is assumed to be unexercised and it is not distributed water; it is shown with a consumptive use equivalent entitlement of zero.

Various Entitlements

A group of 10 entitlements established under various authorities shares approximately 12 percent of the available priority three water, up to the limit of the sum of the consumptive use (or equivalent) entitlements within the group. Water is distributed to the Ak-Chin Indian Community; the Arizona cities of Chandler, Gilbert, Glendale, Mesa, Phoenix, Scottsdale, and Tempe; the Department of the Army (Yuma Proving Ground); and Gila Monster Farms coequally in proportion to their

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[3] Domestic use within each district's entitlement is assumed to be subordinated to irrigation use in the district, but is not itemized separately.

[4] Water use is subject to availability and is assumed not to be detrimental to water service for the project or prior appropriators.

consumptive use (or equivalent) entitlements. The distribution of water is stated in terms of quantities available at the mainstream point of diversion, and no assumptions are made about the further distribution of priority three water delivered through the CAP.

The City of Yuma

The City of Yuma gets a distribution of all remaining priority three water, up to the limit of its consumptive use entitlement (minus a portion assumed to be satisfied by PPR No. 21), reflecting that water delivery under its Contract No. 14-06-W-106 is subject to the prior fulfillment of contracts for the diversion of Colorado River water at Imperial Dam and for the delivery of such water through the Gila Gravity Main Canal or the All-American Canal for the irrigation of lands in the State of Arizona.

E.3.2.5.2 Arizona Priority Four Assumptions

Reclamation implemented the State of Arizona's August 6, 2009, Arizona Shortage Sharing Recommendation and the "pool" approach described by letter dated January 25, 2021, to inform approval of fourth priority water orders for operational years 2022 and 2023. Consistent with the Arizona mainstream Colorado River water priority system, the approach recognizes that the fourth priority Colorado River water entitlements of the P4(i) or 'mainstream' users and the CAP (P4(ii)) are coequal.

The Shortage Allocation Model uses the same fourth priority shortage sharing assumptions documented and described in:

- Reclamation's September 14, 2022 letter notifying interested parties of a Tier 2 Shortage Condition and required DCP contributions in operational year 2023 (Attachment E-1 to this Appendix E)
- Reclamation's September 28, 2022 letter to the Central Arizona Water Conservation District announcing the operational year 2023 Available CAP Supply (Attachment E-2 to this Appendix E)

Those assumptions result in the P4(i) pool receiving 9.85 percent of the Arizona fourth priority Colorado River water available under the modeled shortage scenarios, while the remainder is available for diversion as fourth priority water by the CAP to fulfill CAP contracts and subcontracts.

E.3.2.5.3 P4(i) (Mainstream) Framework and Assumptions

Water is distributed to each entitlement within the P4(i) pool in proportion to its diversion[5] volume relative to the current total for the pool, 151,274 AFY, which does not include outstanding ADWR recommendations, unallocated water, or the 3,500 AFY reserved for use in a future Navajo-Hopi

[5] Historically Arizona P4(i) entitlements have been quantified on a diversion basis. More recently some entitlements, currently including the Bureau of Land Management's and Town of Queen Creek's Arizona P4(i) entitlements, specify consumptive use volumes (consumptive use = diversions minus return flows). These entitlements are shown in Table E-5 as their diversion equivalents (consumptive use + return flows = diversion equivalent) for modeling purposes because distribution during shortage within the Arizona P4(i) pool currently is administered in proportion to all users' diversion volumes, not in proportion to consumptive use volumes, for uniformity and consistency. The diversion equivalency volumes listed in Table E-5 are necessary to analyze the distribution of the Arizona P4(i) entitlements with a uniform metric, do not modify the entitlements, and are consistent with applicable contracts and agency decision documents.

Indian water rights settlement in accordance with subsection 11.3 of the 2006 Arizona Water Settlement Agreement. (See **Table E-5**)

Contracts and subcontracts are itemized separately, meaning an entity's total modeled supply may be the sum of multiple distributions.

Table E-5
Framework for Priority-Based Distribution of Available Water Within Arizona P4(i) (Mainstream)

4th Priority Mainstream Entitlement Holders	4th Priority Contract Information				Initial Proportional Distribution of 4thth Priority Mainstream Available Supply			
	Contract Number(s)	Date	Type of Use	Diversion Entitle-ment in AFY	Divided By	Sum of Entitle-ments in AFY	Equals	Proportionate Share of 4th Priority Mainstream Pool
Arizona Game and Fish Commission	07-XX-30-W0509	2007	Irrigation	2,838.00	/	151,274	=	1.876%
Arizona State Land Department	4-07-30-W0317	1999	Irrigation	6,607.00	/	151,274	=	4.368%
Beattie Farms, Southwest	05-XX-30-W0446	2006	Irrigation	1,110.00	/	151,274	=	0.734%
Bishop, Alfred F. and Erma Jean Family Trust	21-XX-30-W0718	1983	Irrigation	420.00	/	151,274	=	0.278%
Cathcart, Bruce Y. and Lora M. and James Y. and Maria E.	21-XX-30-W0719	1983	Irrigation	126.00	/	151,274	=	0.083%
ChaCha, LLC	09-XX-30-W0539	2009	Irrigation	2,100.00	/	151,274	=	1.388%
Cibola Sportsman's Club, Inc.	21-XX-30-W0717	1983	Irrigation	216.00	/	151,274	=	0.143%
Cibola Valley Irrigation and Drainage District	2-07-30-W0028	1983	Irrigation/Domestic	7,442.52	/	151,274	=	4.920%
Cocopah Indian Reservation	Consolidated Decree in AZ v. CA	1974	Irrigation/Domestic	2,026.00	/	151,274	=	1.339%
Curtis, Armon	3-07-30-W0037	1983	Irrigation	300.00	/	151,274	=	0.198%
Gila Monster Farms, Inc.	6-07-30-W0337	1997	Irrigation	1,435.00	/	151,274	=	0.949%
GM Gabrych Family Limited Partnership	17-XX-30-W0628	2018	Irrigation	4,500.00	/	151,274	=	2.975%
GSC Farm, LLC[6]	13-XX-30-W0571	2013	Irrigation	69.93	/	151,274	=	1.926%
Hopi Tribe	04-XX-30-W0432	2004	Irrigation	4,278.00	/	151,274	=	2.828%
JRJ Partners, L.L.C.	06-XX-30-W0448	2007	Irrigation	1,080.00	/	151,274	=	0.714%
Mohave Valley Irrigation and Drainage District	14-06-W-204	1968	Irrigation/Domestic	35,060.00	/	151,274	=	23.176%
North Baja Pipeline, LLC	04-XX-30-W0433	2005	Irrigation/Domestic	480.00	/	151,274	=	0.317%
Ogram Boys Enterprises, Inc.	01-XX-30-W0402	2005	Irrigation	924.00	/	151,274	=	0.611%
Ott, Larry and Gina, and Lee C. and Candace M.	18-XX-30-W0639	2018	Irrigation	480.00	/	151,274	=	0.317%
Pasquinelli, Gary J. and Barbara J.	5-07-30-W0065	1986	Irrigation	486.00	/	151,274	=	0.321%
Red River Land Company, LLC	17-XX-30-W0630	2018	Irrigation	300.00	/	151,274	=	0.198%
Western Water, LLC	16-XX-30-W0619	2018	Irrigation	536.48	/	151,274	=	0.355%
Arizona State Land Department	7-07-30-W0358	2004	Domestic	1,534.00	/	151,274	=	1.014%
Arizona State Parks Board - Windsor Beach	7-07-30-W0364	1998	Domestic	90.00	/	151,274	=	0.059%
B&F Investment, LLC	06-XX-30-W0453	2006	Domestic	60.00	/	151,274	=	0.040%
Bullhead City	2-07-30-W0273	1994	Domestic	15,210.00	/	151,274	=	10.055%
Bullhead City (MCWA Subcontract)	Subcontract to 04-XX-30-W0431	2004	Domestic	2,139.00	/	151,274	=	1.414%
Bullhead City (MCWA Subcontract)	Subcontract No. 95-102 to 5-07-30-W0320	1995	Domestic	7,000.00	/	151,274	=	4.627%
Bureau of Land Management (diversion equivalent)	8-07-30-W0373	2000	Domestic	6,169.00	/	151,274	=	4.078%
Crystal Beach Water Conservation District	6-07-30-W0352	1997	Domestic	132.00	/	151,274	=	0.087%
Desert Lawn Memorial Park Association, Inc.	14-06-300-2587	1975	Domestic	360.00	/	151,274	=	0.238%
Ehrenburg Improvement District	8-07-30-W0006	1977	Domestic	735.00	/	151,274	=	0.486%
EPCOR Water Arizona Inc.	20-XX-30-W0690	2021	Domestic	1,874.00	/	151,274	=	1.239%
Fisher's Landing Water and Sewer Works, L.L.C.	06-XX-30-W0450	2006	Domestic	53.00	/	151,274	=	0.035%
Frontier Communications West Coast Inc.	14-06-300-2506	1974	Domestic	1.00	/	151,274	=	0.001%
Gold Dome Mining Corporation	0-07-30-W0250	1990	Domestic	7.00	/	151,274	=	0.005%
Gold Standard Mines Corp.	3-07-30-W0038	1983	Domestic	75.00	/	151,274	=	0.050%

[6] On April 28, 2023, the US executed a partial assignment and transfer of Arizona P4(i) Colorado River water from GSC Farm, LLC to the Town of Queen Creek. Table E-5, which previously only included the GSC Farm, LLC entitlement, has been revised to include the assignment and transfer volumes, and the Shortage Allocation Model reflects an updated proportionate share of the Arizona P4(i) entitlement pool for both GSC Farm, LLC and the Town of Queen Creek (with the nontransferable historical return flow volume modeled in the diversion equivalent volume). Otherwise, the assignment and transfer does not modify the Arizona P4(i) pool volume under contract or the framework and assumptions discussed herein.

4th Priority Mainstream Entitlement Holders	4th Priority Contract Information				Initial Proportional Distribution of 4thth Priority Mainstream Available Supply			
	Contract Number(s)	Date	Type of Use	Diversion Entitle-ment in AFY	Divided By	Sum of Entitle-ments in AFY	Equals	Proportionate Share of 4th Priority Mainstream Pool
Golden Shores Water Conservation District	9-07-30-W0203	1989	Domestic	2,000.00	/	151,274	=	1.322%
Hillcrest Water Company	5-07-30-W0078	1985	Domestic	84.00	/	151,274	=	0.056%
Lake Havasu City	3-07-30-W0039	1995	Domestic	19,192.70	/	151,274	=	12.687%
Lake Havasu City (MCWA Subcontract)	Subcontract to 04-XX-30-W0431	2004	Domestic	2,139.00	/	151,274	=	1.414%
Lake Havasu City (MCWA Subcontract)	Subcontract No. 95-101 to 5-07-30-W0320	1995	Domestic	7,250.00	/	151,274	=	4.793%
La Paz County	08-XX-30-W0530	2008	Domestic	350.00	/	151,274	=	0.231%
McAlister Family Trust	7-07-30-W0355	1998	Domestic	40.00	/	151,274	=	0.026%
Mohave Valley Irrigation and Drainage District (MCWA Subcontract)	Subcontract No. 09-101 to 5-07-30-W0320	1995	Domestic	1,250.00	/	151,274	=	0.826%
Mohave Water Conservation District	9-07-30-W0012	1979	Domestic	1,800.00	/	151,274	=	1.190%
Mohave Water Conservation District (MCWA Subcontract)	Subcontract No. 95-103 to 5-07-30-W0320	1995	Domestic	3,000.00	/	151,274	=	1.983%
Parker, Town of	2-07-30-W0025	1982	Domestic	1,030.00	/	151,274	=	0.681%
Quartzsite, Town of	7-07-30-W0353	1999	Domestic	1,070.00	/	151,274	=	0.707%
Queen Creek, Town of (mainstream diversion equivalent)	20-XX-30-W0689	2023	Domestic	2,843.37	/	151,274	=	1.880%
Roy, Estates of Anna R. and Edward P.	6-07-30-W0124	1986	Domestic	1.00	/	151,274	=	0.001%
Shepard Water Company, Incorporated	08-XX-30-W0535	2009	Domestic	50.00	/	151,274	=	0.033%
Somerton, City of	03-XX-30-W0419	2006	Domestic	750.00	/	151,274	=	0.496%
Springs Del Sol Domestic Water Improvement District	08-XX-30-W0524	2008	Domestic	100.00	/	151,274	=	0.066%
TV Marble Canyon AZ, LLC	5-07-30-W0322	1996	Domestic	70.00	/	151,274	=	0.046%
Total				**151,274**				**100%**

Each entitlement's proportional share of the available P4(i) supply is initially calculated on a diversion (or mainstream diversion equivalent) basis, then converted to a consumptive use equivalent using consumptive use to diversion ratios from the operational year 2021 *Colorado River Accounting and Water Use Report: Arizona, California, and Nevada*[7] or equivalent source data. Shortage is calculated as the difference between each entitlement's consumptive use equivalent supply and its 2021 consumptive use adjusted for participation in conservation programs (if applicable). The Shortage Allocation Model does not contain data for estimated orders in this priority, and therefore cannot illustrate the potential effect of the pool approach to redistributing water that may be available but unordered under any specific entitlement.

E.3.2.5.4 CAP Framework and Assumptions

In the Shortage Allocation Model, Arizona priority three Colorado River water entitlements delivered through the CAP are assumed to be fully satisfied consistent with their Colorado River third priority, and Arizona fourth priority (P4(i)) water transported through the CAP is assumed to be satisfied according to its priority. Terms and conditions for priority in case of shortage to the Available CAP Supply relate only to CAP fourth priority water (P4(ii)). The Shortage Allocation Model attempts to reflect the legislative and contractual terms and conditions applicable to CAP (P4(ii)) shortages, which shortage would impact the CAP P4(ii) distribution to CAP contractors and subcontractors.

Levels of shortage to date have not required the implementation of shortage provisions in all CAP contracts, and their modeling should be understood as theoretical.

[7] Internet website: https://www.usbr.gov/lc/region/g4000/4200Rpts/DecreeRpt/2021/2021.pdf, also known as Decree Accounting.

Available CAP Supply is first made available to Indian and Municipal & Industrial (M&I) Priority long-term contracts and subcontracts, and then to Non-Indian Agricultural (NIA) Priority long-term contracts and subcontracts. After all long-term CAP contracts and subcontracts are fulfilled[8], the remaining available water could be ordered under one-year excess contracts; however, none of the modeled shortage volumes are assumed to provide for enough available supply for excess contracts under the assumptions of the model.

The Shortage Allocation Model calculates Available CAP Supply as described in Reclamation's September 28, 2022 letter to the Central Arizona Water Conservation District (Attachment E-2 to this Appendix). A range of Available CAP Supply from zero to 1,251,317 AF, in rounded 10,000 af increments except at pivotal quantities, is presented in **Table E-6** below; all of these discrete levels of supply are contained within the Shortage Allocation Model, but because this Draft SEIS only includes a distribution analysis over a specified range of shortage volumes, certain rows on **Table E-6** below an Available CAP Supply of 810,000 AF are not projected to be implicated under the assumptions of the Shortage Allocation Model. These rows are shaded gray to indicate inactivity in the analysis, but are included in this Appendix E for constancy.

Table E-6
Discrete Levels and Distribution of Available CAP Supply Modeled in the Shortage Allocation Model

Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	M&I Priority Supply (AF)	NIA Priority Supply (AF)
1,251,317	Full Supply	343,079	638,823	269,415
1,250,000	Full Supply	343,079	638,823	268,098
1,240,000	Full Supply	343,079	638,823	258,098
1,230,000	Full Supply	343,079	638,823	248,098
1,220,000	Full Supply	343,079	638,823	238,098
1,210,000	Full Supply	343,079	638,823	228,098
1,200,000	Full Supply	343,079	638,823	218,098
1,190,000	Full Supply	343,079	638,823	208,098
1,180,000	Full Supply	343,079	638,823	198,098
1,170,000	Full Supply	343,079	638,823	188,098
1,160,000	Full Supply	343,079	638,823	178,098
1,150,000	Full Supply	343,079	638,823	168,098
1,140,000	Full Supply	343,079	638,823	158,098
1,130,000	Full Supply	343,079	638,823	148,098
1,120,000	Full Supply	343,079	638,823	138,098
1,110,000	Full Supply	343,079	638,823	128,098
1,100,000	Full Supply	343,079	638,823	118,098
1,090,000	Full Supply	343,079	638,823	108,098
1,080,000	Full Supply	343,079	638,823	98,098

[8] Under Article 3.(b) of the 1985 Contract Between the United States and the Ak-Chin Indian Community to Provide Permanent Water and Settle Interim Water Rights, in any year in which sufficient surface water is available, the Secretary shall deliver certain additional water to the Ak-Chin Indian Community. Such water is assumed to be available if there is unused CAP water after CAP orders under long-term contracts and subcontracts are fulfilled; however, there is assumed to be no unused CAP water at the volumes of shortage modeled.

Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	M&I Priority Supply (AF)	NIA Priority Supply (AF)
1,070,000	Full Supply	343,079	638,823	88,098
1,060,000	Full Supply	343,079	638,823	78,098
1,050,000	Full Supply	343,079	638,823	68,098
1,040,000	Full Supply	343,079	638,823	58,098
1,030,000	Full Supply	343,079	638,823	48,098
1,020,000	Full Supply	343,079	638,823	38,098
1,010,000	Full Supply	343,079	638,823	28,098
1,000,000	Full Supply	343,079	638,823	18,098
990,000	Full Supply	343,079	638,823	8,098
981,902	Formula	343,079	638,823	-
980,000	Formula	342,595	637,405	-
970,000	Formula	340,051	629,949	-
960,000	Formula	337,508	622,492	-
950,000	Formula	334,964	615,036	-
940,000	Formula	332,420	607,580	-
930,000	Formula	329,876	600,124	-
920,000	Formula	327,332	592,668	-
910,000	Formula	324,789	585,211	-
900,000	Formula	322,245	577,755	-
890,000	Formula	319,701	570,299	-
880,000	Formula	317,157	562,843	-
870,000	Formula	314,613	555,387	-
860,000	Formula	312,070	547,930	-
853,079	36.37518%	310,309	542,770	-
850,000	36.37518%	309,189	540,811	-
840,000	36.37518%	305,552	534,448	-
830,000	36.37518%	301,914	528,086	-
820,000	36.37518%	298,276	521,724	-
819,828	36.37518%	298,214	521,614	-
810,000	36.37518%	294,639	515,361	-
801,574	36.37518%	291,574	510,000	-
800,000	36.37518%	291,001	508,999	-
790,000	36.37518%	287,364	502,636	-
780,000	36.37518%	283,726	496,274	-
770,000	36.37518%	280,089	489,911	-
760,000	36.37518%	276,451	483,549	-
750,000	36.37518%	272,814	477,186	-
740,000	36.37518%	269,176	470,824	-
730,000	36.37518%	265,539	464,461	-
720,000	36.37518%	261,901	458,099	-
710,000	36.37518%	258,264	451,736	-
700,000	36.37518%	254,626	445,374	-
690,000	36.37518%	250,989	439,011	-
680,000	36.37518%	247,351	432,649	-
670,000	36.37518%	243,714	426,286	-
660,000	36.37518%	240,076	419,924	-

Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	M&I Priority Supply (AF)	NIA Priority Supply (AF)
650,000	36.37518%	236,439	413,561	-
640,000	36.37518%	232,801	407,199	-
630,000	36.37518%	229,164	400,836	-
620,000	36.37518%	225,526	394,474	-
610,000	36.37518%	221,889	388,111	-
600,000	36.37518%	218,251	381,749	-
590,000	36.37518%	214,614	375,386	-
580,000	36.37518%	210,976	369,024	-
570,000	36.37518%	207,339	362,661	-
560,000	36.37518%	203,701	356,299	-
550,000	36.37518%	200,064	349,936	-
540,000	36.37518%	196,426	343,574	-
530,000	36.37518%	192,788	337,212	-
520,000	36.37518%	189,151	330,849	-
510,000	36.37518%	185,513	324,487	-
500,000	36.37518%	181,876	318,124	-
490,000	36.37518%	178,238	311,762	-
480,000	36.37518%	174,601	305,399	-
470,000	36.37518%	170,963	299,037	-
460,000	36.37518%	167,326	292,674	-
450,000	36.37518%	163,688	286,312	-
440,000	36.37518%	160,051	279,949	-
430,000	36.37518%	156,413	273,587	-
420,000	36.37518%	152,776	267,224	-
410,000	36.37518%	149,138	260,862	-
400,000	36.37518%	145,501	254,499	-
390,000	36.37518%	141,863	248,137	-
380,000	36.37518%	138,226	241,774	-
370,000	36.37518%	134,588	235,412	-
360,000	36.37518%	130,951	229,049	-
350,000	36.37518%	127,313	222,687	-
340,000	36.37518%	123,676	216,324	-
330,000	36.37518%	120,038	209,962	-
320,000	36.37518%	116,401	203,599	-
310,000	36.37518%	112,763	197,237	-
300,000	36.37518%	109,126	190,874	-
290,000	36.37518%	105,488	184,512	-
280,000	36.37518%	101,851	178,149	-
270,000	36.37518%	98,213	171,787	-
260,000	36.37518%	94,575	165,425	-
250,000	36.37518%	90,938	159,062	-
240,000	36.37518%	87,300	152,700	-
230,000	36.37518%	83,663	146,337	-
220,000	36.37518%	80,025	139,975	-
210,000	36.37518%	76,388	133,612	-
200,000	36.37518%	72,750	127,250	-

Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	M&I Priority Supply (AF)	NIA Priority Supply (AF)
190,000	36.37518%	69,113	120,887	-
180,000	36.37518%	65,475	114,525	-
170,000	36.37518%	61,838	108,162	-
160,000	36.37518%	58,200	101,800	-
150,000	36.37518%	54,563	95,437	-
140,000	36.37518%	50,925	89,075	-
130,000	36.37518%	47,288	82,712	-
120,000	36.37518%	43,650	76,350	-
110,000	36.37518%	40,013	69,987	-
100,000	36.37518%	36,375	63,625	-
90,000	36.37518%	32,738	57,262	-
80,000	36.37518%	29,100	50,900	-
70,000	36.37518%	25,463	44,537	-
60,000	36.37518%	21,825	38,175	-
50,000	36.37518%	18,188	31,812	-
40,000	36.37518%	14,550	25,450	-
30,000	36.37518%	10,913	19,087	-
20,000	36.37518%	7,275	12,725	-
10,000	36.37518%	3,638	6,362	-
-	36.37518%	-	-	-

Through term-limited or temporary arrangements, to the extent that such arrangements may be allowed under specific long-term CAP contracts or other legal authority, CAP contractors and subcontractors may make their water available for end use by others. The Shortage Allocation Model does not replicate those arrangements, and it only provides approximate estimates at the contract or subcontract allocation level that interested parties could then consider in planning for administering their respective arrangements during shortage conditions. The CAP contractor, subcontractor, and/or parties to those arrangements would have specific decisions to make during shortage conditions to administer those arrangements that Reclamation cannot predict with sufficient certainty to analyze in this Draft SEIS.

The Shortage Allocation Model does not attempt to replicate the provisions of the CAP priority system that provide for unordered water to be made available to other contractors or subcontractors within a priority, or unordered water from one priority to be made available to another.

Shortage volumes are calculated as the difference between available water distributed to each allocation and the 2024–2026 projected water orders associated with that allocation, as compiled for the 2023 Arizona DCP Implementation Plan Exhibit 7.1 dated December 15, 2022[9]. Allocations which are currently unused are shown as bearing no shortage, and unallocated or water not yet placed under contract (including the Secretary's retention of 6,411 AFY of CAP NIA Priority water for use for a future water rights settlement agreement approved by an Act of Congress that settles the Navajo Nation's claims to water in Arizona, consistent with the Arizona Water Settlements Act

[9] Internet website: https://new.azwater.gov/sites/default/files/media/2022.12.15%20Exhibit%207.1%20Public%20Posting.pdf.

of 2004, section 104(a)) is not reflected in the distribution of available water and is not shown as bearing shortage. These modeling assumptions reflect only that it cannot be speculated when or whether such water or volumes may be allocated or placed under contract, but are not intended to preclude allocations or the entry of contracts during the remainder of the interim period consistent with applicable law and authority.

CAP Indian Priority Assumptions

The overall deliverable quantity of Indian Priority supply is calculated as authorized in the 2004 Arizona Water Settlements Act (AWSA) (Public Law 108-451) section 104(d). The available Indian Priority supply is then distributed as described in applicable law, contracts, and subcontracts and as noted below.

Shortage to the Ak-Chin Indian Community's Indian Priority irrigation allocation is shown at the allocation level, and it does not reflect the conditional entitlement to a portion of that allocation that is held by the San Carlos Apache Tribe. In addition, the shortages attributed to Indian Priority allocations, pursuant to the internal priority system of the Indian Priority pool, do not account for the existence of external arrangements and commitments that would affect the ultimate impacts of shortage. For example, the ultimate impact of shortage may fall in whole or in part on a lessor who has leased a portion of a contractor's Indian Priority water, but the terms and duration of such leasing arrangements are varied, and the arrangement does not change the underlying allocation-holder. Shortages attributed to Indian Priority allocations in the Shortage Allocation Model form the basis for additional analyses on a case-by-case basis as necessary to administer shortage consistent with applicable contracts and subcontracts.

Further, the Shortage Allocation Model does not analyze any applicable Secretarial obligations to deliver certain contractors or subcontractors other sources of water in any given year, which might have the effect of offsetting or negating the numerical impacts shown to specific Indian Priority pool allocations and could appear to understate the regional effect of a Colorado River shortage. This Draft SEIS presents the worst case impacts of a regional loss of supply relative to the quantified volumes of Colorado River water the Secretary has allocated and contracted for and actively administers, rather than attempting to analyze and monetize the loss relative to all sources of water supply any given water user may have available.

For the purpose of calculating water available to individual Indian Priority allocations, the Indian Priority supply is distributed under a set of assumptions consistent with AWSA section 104(d) and the approach described in Exhibit 5.3.4.1 to the Tohono O'odham Settlement Agreement[10], *Secretary's Approach for Determining the Amount of Water Available to the Nation During a Time of Shortage Under 1980 Contract*, except as provided in the following paragraph.

Calculations for the distribution of water are performed as though all Indian Priority entitlements were fully used during the most recent operational year which was not a Time of Shortage.

[10] Attachment E-3 to this Appendix E

These assumptions yield the distribution of available Indian Priority water shown in **Table E-7** for a range of discrete Available CAP Supplies. All of these discrete levels of supply are contained within the Shortage Allocation Model, but because this draft SEIS only includes a distribution analysis over a specified range of shortage volumes, certain rows on **Table E-7** below a CAP Available Supply of 810,000 AF are not projected to be implicated under the assumptions of the Shortage Allocation Model. These rows are shaded gray to indicate inactivity in the analysis, but are included in this Appendix E for constancy.

Table E-7
Distribution of CAP Indian Priority Supply

	Post-AWSA Contracts						Pre-AWSA Contracts									
			Distribution to Contractors (AF)						Distribution to Contractors (AF)							
Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	Gila River Indian Community	Tohono O'odham Nation (SX & ST)	White Mountain Apache Tribe	Scottsdale (Yavapai Prescott Indian Tribe)	Indian Priority Share	Indian Priority Supply (AF)	Ak-Chin Indian Community	Fort McDowell Yavapai Nation	Pascua Yaqui Tribe	San Carlos Apache Tribe	Salt River Pima-Maricopa Indian Community	Sif Oidak District	Tonto Apache Tribe	Yavapai Apache Nation
990,000	Full Supply	343,079	191,200	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
981,902	Formula	343,079	191,200	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
980,000	Formula	342,595	190,716	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
970,000	Formula	340,051	188,172	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
960,000	Formula	337,508	185,629	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
950,000	Formula	334,964	183,085	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
940,000	Formula	332,420	180,541	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
930,000	Formula	329,876	177,997	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
920,000	Formula	327,332	175,453	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
910,000	Formula	324,789	172,910	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
900,000	Formula	322,245	170,366	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
890,000	Formula	319,701	167,822	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
880,000	Formula	317,157	165,278	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
870,000	Formula	314,613	162,734	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
860,000	Formula	312,070	160,191	37,800	1,218	500	Full Supply	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
853,079	36.37518%	310,309	158,430	37,800	1,218	500	Imputed	343,079	58,300	18,233	500	12,700	13,300	8,000	128	1,200
850,000	36.37518%	309,189	157,802	37,800	1,218	500	Imputed	340,000	57,951	18,233	500	12,684	13,220	7,952	128	1,200
840,000	36.37518%	305,552	155,762	37,800	1,218	500	Imputed	330,000	56,820	18,233	500	12,631	12,962	7,797	128	1,200
830,000	36.37518%	301,914	153,723	37,800	1,218	500	Imputed	320,000	55,688	18,233	500	12,579	12,704	7,642	128	1,200
820,000	36.37518%	298,276	151,683	37,800	1,218	500	Imputed	310,000	54,556	18,233	500	12,527	12,446	7,486	128	1,200
819,828	36.37518%	298,214	151,648	37,800	1,218	500	Imputed	309,828	54,536	18,233	500	12,526	12,441	7,484	128	1,200
810,000	36.37518%	294,639	149,644	37,800	1,218	500	Imputed	300,000	53,424	18,233	500	12,474	12,188	7,331	128	1,200
801,574	36.37518%	291,574	147,925	37,800	1,218	500	Either	291,574	52,470	18,233	500	12,430	11,970	7,200	128	1,200
800,000	36.37518%	291,001	147,635	37,726	1,216	499	36.37518%	291,001	52,367	18,197	499	12,406	11,946	7,186	128	1,198
790,000	36.37518%	287,364	145,789	37,254	1,200	493	36.37518%	287,364	51,712	17,970	493	12,251	11,797	7,096	126	1,183
780,000	36.37518%	283,726	143,944	36,783	1,185	487	36.37518%	283,726	51,058	17,742	487	12,095	11,648	7,006	125	1,168
770,000	36.37518%	280,089	142,098	36,311	1,170	480	36.37518%	280,089	50,403	17,515	480	11,940	11,499	6,916	123	1,153
760,000	36.37518%	276,451	140,253	35,839	1,155	474	36.37518%	276,451	49,749	17,287	474	11,785	11,349	6,827	121	1,138
750,000	36.37518%	272,814	138,407	35,368	1,140	468	36.37518%	272,814	49,094	17,060	468	11,630	11,200	6,737	120	1,123
740,000	36.37518%	269,176	136,562	34,896	1,124	462	36.37518%	269,176	48,439	16,832	462	11,475	11,051	6,647	118	1,108

	Post-AWSA Contracts						Pre-AWSA Contracts									
Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	Distribution to Contractors (AF)				Indian Priority Share	Indian Priority Supply (AF)	Distribution to Contractors (AF)							
			Gila River Indian Community	Tohono O'odham Nation (SX & ST)	White Mountain Apache Tribe	Scottsdale (Yavapai Prescott Indian Tribe)			Ak-Chin Indian Community	Fort McDowell Yavapai Nation	Pascua Yaqui Tribe	San Carlos Apache Tribe	Salt River Pima-Maricopa Indian Community	Sif Oidak District	Tonto Apache Tribe	Yavapai Apache Nation
730,000	36.37518%	265,539	134,717	34,425	1,109	455	36.37518%	265,539	47,785	16,605	455	11,320	10,901	6,557	117	1,093
720,000	36.37518%	261,901	132,871	33,953	1,094	449	36.37518%	261,901	47,130	16,377	449	11,165	10,752	6,467	115	1,078
710,000	36.37518%	258,264	131,026	33,482	1,079	443	36.37518%	258,264	46,476	16,150	443	11,010	10,603	6,377	113	1,063
700,000	36.37518%	254,626	129,180	33,010	1,064	437	36.37518%	254,626	45,821	15,923	437	10,855	10,453	6,288	112	1,048
690,000	36.37518%	250,989	127,335	32,538	1,048	430	36.37518%	250,989	45,167	15,695	430	10,700	10,304	6,198	110	1,033
680,000	36.37518%	247,351	125,489	32,067	1,033	424	36.37518%	247,351	44,512	15,468	424	10,545	10,155	6,108	109	1,018
670,000	36.37518%	243,714	123,644	31,595	1,018	418	36.37518%	243,714	43,857	15,240	418	10,390	10,005	6,018	107	1,003
660,000	36.37518%	240,076	121,798	31,124	1,003	412	36.37518%	240,076	43,203	15,013	412	10,235	9,856	5,928	105	988
650,000	36.37518%	236,439	119,953	30,652	988	405	36.37518%	236,439	42,548	14,785	405	10,080	9,707	5,839	104	973
640,000	36.37518%	232,801	118,108	30,181	972	399	36.37518%	232,801	41,894	14,558	399	9,924	9,557	5,749	102	958
630,000	36.37518%	229,164	116,262	29,709	957	393	36.37518%	229,164	41,239	14,330	393	9,769	9,408	5,659	101	943
620,000	36.37518%	225,526	114,417	29,237	942	387	36.37518%	225,526	40,584	14,103	387	9,614	9,259	5,569	99	928
610,000	36.37518%	221,889	112,571	28,766	927	381	36.37518%	221,889	39,930	13,875	381	9,459	9,109	5,479	97	913
600,000	36.37518%	218,251	110,726	28,294	912	374	36.37518%	218,251	39,275	13,648	374	9,304	8,960	5,389	96	898
590,000	36.37518%	214,614	108,880	27,823	897	368	36.37518%	214,614	38,621	13,420	368	9,149	8,811	5,300	94	883
580,000	36.37518%	210,976	107,035	27,351	881	362	36.37518%	210,976	37,966	13,193	362	8,994	8,661	5,210	93	868
570,000	36.37518%	207,339	105,190	26,880	866	356	36.37518%	207,339	37,311	12,966	356	8,839	8,512	5,120	91	853
560,000	36.37518%	203,701	103,344	26,408	851	349	36.37518%	203,701	36,657	12,738	349	8,684	8,363	5,030	89	838
550,000	36.37518%	200,064	101,499	25,936	836	343	36.37518%	200,064	36,002	12,511	343	8,529	8,213	4,940	88	823
540,000	36.37518%	196,426	99,653	25,465	821	337	36.37518%	196,426	35,348	12,283	337	8,374	8,064	4,850	86	808
530,000	36.37518%	192,788	97,808	24,993	805	331	36.37518%	192,788	34,693	12,056	331	8,219	7,915	4,761	85	793
520,000	36.37518%	189,151	95,962	24,522	790	324	36.37518%	189,151	34,039	11,828	324	8,064	7,765	4,671	83	778
510,000	36.37518%	185,513	94,117	24,050	775	318	36.37518%	185,513	33,384	11,601	318	7,909	7,616	4,581	81	763
500,000	36.37518%	181,876	92,272	23,579	760	312	36.37518%	181,876	32,729	11,373	312	7,753	7,467	4,491	80	749
490,000	36.37518%	178,238	90,426	23,107	745	306	36.37518%	178,238	32,075	11,146	306	7,598	7,317	4,401	78	734
480,000	36.37518%	174,601	88,581	22,635	729	299	36.37518%	174,601	31,420	10,918	299	7,443	7,168	4,312	77	719
470,000	36.37518%	170,963	86,735	22,164	714	293	36.37518%	170,963	30,766	10,691	293	7,288	7,019	4,222	75	704
460,000	36.37518%	167,326	84,890	21,692	699	287	36.37518%	167,326	30,111	10,463	287	7,133	6,869	4,132	73	689
450,000	36.37518%	163,688	83,044	21,221	684	281	36.37518%	163,688	29,456	10,236	281	6,978	6,720	4,042	72	674
440,000	36.37518%	160,051	81,199	20,749	669	274	36.37518%	160,051	28,802	10,008	274	6,823	6,571	3,952	70	659
430,000	36.37518%	156,413	79,354	20,278	653	268	36.37518%	156,413	28,147	9,781	268	6,668	6,421	3,862	69	644
420,000	36.37518%	152,776	77,508	19,806	638	262	36.37518%	152,776	27,493	9,554	262	6,513	6,272	3,773	67	629
410,000	36.37518%	149,138	75,663	19,334	623	256	36.37518%	149,138	26,838	9,326	256	6,358	6,123	3,683	65	614
400,000	36.37518%	145,501	73,817	18,863	608	250	36.37518%	145,501	26,183	9,099	250	6,203	5,973	3,593	64	599
390,000	36.37518%	141,863	71,972	18,391	593	243	36.37518%	141,863	25,529	8,871	243	6,048	5,824	3,503	62	584
380,000	36.37518%	138,226	70,126	17,920	577	237	36.37518%	138,226	24,874	8,644	237	5,893	5,675	3,413	61	569
370,000	36.37518%	134,588	68,281	17,448	562	231	36.37518%	134,588	24,220	8,416	231	5,738	5,525	3,323	59	554
360,000	36.37518%	130,951	66,436	16,977	547	225	36.37518%	130,951	23,565	8,189	225	5,583	5,376	3,234	57	539
350,000	36.37518%	127,313	64,590	16,505	532	218	36.37518%	127,313	22,911	7,961	218	5,427	5,227	3,144	56	524
340,000	36.37518%	123,676	62,745	16,033	517	212	36.37518%	123,676	22,256	7,734	212	5,272	5,077	3,054	54	509

	Post-AWSA Contracts						Pre-AWSA Contracts									
			Distribution to Contractors (AF)						Distribution to Contractors (AF)							
Available CAP Supply (AF)	Indian Priority Share	Indian Priority Supply (AF)	Gila River Indian Community	Tohono O'odham Nation (SX & ST)	White Mountain Apache Tribe	Scottsdale (Yavapai Prescott Indian Tribe)	Indian Priority Share	Indian Priority Supply (AF)	Ak-Chin Indian Community	Fort McDowell Yavapai Nation	Pascua Yaqui Tribe	San Carlos Apache Tribe	Salt River Pima-Maricopa Indian Community	Sif Oidak District	Tonto Apache Tribe	Yavapai Apache Nation
330,000	36.37518%	120,038	60,899	15,562	501	206	36.37518%	120,038	21,601	7,506	206	5,117	4,928	2,964	53	494
320,000	36.37518%	116,401	59,054	15,090	486	200	36.37518%	116,401	20,947	7,279	200	4,962	4,779	2,874	51	479
310,000	36.37518%	112,763	57,208	14,619	471	193	36.37518%	112,763	20,292	7,051	193	4,807	4,629	2,785	50	464
300,000	36.37518%	109,126	55,363	14,147	456	187	36.37518%	109,126	19,638	6,824	187	4,652	4,480	2,695	48	449
290,000	36.37518%	105,488	53,518	13,676	441	181	36.37518%	105,488	18,983	6,596	181	4,497	4,331	2,605	46	434
280,000	36.37518%	101,851	51,672	13,204	425	175	36.37518%	101,851	18,328	6,369	175	4,342	4,181	2,515	45	419
270,000	36.37518%	98,213	49,827	12,732	410	168	36.37518%	98,213	17,674	6,142	168	4,187	4,032	2,425	43	404
260,000	36.37518%	94,575	47,981	12,261	395	162	36.37518%	94,575	17,019	5,914	162	4,032	3,883	2,335	42	389
250,000	36.37518%	90,938	46,136	11,789	380	156	36.37518%	90,938	16,365	5,687	156	3,877	3,733	2,246	40	374
240,000	36.37518%	87,300	44,290	11,318	365	150	36.37518%	87,300	15,710	5,459	150	3,722	3,584	2,156	38	359
230,000	36.37518%	83,663	42,445	10,846	349	143	36.37518%	83,663	15,056	5,232	143	3,567	3,435	2,066	37	344
220,000	36.37518%	80,025	40,599	10,375	334	137	36.37518%	80,025	14,401	5,004	137	3,412	3,285	1,976	35	329
210,000	36.37518%	76,388	38,754	9,903	319	131	36.37518%	76,388	13,746	4,777	131	3,256	3,136	1,886	34	314
200,000	36.37518%	72,750	36,909	9,431	304	125	36.37518%	72,750	13,092	4,549	125	3,101	2,987	1,796	32	299
190,000	36.37518%	69,113	35,063	8,960	289	119	36.37518%	69,113	12,437	4,322	119	2,946	2,837	1,707	30	284
180,000	36.37518%	65,475	33,218	8,488	274	112	36.37518%	65,475	11,783	4,094	112	2,791	2,688	1,617	29	269
170,000	36.37518%	61,838	31,372	8,017	258	106	36.37518%	61,838	11,128	3,867	106	2,636	2,539	1,527	27	254
160,000	36.37518%	58,200	29,527	7,545	243	100	36.37518%	58,200	10,473	3,639	100	2,481	2,389	1,437	26	240
150,000	36.37518%	54,563	27,681	7,074	228	94	36.37518%	54,563	9,819	3,412	94	2,326	2,240	1,347	24	225
140,000	36.37518%	50,925	25,836	6,602	213	87	36.37518%	50,925	9,164	3,185	87	2,171	2,091	1,258	22	210
130,000	36.37518%	47,288	23,991	6,130	198	81	36.37518%	47,288	8,510	2,957	81	2,016	1,941	1,168	21	195
120,000	36.37518%	43,650	22,145	5,659	182	75	36.37518%	43,650	7,855	2,730	75	1,861	1,792	1,078	19	180
110,000	36.37518%	40,013	20,300	5,187	167	69	36.37518%	40,013	7,200	2,502	69	1,706	1,643	988	18	165
100,000	36.37518%	36,375	18,454	4,716	152	62	36.37518%	36,375	6,546	2,275	62	1,551	1,493	898	16	150
90,000	36.37518%	32,738	16,609	4,244	137	56	36.37518%	32,738	5,891	2,047	56	1,396	1,344	808	14	135
80,000	36.37518%	29,100	14,763	3,773	122	50	36.37518%	29,100	5,237	1,820	50	1,241	1,195	719	13	120
70,000	36.37518%	25,463	12,918	3,301	106	44	36.37518%	25,463	4,582	1,592	44	1,085	1,045	629	11	105
60,000	36.37518%	21,825	11,073	2,829	91	37	36.37518%	21,825	3,928	1,365	37	930	896	539	10	90
50,000	36.37518%	18,188	9,227	2,358	76	31	36.37518%	18,188	3,273	1,137	31	775	747	449	8	75
40,000	36.37518%	14,550	7,382	1,886	61	25	36.37518%	14,550	2,618	910	25	620	597	359	6	60
30,000	36.37518%	10,913	5,536	1,415	46	19	36.37518%	10,913	1,964	682	19	465	448	269	5	45
20,000	36.37518%	7,275	3,691	943	30	12	36.37518%	7,275	1,309	455	12	310	299	180	3	30
10,000	36.37518%	3,638	1,845	472	15	6	36.37518%	3,638	655	227	6	155	149	90	2	15
-	36.37518%	-	-	-	-	-	36.37518%	-	-	-	-	-	-	-	-	-

CAP M&I Priority Assumptions

The M&I Priority supply is calculated as the remainder of Available CAP Supply (up to 981,902 AF) not made available for delivery as Indian Priority supply. When Available CAP Supply equals or exceeds 981,902 AF, the Indian and M&I Priorities both receive a full supply.

The available M&I Priority supply is distributed to each allocation in proportion to 2024–2026 projected water orders, relative to total projected orders for M&I Priority water. (The proportions are shown below in **Table E-8**) This assumption is consistent with a joint consultation undertaken by Reclamation and the Central Arizona Water Conservation District (CAWCD) with M&I Priority water users in 2022.[11]

Table E-8
Distribution of CAP M&I Priority Water in Proportion to 2024-2026 Orders

M&I Contractor or Subcontractor	2024-2026 Orders (AF)	Percentage of Orders
Freeport-Morenci (SCAT Lease)	5,645	0.94%
Scottsdale (SCAT Lease)	12,500	2.07%
ASARCO	21,000	3.48%
Avondale	5,416	0.90%
AZSLD	5,200	0.86%
AZWC, Casa Grande	8,884	1.47%
AZWC, Coolidge	2,000	0.33%
AZWC, Superstition	6,285	1.04%
AZWC, White Tank	968	0.16%
Buckeye	223	0.04%
CAGRD	6,426	1.07%
Carefree WC	886	0.15%
Cave Creek	2,606	0.43%
Chandler	8,654	1.44%
Chaparral City WC	8,909	1.48%
Circle City	-	0.00%
El Mirage	508	0.08%
Eloy	2,171	0.36%
EPCOR, AF	11,093	1.84%
EPCOR, PV	3,231	0.54%
EPCOR, SC	4,189	0.70%
EPCOR, SCW	2,372	0.39%
Florence	2,048	0.34%
Freeport-Miami	2,906	0.48%
FWID	2,854	0.47%
Gilbert	7,235	1.20%
Glendale	17,236	2.86%
Goodyear	10,742	1.78%
Greater Tonopah, Water Utility	64	0.01%
Green Valley CWC	-	0.00%
Green Valley DWID	-	0.00%
Marana	2,336	0.39%
Maricopa Cty P&R	665	0.11%

[11] As documented by Letter Agreement No. 22-XX-30-W0743LA between Reclamation and CAWCD, dated May 15, 2023.

M&I Contractor or Subcontractor	2024-2026 Orders (AF)	Percentage of Orders
Mesa	43,503	7.22%
Metro DWID (Includes ICS Creation)	13,460	2.23%
Oro Valley	10,305	1.71%
Peoria	27,121	4.50%
Phoenix	122,204	20.28%
Pine	-	0.00%
Queen Creek	495	0.08%
Rio Verde Utilities	812	0.13%
San Tan ID	-	0.00%
Scottsdale	52,810	8.76%
Spanish Trail WC	3,037	0.50%
Surprise	10,249	1.70%
Tempe	4,315	0.72%
Tonopah	-	0.00%
Tonto Hills DWID	71	0.01%
Tucson	144,191	23.93%
Vail WC	1,857	0.31%
WUCFD, Apache Junction	2,919	0.48%
TOTAL	**602,601**	**100.00%**

CAP NIA Priority Assumptions

Only when Available CAP Supply is calculated to be greater than 981,902 AF, the NIA Priority supply is calculated as the difference between Available CAP Supply and the sum of the Indian and M&I Priority entitlements. NIA Priority supply is assumed not to be available when Available CAP Supply is less than 981,902 AF.

The Shortage Allocation Model does not contain data for CAP water use in the most recent year that a full NIA Priority supply (inclusive of NIA-A and NIA-B) was available. However, in this modeling, available water is distributed first to NIA Priority contractors and subcontractors assumed to have used CAP NIA Priority Water in the last year in which the Available CAP Supply was sufficient to fill all orders for CAP NIA Priority Water (NIA-A) (**Table E-9**), before available water is distributed to the other NIA Priority contracts and subcontracts (NIA-B) (**Table E-10**).[12] Within each sub-priority, available water is modeled as being distributed to each allocation in proportion to 2024-2026 projected water orders, relative to total projected orders for the sub-priority.

[12] The CAP NIA Priority Water is distributed in accordance with the CAP NIA Priority Water subcontracts, in particular paragraph 4.7(b)-(c) of such subcontracts, and the settlement agreements with the Gila River Indian Community and the Tohono O'odham Nation. The Hualapai Tribe's CAP NIA Priority water will be distributed in accordance with its settlement agreement (pending enforceability) and the Hualapai Tribe Water Rights Settlement Act of 2022, in particular section 13.

Table E-9
Distribution of CAP NIA-A Priority Water in Proportion to 2024-2026 Orders

NIA A Priority Contractor or Subcontractor	2024-2026 Orders (AF)	Percentage of Orders
GRIC (own account)	102,415	50.93%
Tohono O'odham - Schuk Toak & San Xavier	28,200	14.02%
CAGRD [GRIC]	18,185	9.04%
Phoenix	37,280	18.54%
Chandler	3,924	1.95%
Gilbert	1,537	0.76%
Glendale	682	0.34%
Mesa	5,551	2.76%
Scottsdale	3,306	1.64%
Tempe	23	0.01%
TOTAL	**201,103**	**100.00%**

Table E-10
Distribution of CAP NIA-B Priority Water in Proportion to 2024–2026 Orders

NIA B Priority Contractor or Subcontractor	2024-2026 Orders (AF)	Percentage of Orders
WMAT	-	0.00%
Buckeye	2,786	6.26%
CAGRD	18,185	40.84%
Carefree WC	112	0.25%
Cave Creek	386	0.87%
El Mirage	1,318	2.96%
EPCOR, San Tan (ST)	3,217	7.22%
Freeport	5,678	12.75%
Gilbert	1,832	4.11%
Marana	515	1.16%
Queen Creek	4,162	9.35%
Resolution Copper	2,238	5.03%
Rosemont Copper	1,124	2.52%
SRP	2,160	4.85%
WUCFD, Apache Junction	817	1.83%
TOTAL	**44,530**	**100.00%**

E.3.3 Present Perfected Rights Assumptions

This analysis does not result in a reduction to PPRs according to the fill order provided below in **Table E-11** (bottom up), derived from Paragraph 5 of the Appendix to the Consolidated Decree. As set forth in the Consolidated Decree, the PPR priority system is administered without regard to state lines. This information is included for reference in cases where the Shortage Allocation Model distinguished PPRs from other priorities of water held by a single entitlement holder. PPRs are also enumerated in summary tables, but are shown as bearing no shortage under the alternatives.

Table E-11
Present Perfected Right Summary and Assumed Fill Order

Entitlements

Arizona, California, and Nevada Summary	CU Equivalent (AF)	Diversion (AF)
Arizona Total	567,499	1,077,971
California Total	2,694,276	3,019,573
Nevada Total	8,697	13,034
Total	3,270,473	4,110,578

Entitlement Holders	CU Equivalent (AF)†	Diversion (AF)	PPR No.	Date	State	Category	Cumulative Consumptive Use Equivalent (AF)
Lake Mead National Recreation Area (Overton Area, EO 5105)	300	500	82	1929	NV	Federal Establishments & Water Projects	3,270,473
Molina	64	318	15	1928	AZ	Miscellaneous	3,270,173
Sonny Gowan (Grannis)	108	180	32	1928	CA	Miscellaneous	3,270,109
Diehl*	0.6	1	59	1928	CA	Miscellaneous	3,270,001
Stallard*	0.6	1	66	1928	CA	Miscellaneous	3,270,000
Estrada*	0.6	1	77	1928	CA	Miscellaneous	3,269,999
Corrington*	0.6	1	79	1928	CA	Miscellaneous	3,269,999
Tolliver*	0.6	1	80	1928	CA	Miscellaneous	3,269,998
Randolph*	0.6	1	65	1926	CA	Miscellaneous	3,269,998
Keefe*	0.6	1	67	1926	CA	Miscellaneous	3,269,997
Sturges (Gila Monster Farms, Inc.)	436	780	16	1925	AZ	Miscellaneous	3,269,996
Chagnon	72	120	41	1925	CA	Miscellaneous	3,269,560
Faubion*	0.6	1	48	1925	CA	Miscellaneous	3,269,488
Earle*	0.6	1	58	1925	CA	Miscellaneous	3,269,487
Whittle*	0.6	1	78	1925	CA	Miscellaneous	3,269,487
Beauchamp*	0.6	1	51	1924	CA	Miscellaneous	3,269,486
McGee*	0.6	1	63	1924	CA	Miscellaneous	3,269,486
Stallard*	0.6	1	64	1924	CA	Miscellaneous	3,269,485
Hadlock*	0.6	1	72	1924	CA	Miscellaneous	3,269,484
Stephenson	137	240	30	1923	CA	Miscellaneous	3,269,484
Draper, G.*	0.6	1	46	1923	CA	Miscellaneous	3,269,347
Dudley*	0.6	1	49	1922	CA	Miscellaneous	3,269,346
Colorado River Sportsmen's League	58	96	36	1921	CA	Miscellaneous	3,269,346
Andrade	37	66	38	1921	CA	Miscellaneous	3,269,288
Conger*	0.6	1	45	1921	CA	Miscellaneous	3,269,251
Vaulin*	0.6	1	70	1920	CA	Miscellaneous	3,269,251
Salisbury*	0.6	1	71	1920	CA	Miscellaneous	3,269,250
McDonough*	0.6	1	47	1919	CA	Miscellaneous	3,269,249
Cate*	0.6	1	62	1919	CA	Miscellaneous	3,269,249
Milpitas	65	108	34	1918	CA	Miscellaneous	3,269,248
Yuma Auxiliary Project, Unit B	4,176	6,800	5	1905	AZ	Federal Establishments & Water Projects*	3,269,183
North Gila Valley Unit, Yuma Mesa Division, Gila Project	4,959	24,500	6	1905	AZ	Federal Establishments & Water Projects*	3,265,007

Entitlement Holders	CU Equivalent (AF)†	Diversion (AF)	PPR No.	Date	State	Category	Cumulative Consumptive Use Equivalent (AF)
Reservation Division/Yuma Project (non-Indian portion)	18,599	38,270	28	1905	CA	Federal Establishments & Water Projects*	3,260,049
Valley Division, Yuma Project (Yuma County Water Users' Association)	180,834	254,200	4	1901	AZ	Federal Establishments & Water Projects*	3,241,450
Imperial Irrigation District & CVWD lands	2,485,000	2,600,000	27	1901	CA	Federal Establishments & Water Projects*	3,060,615
Palo Verde Irrigation District	100,231	219,780	26	1877	CA	Federal Establishments & Water Projects*	575,615
Cocopah Indian Reservation	4,941	7,681	1	1917	AZ	Indian Reservations	475,384
Schneider*	0.6	1	56	1917	CA	Miscellaneous	470,443
Douglas*	0.6	1	50	1916	CA	Miscellaneous	470,442
Clark*	0.6	1	52	1916	CA	Miscellaneous	470,442
Graham*	0.6	1	61	1916	CA	Miscellaneous	470,441
Powers	624	960	7	1915	AZ	Miscellaneous	470,441
United States (Cocopah Indian Tribe)	733	1,140	8	1915	AZ	Miscellaneous	469,817
Lawrence	72	120	42	1915	CA	Miscellaneous	469,083
Lawrence*	0.6	1	53	1915	CA	Miscellaneous	469,011
Milpitas	41	69	37	1914	CA	Miscellaneous	469,011
Graham, J.*	0.6	1	54	1914	CA	Miscellaneous	468,969
Morgan	90	150	33	1913	CA	Miscellaneous	468,969
Zozaya (MVIDD)	389	720	17	1912	AZ	Miscellaneous	468,879
Reid*	0.6	1	60	1912	CA	Miscellaneous	468,490
Fitz*	0.6	1	75	1912	CA	Miscellaneous	468,489
EPCOR CSA #2 (Formerly Brooke Water Company) (Graham)	241	360	9	1910	AZ	Miscellaneous	468,489
Geiger*	0.6	1	55	1910	CA	Miscellaneous	468,248
Williams*	0.6	1	76	1909	CA	Miscellaneous	468,247
Chemehuevi Indian Reservation	6,091	11,340	22	1907	CA	Indian Reservations	468,246
Parker, City of	400	630	20	1905	AZ	Miscellaneous	462,155
Cooper	36	60	40	1905	CA	Miscellaneous	461,755
Reynolds	22	36	39	1904	CA	Miscellaneous	461,719
Ferguson, C.*	0.6	1	68	1903	CA	Miscellaneous	461,698
Ferguson, W.*	0.6	1	69	1903	CA	Miscellaneous	461,697
Streeter*	0.6	1	73	1903	CA	Miscellaneous	461,696
Draper, J.*	0.6	1	74	1903	CA	Miscellaneous	461,696
Hulet (MVIDD)	648	1,080	10	1902	AZ	Miscellaneous	461,695
Hurschler (First American Title Insurance Agency of Mohave, Inc.) (MVIDD)	567	1,050	11	1902	AZ	Miscellaneous	461,047
Miller (MVIDD)	130	240	12	1902	AZ	Miscellaneous	460,480
McKellips and Granite Reef Farms (MVIDD)	437	810	13	1902	AZ	Miscellaneous	460,351
Sherrill & Lafollette (MVIDD)	583	1,080	14	1902	AZ	Miscellaneous	459,913
Swan (MVIDD)	518	960	18	1902	AZ	Miscellaneous	459,330
Phillips, Milton and Jean	25	42	19	1900	AZ	Miscellaneous	458,812
Atchison, Topeka, and Santa Fe Railway Co.	273	1,260	44	1896	CA	Miscellaneous	458,786
Martinez*	0.6	1	57	1895	CA	Miscellaneous	458,513
Yuma, City of	1,478	2,333	21	1893	AZ	Miscellaneous	458,513
Mendivil (Picacho Development Corp. and CA Dept. of Parks and Rec.)	72	120	31	1893	CA	Miscellaneous	457,035
Fort Mojave Indian Reservation	40,806	75,566	3	1890	AZ	Indian Reservations	456,963
Fort Mojave Indian Reservation	15,103	27,969	3	1890	AZ	Indian Reservations	416,157
Fort Mojave Indian Reservation	8,995	16,720	25	1890	CA	Indian Reservations	401,054

Entitlement Holders	CU Equivalent (AF)†	Diversion (AF)	PPR No.	Date	State	Category	Cumulative Consumptive Use Equivalent (AF)
Fort Mojave Indian Reservation	8,397	12,534	81	1890	NV	Indian Reservations	392,059
Simons	36	60	35	1889	CA	Miscellaneous	383,662
City of Needles	950	1,500	43	1885	CA	Miscellaneous	383,626
Fort Yuma Indian Reservation	39,594	71,616	23	1884	CA	Indian Reservations	382,676
Fort Yuma Indian Reservation	4,039	6,350	3a	1884	AZ	Indian Reservations	343,081
Colorado River Indian Reservation	3,417	5,860	24	1876	CA	Indian Reservations	339,043
Colorado River Indian Reservation	23,966	51,986	2	1874	AZ	Indian Reservations	335,626
Colorado River Indian Reservation	23,463	40,241	24	1874	CA	Indian Reservations	311,660
Colorado River Indian Reservation	116,179	252,016	2	1873	AZ	Indian Reservations	288,198
Colorado River Indian Reservation	6,265	10,745	24	1873	CA	Indian Reservations	172,018
Colorado River Indian Reservation	165,222	358,400	2	1865	AZ	Indian Reservations	165,753
Yuma Associates LTD and Winterhaven Water District (formerly Wavers)	531	780	29	1856	CA	Miscellaneous	531
Total	**3,270,473**	**4,110,578**					

†Calculated consumptive use equivalents in italics (factor of .6 were given by the Court; for IID/CVWD, 115,000af of return flow; all others according to their CU/diversion ratio from Reclamation's *Colorado River Accounting and Water Use Report: Arizona, California, and Nevada*). The Cumulative Consumptive Use Equivalent column is included as a reference for the estimated amount of water that would need to be available to PPRs to fulfill a given entitlement on this table.

*Fill order reflects paragraph (5) of the Appendix to the 2006 Consolidated Decree in Arizona v. California: "In the event of a determination of insufficient mainstream water to satisfy present perfected rights pursuant to Article II(B)(3) of this decree, the Secretary of the Interior shall, before providing for the satisfaction of any of the other present perfected rights except for those listed herein as “MISCELLANEOUS PRESENT PERFECTED RIGHTS” (rights numbered 7–21 and 29–80 below) in the order of their priority dates without regard to state lines, first provide for the satisfaction in full of all rights of the Chemehuevi Indian Reservation, Cocopah Indian Reservation, Fort Yuma Indian Reservation, Colorado River Indian Reservation, and the Fort Mojave Indian Reservation as set forth in Article II(D)(1)–(5) of this decree...".

E.3.4 Shortage Allocation Model Results

The tables in this section summarize the results of the Shortage Allocation Model over the range of total shortages to the Lower Division States that comprise the 2007 Interim Guidelines shortage reductions and 2019 DCP water savings contributions.

Table E-12 below summarizes the shortage attributed to each priority within the Lower Division States in the Shortage Allocation Model. Contracts for Arizona fifth and sixth priority and unused water within CAP, and CAP excess contracts, are immediately affected and potentially fully reduced. The only other priority group potentially fully reduced in the Shortage Allocation Model is CAP NIA Priority, although other priorities are affected to some degree.

Table E-12
Shortage Allocation Model Regional Summary

Summary of Shortage Impacts by State and Priority		Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
		200,000	**533,000**	**617,000**	**867,000**	**917,000**	**967,000**	**1,017,000**	**1,100,000**
Arizona	**Priority**								
	5th, 6th, and CAP Agricultural and Other Excess	192,000	294,465	335,708	338,687	338,687	338,687	338,687	330,681
	4th Priority i (Mainstream)	0	0	0	0	0	0	0	18,520
	4th Priority ii (CAP)[1]								
	NIA Priority	0	217,535	245,633	245,633	245,633	245,633	245,633	245,633
	M&I Priority	0	0	0	32,302	32,302	32,302	32,302	80,877
	Indian Priority	0	0	10,659	23,378	23,378	23,378	23,378	44,289
	2nd & 3rd Priorities	0	0	0	0	0	0	0	0
	1st Priority (Present Perfected Rights)	0	0	0	0	0	0	0	0
	Subtotal	**192,000**	**512,000**	**592,000**	**640,000**	**640,000**	**640,000**	**640,000**	**720,000**
California	**Priority**								
	4th Priority (MWD)	0	0	0	186,000	232,500	279,000	325,500	325,500
	3rd Priority (IID, CVWD, PVID, QSA Diversions by MWD)	0	0	0	14,000	17,500	21,000	24,500	24,500
	2nd Priority (Yuma Project Reservation Division)	0	0	0	0	0	0	0	0
	1st Priority (PVID)	0	0	0	0	0	0	0	0
	Present Perfected Rights (PPRs)	0	0	0	0	0	0	0	0
	Subtotal	**0**	**0**	**0**	**200,000**	**250,000**	**300,000**	**350,000**	**350,000**

Summary of Shortage Impacts by State and Priority		Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
Nevada	**Priority**								
	8th Priority (SNWA - Balance & Unused)	8,000	21,000	25,000	27,000	27,000	27,000	27,000	30,000
	8th Priority (SNWA & Big Bend)	0	0	0	0	0	0	0	0
	7th Priority (Boy Scouts, Reclamation, NV Dept. of Wildlife)	0	0	0	0	0	0	0	0
	6th Priority (Las Vegas Valley Water District)	0	0	0	0	0	0	0	0
	5th Priority (PABCO & Lakeview Co.)	0	0	0	0	0	0	0	0
	4th Priority (Henderson & Basic Management)	0	0	0	0	0	0	0	0
	3rd Priority (Boulder City)	0	0	0	0	0	0	0	0
	2nd Priority (Lake Mead National Rec. Area)	0	0	0	0	0	0	0	0
	1st Priority (PPRs: LMNRA & Fort Mojave Indian Reservation)	0	0	0	0	0	0	0	0
	Subtotal	**8,000**	**21,000**	**25,000**	**27,000**	**27,000**	**27,000**	**27,000**	**30,000**
	Total	**200,000**	**533,000**	**617,000**	**867,000**	**917,000**	**967,000**	**1,017,000**	**1,100,000**

Note: This analysis does not reflect an operational estimate of when water may cease to be physically available to certain users.
Note: Orange highlights indicate the level at which available water for a priority is reduced to zero.
[1]Agricultural and other CAP excess contracts do not confer a Colorado River water entitlement, and are assumed to be unavailable for the purpose of this analysis.
Disclaimer: These modeling results should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as agency position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This model is not a substitute for the annual process of reviewing water orders and determining which can be filled, and it cannot replicate the precision required for that process.

Table E-13 below summarizes the shortage impacts on Tribes according to the Shortage Allocation Model. Tribal entitlements within the Arizona fourth priority are potentially affected, and CAP NIA Priority entitlements are potentially fully reduced.

Table E-13
Shortage Allocation Model Tribal Summary

Summary of Consumptive Use Impacts on Tribal Allocations			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
Arizona			200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
Priority	Entitlement Holder	County								
4(i)	Hopi Tribe[1]	La Paz County	0	0	0	0	0	0	0	1,164
4(i)	Cocopah Indian Reservation[2]	Yuma County	0	0	0	0	0	0	0	0
CAP Indian Priority	Gila River Indian Community[1]	Maricopa and Pinal Counties	0	0	10,659	23,378	23,378	23,378	23,378	39,517
CAP Indian Priority	Tohono O'odham Nation (Schuk Toak & San Xavier Districts)[1]	Pima County	0	0	0	0	0	0	0	0
CAP Indian Priority	White Mountain Apache Tribe	Apache, Gila, and Navajo Counties	0	0	0	0	0	0	0	0
CAP Indian Priority	Ak-Chin Indian Community[1]	Pinal County	0	0	0	0	0	0	0	3,744
CAP Indian Priority	Fort McDowell Yavapai Nation	Maricopa County	0	0	0	0	0	0	0	0
CAP Indian Priority	Pascua Yaqui Tribe	Pima County	0	0	0	0	0	0	0	0
CAP Indian Priority	San Carlos Apache Tribe	Gila County	0	0	0	0	0	0	0	173
CAP Indian Priority	Salt River Pima-Maricopa Indian Community	Maricopa County	0	0	0	0	0	0	0	854
CAP Indian Priority	Tohono O'odham Nation Sif Oidak District	Pinal County	0	0	0	0	0	0	0	0
CAP Indian Priority	Tonto Apache Tribe	Gila County	0	0	0	0	0	0	0	0
CAP Indian Priority	Yavapai Apache Nation	Gila County	0	0	0	0	0	0	0	0
CAP M&I Priority	San Carlos Apache Tribe	Gila County	0	0	0	973	973	973	973	2,435
CAP NIA-A Priority	Tohono O'odham Nation (Schuk Toak & San Xavier Districts)	Pima County	0	24,260	28,200	28,200	28,200	28,200	28,200	28,200
CAP NIA-A Priority	Gila River Indian Community	Maricopa and Pinal County	0	103,750	120,600	120,600	120,600	120,600	120,600	120,600
CAP NIA-B Priority	White Mountain Apache Tribe	Apache, Gila, and Navajo Counties	0	0	0	0	0	0	0	0
3	Ak-Chin Indian Community[1]	Pinal County	0	0	0	0	0	0	0	0

Summary of Consumptive Use Impacts on Tribal Allocations			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
1 (PPR)	Cocopah Indian Reservation[1]	Yuma County	0	0	0	0	0	0	0	0
1 (PPR)	United States (Cocopah Indian Tribe)[1]	Yuma County	0	0	0	0	0	0	0	0
1 (PPR)	Fort Mojave Indian Reservation[1]	Mohave County	0	0	0	0	0	0	0	0
1 (PPR)	Fort Yuma Indian Reservation[1]	Yuma County	0	0	0	0	0	0	0	0
1 (PPR)	Colorado River Indian Reservation[1]	La Paz County	0	0	0	0	0	0	0	0
		Subtotal	**0**	**128,010**	**159,459**	**173,151**	**173,151**	**173,151**	**173,151**	**196,688**
California										
Priority	**Entitlement Holder**	**County**								
PPR	Chemehuevi Indian Reservation[1]	San Bernardino	0	0	0	0	0	0	0	0
PPR	Fort Mojave Indian Reservation[1]	San Bernardino	0	0	0	0	0	0	0	0
PPR	Fort Yuma Indian Reservation[1]	Imperial	0	0	0	0	0	0	0	0
PPR	Colorado River Indian Reservation[1]	San Bernardino, Riverside	0	0	0	0	0	0	0	0
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nevada										
Priority	**Entitlement Holder**	**County**								
1 (PPR)	Fort Mojave Indian Reservation[1]	Clark	0	0	0	0	0	0	0	0
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Total	**0**	**128,010**	**159,459**	**173,151**	**173,151**	**173,151**	**173,151**	**196,688**
Summary by County										
	Arizona	**# of Entitlement Holders /County**								
	Coconino County	0	0	0	0	0	0	0	0	0
	Gila County	4.33	0	0	0	973	973	973	973	2,609
	La Paz County	2	0	0	0	0	0	0	0	1,164
	Maricopa County	2.3	0	31,125	39,378	43,193	43,193	43,193	43,193	48,889
	Mohave County	1	0	0	0	0	0	0	0	0
	Pima County	3	0	24,260	28,200	28,200	28,200	28,200	28,200	28,200
	Pinal County	3.70	0	72,625	91,881	100,785	100,785	100,785	100,785	115,826

Summary of Consumptive Use Impacts on Tribal Allocations			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
	Yuma County	4	0	0	0	0	0	0	0	0
	Apache County	0.33	0	0	0	0	0	0	0	0
	Navajo County	0.33	0	0	0	0	0	0	0	0
	Subtotal Arizona Tribal	**21**	**0**	**128,010**	**159,459**	**173,151**	**173,151**	**173,151**	**173,151**	**196,688**
	California									
	San Bernardino	2.5	0	0	0	0	0	0	0	0
	Riverside	0.50	0	0	0	0	0	0	0	0
	Imperial	1	0	0	0	0	0	0	0	0
	Subtotal California Tribal	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Nevada									
	Clark	1	0	0	0	0	0	0	0	0
	Subtotal Nevada Tribal	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: PPRs are included here to provide a complete list of tribal entitlements, but they are not affected at the evaluated levels of shortage.

Note: Orange highlights indicate the level at which available water for a user under this priority is reduced to zero.

Note: This preliminary analysis attributes shortage to the base allocation or entitlement according to its priority. The ultimate impacts, both financial and in terms of the lost productive value of water, are diverse according to their varied uses and compensation structures under a large body of exchanges, leases, and other federal and non-federal arrangements and commitments. This distribution of shortage to the base allocation only provides the initial necessary information to assess impacts in detail as part of administering the related contracts; actual water orders received each year will affect those impacts.

Note: This analysis does not reflect an operational estimate of when water may cease to be physically available to certain users.

[1]Denotes full or substantial use in Tribal agricultural operations, which may or may not be affected according to the terms of related agreements.

[2]This user also holds a PPR entitlement, which is not affected at these levels of shortages.

Table E-14 below summarizes the shortage impacts on irrigation according to the Shortage Allocation Model. Contracts for Arizona fifth and sixth priority and unused[13] water within CAP, and CAP excess contracts, are immediately affected and potentially fully reduced, but other irrigation entitlements are potentially affected at the deepest levels of shortage.

Table E-14
Shortage Allocation Model Irrigation Summary

Summary of Consumptive Use Impacts on Irrigation			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
Arizona			200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
Priority	Entitlement Holder	County								
All Other	5th and 6th Priority Contracts, and CAP Agricultural and Other Excess	Maricopa, Pinal, and Pima Counties	192,000	294,465	335,708	338,687	338,687	338,687	338,687	330,681
4(i)	Arizona Game and Fish Commission	La Paz County	0	0	0	0	0	0	0	772
4(i)	Arizona State Land Department	Yuma County	0	0	0	0	0	0	0	1,545
4(i)	Beattie Farms, Southwest	Yuma County	0	0	0	0	0	0	0	138
4(i)	Bishop, Alfred F. and Erma Jean Family Trust	La Paz County	0	0	0	0	0	0	0	0
4(i)	Cathcart, Bruce Y. and Lora M. and James Y. and Maria E.	La Paz County	0	0	0	0	0	0	0	7
4(i)	ChaCha, LLC	Yuma County	0	0	0	0	0	0	0	31
4(i)	Cibola Sportsman's Club, Inc.	La Paz County	0	0	0	0	0	0	0	43
4(i)	Cibola Valley Irrigation and Drainage District[2]	La Paz County	0	0	0	0	0	0	0	2,027
4(i)	Curtis, Armon	Yuma County	0	0	0	0	0	0	0	41
4(i)	Gila Monster Farms, Inc.[3]	Yuma County	0	0	0	0	0	0	0	0
4(i)	GM Gabrych Family Limited Partnership	La Paz County	0	0	0	0	0	0	0	1,087
4(i)	GSC Farm, LLC	La Paz County	0	0	0	0	0	0	0	19
4(i)	JRJ Partners, L.L.C.	Yuma County	0	0	0	0	0	0	0	227
4(i)	Mohave Valley Irrigation and Drainage District[2,3]	Mohave County	0	0	0	0	0	0	0	6,992
4(i)	North Baja Pipeline, LLC[2]	La Paz County	0	0	0	0	0	0	0	4
4(i)	Ogram Boys Enterprises, Inc.	Yuma County	0	0	0	0	0	0	0	221

[13] Under Article 3.(b) of the 1985 Contract Between the United States and the Ak-Chin Indian Community to Provide Permanent Water and Settle Interim Water Rights, in any year in which sufficient surface water is available, the Secretary shall deliver certain additional water to the Ak-Chin Indian Community. Such water is assumed to be available if there is unused CAP water, after CAP orders under long-term contracts and subcontracts are fulfilled; it is not itemized, but there is only unused water projected to be available at the 200,000 af level of total shortage in the Shortage Allocation Model.

Summary of Consumptive Use Impacts on Irrigation			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
4(i)	Ott, Larry and Gina, and Lee C. and Candace M.	Yuma County	0	0	0	0	0	0	0	33
4(i)	Pasquinelli, Gary J. and Barbara J.	Yuma County	0	0	0	0	0	0	0	0
4(i)	Red River Land Company, LLC	La Paz County	0	0	0	0	0	0	0	80
4(i)	Western Water, LLC	La Paz County	0	0	0	0	0	0	0	0
3	Sturges, Harold	Yuma County	0	0	0	0	0	0	0	0
3	Sturges, Irma	Yuma County	0	0	0	0	0	0	0	0
3	Yuma Mesa Irrigation & Drainage District (10,000af M&I)[1]	Yuma County	0	0	0	0	0	0	0	0
3	Yuma Irrigation District (5,000af M&I)[1]	Yuma County	0	0	0	0	0	0	0	0
3	North Gila Valley Irrigation District (2,500af M&I)[1,3]	Yuma County	0	0	0	0	0	0	0	0
3	Wellton-Mohawk Irrigation and Drainage District (12,000af M&I)[1]	Yuma County	0	0	0	0	0	0	0	0
3	Gila Monster Farms (formerly Sturges)[3]	Yuma County	0	0	0	0	0	0	0	0
3	Yuma County Water Users' Association (14,701af M&I includes YAO's 489.95af conversion)[2,3]	Yuma County	0	0	0	0	0	0	0	0
3	University of Arizona	Yuma County	0	0	0	0	0	0	0	0
3	Camille Allec, Jr. (Formerly Yuma Mesa Grapefruit Company)	Yuma County	0	0	0	0	0	0	0	0
3	Unit B Irrigation & Drainage District[3]	Yuma County	0	0	0	0	0	0	0	0
		Subtotal	**192,000**	**294,465**	**335,708**	**338,687**	**338,687**	**338,687**	**338,687**	**343,948**
California										
3	Palo Verde Irrigation District (3b) - Lower Palo Verde Mesa Lands	Riverside County	0	0	0	0	0	0	0	0
3	Coachella Valley Water District (CVWD) (3a)	Riverside County	0	0	0	14,000	17,500	21,000	24,500	24,500
3	Imperial Irrigation District (IID) (3a)	Imperial County	0	0	0	0	0	0	0	0
2	Yuma Project, Reservation Division4 (Bard Unit Only - Indian Unit Under PPRs)	Imperial County	0	0	0	0	0	0	0	0
1	Palo Verde Irrigation District - Valley Lands	Riverside, Imperial	0	0	0	0	0	0	0	0
		Subtotal	**0**	**0**	**0**	**14,000**	**17,500**	**21,000**	**24,500**	**24,500**

Summary of Consumptive Use Impacts on Irrigation			**Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)**							
Nevada										
None	None		0	0	0	0	0	0	0	0
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Total	**192,000**	**294,465**	**335,708**	**352,687**	**356,187**	**359,687**	**363,187**	**368,448**
Summary by County										
	Arizona	**# of Entitlement Holders /County**								
	Coconino County	0	0	0	0	0	0	0	0	0
	La Paz County	10	0	0	0	0	0	0	0	4,040
	Mohave County	1	0	0	0	0	0	0	0	6,992
	Yuma County	20	0	0	0	0	0	0	0	2,236
	Pima County	0.2	38,400	58,893	67,142	67,737	67,737	67,737	67,737	66,136
	Pinal County	0.5	96,000	147,233	167,854	169,344	169,344	169,344	169,344	165,340
	Maricopa County	0.3	57,600	88,340	100,712	101,606	101,606	101,606	101,606	99,204
	Subtotal Arizona Irrigation	31	192,000	294,465	335,708	338,687	338,687	338,687	338,687	343,948
	California									
	Riverside County	2.5	0	0	0	14,000	17,500	21,000	24,500	24,500
	Imperial County	2.5	0	0	0	0	0	0	0	0
	Subtotal California Irrigation	5	0	0	0	14,000	17,500	21,000	24,500	24,500
	Nevada									
	None	None	0	0	0	0	0	0	0	0

[1]Combined irrigation and domestic entitlement where domestic use is contractually subordinated to irrigation.
[2]Combined irrigation and domestic entitlement where priority of domestic and irrigation uses may be subject to an annual determination that varies based on the water supply conditions.
[3]This user also holds a PPR entitlement, which is not affected at these levels of shortages and it was not included here.
Note: PPR entitlements are not affected at these levels of shortage.
Note: Orange highlights indicate the level at which available water for a user under this priority is reduced to zero.
Note: This analysis does not reflect an operational estimate of when water may cease to be physically available to certain users.
Disclaimer: These modeling results from the Shortage Allocation Model should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as agency position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This model is not a substitute for the annual process of reviewing water orders and determining which can be filled, and it cannot replicate the precision required for that process.

Table E-15 below summarizes the shortage impacts on domestic use according to the Shortage Allocation Model. Within the Arizona P4(i), certain domestic users may be affected at the deepest level of modeled shortage. CAP M&I Priority uses are potentially affected, and CAP NIA Priority uses are potentially fully reduced. Domestic impacts within California and Nevada are limited to MWD and SNWA, respectively.

Table E-15
Shortage Allocation Model Domestic Summary

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
Arizona			200,000	533,000	617,000	867,000	917,000	967,000	1,017,000	1,100,000
Priority	**Entitlement Holder**	**County**								
4(i)	Arizona State Land Department	Yuma County	0	0	0	0	0	0	0	0
4(i)	Arizona State Parks Board - Windsor Beach	Mohave County	0	0	0	0	0	0	0	0
4(i)	B&F Investment, LLC	La Paz County	0	0	0	0	0	0	0	0
4(i)	Bullhead City	Mohave County	0	0	0	0	0	0	0	2,337
4(i)	Bullhead City (Mohave County Water Authority (MCWA) Subcontract)	Mohave County	0	0	0	0	0	0	0	0
4(i)	Bullhead City (MCWA Subcontract)	Mohave County	0	0	0	0	0	0	0	0
4(i)	Bureau of Land Management (diversion estimated)	La Paz County	0	0	0	0	0	0	0	0
4(i)	Crystal Beach Water Conservation District	Mohave County	0	0	0	0	0	0	0	20
4(i)	Desert Lawn Memorial Park Association, Inc.	Yuma County	0	0	0	0	0	0	0	0
4(i)	Ehrenburg Improvement District	La Paz County	0	0	0	0	0	0	0	0
4(i)	EPCOR Water Arizona Inc.[1]	Mohave County	0	0	0	0	0	0	0	0
4(i)	Fisher's Landing Water and Sewer Works, L.L.C.	Yuma County	0	0	0	0	0	0	0	0
4(i)	Frontier Communications West Coast Inc.	La Paz County	0	0	0	0	0	0	0	1
4(i)	Gold Dome Mining Corporation	Yuma County	0	0	0	0	0	0	0	0
4(i)	Gold Standard Mines Corp.	Mohave County	0	0	0	0	0	0	0	0
4(i)	Golden Shores Water Conservation District	Mohave County	0	0	0	0	0	0	0	0
4(i)	Hillcrest Water Company	La Paz County	0	0	0	0	0	0	0	0

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
4(i)	Lake Havasu City	Mohave County	0	0	0	0	0	0	0	638
4(i)	Lake Havasu City (MCWA Subcontract)	Mohave County	0	0	0	0	0	0	0	0
4(i)	Lake Havasu City (MCWA Subcontract)	Mohave County	0	0	0	0	0	0	0	0
4(i)	La Paz County	La Paz County	0	0	0	0	0	0	0	0
4(i)	McAlister Family Trust	Mohave County	0	0	0	0	0	0	0	0
4(i)	Mohave Valley Irrigation and Drainage District (MCWA Subcontract)	Mohave County	0	0	0	0	0	0	0	257
4(i)	Mohave Water Conservation District	Mohave County	0	0	0	0	0	0	0	62
4(i)	Mohave Water Conservation District (MCWA Subcontract)	Mohave County	0	0	0	0	0	0	0	0
4(i)	Parker, Town of[1]	La Paz County	0	0	0	0	0	0	0	0
4(i)	Quartzsite, Town of	La Paz County	0	0	0	0	0	0	0	0
4(i)	Queen Creek, Town of	Maricopa County	0	0	0	0	0	0	0	774
4(i)	Roy, Estates of Anna R. and Edward P.	Yuma County	0	0	0	0	0	0	0	0
4(i)	Shepard Water Company, Incorporated	Yuma County	0	0	0	0	0	0	0	0
4(i)	Somerton, City of	Yuma County	0	0	0	0	0	0	0	0
4(i)	Springs Del Sol Domestic Water Improvement District	La Paz County	0	0	0	0	0	0	0	0
4(i)	TV Marble Canyon AZ, LLC	Coconino County	0	0	0	0	0	0	0	0
CAP Indian	Scottsdale (Yavapai Prescott Indian Tribe Allocation)	Maricopa County	0	0	0	0	0	0	0	0
CAP M&I	ASARCO	Pima County	0	0	0	1,126	1,126	1,126	1,126	2,818
CAP M&I	Avondale	Maricopa County	0	0	0	290	290	290	290	727
CAP M&I	Arizona State Land Department (AZSLD)	Maricopa County	0	0	0	279	279	279	279	698
CAP M&I	Arizona Water Company, Casa Grande	Pinal County	0	0	0	476	476	476	476	1,192
CAP M&I	Arizona Water Company, Coolidge	Pinal County	0	0	0	107	107	107	107	268
CAP M&I	Arizona Water Company, Superstition	Pinal County	0	0	0	337	337	337	337	844
CAP M&I	Arizona Water Company, White Tank	Maricopa County	0	0	0	52	52	52	52	130
CAP M&I	Buckeye	Maricopa County	0	0	0	12	12	12	12	30

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
CAP M&I	Central Arizona Groundwater Replenishment District (CAGRD)	Maricopa County	0	0	0	344	344	344	344	862
CAP M&I	Carefree Water Company	Maricopa County	0	0	0	47	47	47	47	119
CAP M&I	Cave Creek	Maricopa County	0	0	0	140	140	140	140	350
CAP M&I	Chandler	Maricopa County	0	0	0	464	464	464	464	1,161
CAP M&I	Chaparral City Water Company	Maricopa County	0	0	0	478	478	478	478	1,196
CAP M&I	Circle City	Maricopa County	0	0	0	0	0	0	0	0
CAP M&I	El Mirage	Maricopa County	0	0	0	27	27	27	27	68
CAP M&I	Eloy	Pinal County	0	0	0	116	116	116	116	291
CAP M&I	EPCOR, Agua Fria	Maricopa County	0	0	0	595	595	595	595	1,489
CAP M&I	EPCOR, Paradise Valley	Maricopa County	0	0	0	173	173	173	173	434
CAP M&I	EPCOR, Sun City	Maricopa County	0	0	0	225	225	225	225	562
CAP M&I	EPCOR, Sun City West	Maricopa County	0	0	0	127	127	127	127	318
CAP M&I	Florence	Pinal County	0	0	0	110	110	110	110	275
CAP M&I	Freeport-Miami	Gila County	0	0	0	156	156	156	156	390
CAP M&I	Flowing Wells Irrigation District (FWID)	Pima County	0	0	0	153	153	153	153	383
CAP M&I	Gilbert	Maricopa County	0	0	0	388	388	388	388	971
CAP M&I	Glendale	Maricopa County	0	0	0	924	924	924	924	2,313
CAP M&I	Goodyear	Maricopa County	0	0	0	576	576	576	576	1,442
CAP M&I	Greater Tonopah, Water Utility	Maricopa County	0	0	0	3	3	3	3	9
CAP M&I	Green Valley Community Water Company	Pima County	0	0	0	0	0	0	0	0
CAP M&I	Green Valley Domestic Water Improvement District	Pima County	0	0	0	0	0	0	0	0
CAP M&I	Marana	Pima County	0	0	0	125	125	125	125	314
CAP M&I	Maricopa County Parks & Recreation	Maricopa County	0	0	0	36	36	36	36	89
CAP M&I	Mesa	Maricopa County	0	0	0	2,332	2,332	2,332	2,332	5,839
CAP M&I	Metropolitan Domestic Water Improvement District (Includes ICS Creation)	Pima County	0	0	0	722	722	722	722	1,807
CAP M&I	Oro Valley	Pima County	0	0	0	552	552	552	552	1,383
CAP M&I	Peoria	Maricopa County	0	0	0	1,454	1,454	1,454	1,454	3,640
CAP M&I	Phoenix	Maricopa County	0	0	0	6,551	6,551	6,551	6,551	16,401
CAP M&I	Pine	Gila County	0	0	0	0	0	0	0	0
CAP M&I	Queen Creek	Maricopa County	0	0	0	27	27	27	27	66

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
CAP M&I	Rio Verde Utilities	Maricopa County	0	0	0	44	44	44	44	109
CAP M&I	San Tan Irrigation District	Maricopa County	0	0	0	0	0	0	0	0
CAP M&I	Scottsdale	Maricopa County	0	0	0	2,831	2,831	2,831	2,831	7,088
CAP M&I	Spanish Trail Water Company	Pima County	0	0	0	163	163	163	163	408
CAP M&I	Surprise	Maricopa County	0	0	0	549	549	549	549	1,376
CAP M&I	Tempe	Maricopa County	0	0	0	231	231	231	231	579
CAP M&I	Tonopah	Maricopa County	0	0	0	0	0	0	0	0
CAP M&I	Tonto Hills Domestic Water Improvement District	Maricopa County	0	0	0	4	4	4	4	10
CAP M&I	Tucson	Pima County	0	0	0	7,729	7,729	7,729	7,729	19,352
CAP M&I	Vail Water Company	Pima County	0	0	0	100	100	100	100	249
CAP M&I	Water Utilities Community Facilities District, Apache Junction	Pinal County	0	0	0	156	156	156	156	392
CAP NIA-A	Phoenix	Maricopa County	0	32,071	37,280	37,280	37,280	37,280	37,280	37,280
CAP NIA-A	Chandler	Maricopa County	0	3,376	3,924	3,924	3,924	3,924	3,924	3,924
CAP NIA-A	Gilbert	Maricopa County	0	1,322	1,537	1,537	1,537	1,537	1,537	1,537
CAP NIA-A	Glendale	Maricopa County	0	587	682	682	682	682	682	682
CAP NIA-A	Mesa	Maricopa County	0	4,775	5,551	5,551	5,551	5,551	5,551	5,551
CAP NIA-A	Scottsdale	Maricopa County	0	2,844	3,306	3,306	3,306	3,306	3,306	3,306
CAP NIA-A	Tempe	Maricopa County	0	20	23	23	23	23	23	23
CAP NIA-B	Buckeye	Maricopa County	0	2,786	2,786	2,786	2,786	2,786	2,786	2,786
CAP NIA-B	Central Arizona Groundwater Replenishment District (CAGRD)	Maricopa County	0	18,185	18,185	18,185	18,185	18,185	18,185	18,185
CAP NIA-B	Carefree Water Company	Maricopa County	0	112	112	112	112	112	112	112
CAP NIA-B	Cave Creek	Maricopa County	0	386	386	386	386	386	386	386
CAP NIA-B	El Mirage	Maricopa County	0	1,318	1,318	1,318	1,318	1,318	1,318	1,318
CAP NIA-B	EPCOR, San Tan (ST)	Pinal County	0	3,217	3,217	3,217	3,217	3,217	3,217	3,217
CAP NIA-B	Freeport	Pima County	0	5,678	5,678	5,678	5,678	5,678	5,678	5,678
CAP NIA-B	Gilbert	Maricopa County	0	1,832	1,832	1,832	1,832	1,832	1,832	1,832
CAP NIA-B	Marana	Pima County	0	515	515	515	515	515	515	515
CAP NIA-B	Queen Creek	Maricopa County	0	4,162	4,162	4,162	4,162	4,162	4,162	4,162
CAP NIA-B	Resolution Copper	Maricopa County	0	2,238	2,238	2,238	2,238	2,238	2,238	2,238
CAP NIA-B	Rosemont Copper	Pima County	0	1,124	1,124	1,124	1,124	1,124	1,124	1,124
CAP NIA-B	SRP	Maricopa County	0	2,160	2,160	2,160	2,160	2,160	2,160	2,160
CAP NIA-B	Water Utilities Community Facilities District, Apache Junction	Pinal County	0	817	817	817	817	817	817	817
3	City of Yuma[1]	Yuma County	0	0	0	0	0	0	0	0

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
3	Union Pacific Railroad (formerly Southern Pacific Co.)	Yuma County	0	0	0	0	0	0	0	0
3	Kaman, Inc.	Yuma County	0	0	0	0	0	0	0	0
3	Department of the Navy, MCAS	Yuma County	0	0	0	0	0	0	0	0
3	City of Yuma (cemetery)	Yuma County	0	0	0	0	0	0	0	0
3	Yuma Mesa Fruit Growers' Association	Yuma County	0	0	0	0	0	0	0	0
3	Desert Lawn Memorial Park Association	Yuma County	0	0	0	0	0	0	0	0
3	Chandler (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Gilbert (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Glendale (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Mesa (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Phoenix (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Scottsdale (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Tempe (Salt River Pima-Maricopa Exchange)	Maricopa County	0	0	0	0	0	0	0	0
3	Department of the Army - Yuma Proving Ground	Yuma County	0	0	0	0	0	0	0	0
3	Yuma Union High School District	Yuma County	0	0	0	0	0	0	0	0
2	Cibola National Wildlife Refuge	La Paz County	0	0	0	0	0	0	0	0
2	Lake Mead National Recreation Area	Mohave County	0	0	0	0	0	0	0	0
2	Bureau of Reclamation - Davis Dam	Mohave County	0	0	0	0	0	0	0	0
2	Imperial National Wildlife Refuge	La Paz County	0	0	0	0	0	0	0	0
2	Havasu Lake National Wildlife Refuge	Mohave County	0	0	0	0	0	0	0	0
		Subtotal	**0**	**89,525**	**96,833**	**128,162**	**128,162**	**128,162**	**128,162**	**179,364**

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
California										
Priority	**Entitlement Holder**	**County**								
4	Metropolitan Water District of Southern California (MWD) (4)	Los Angeles, Orange, San Diego, Riverside, San Bernardino	0	0	0	186,000	232,500	279,000	325,500	325,500
3	MWD Diversions from QSA (3a from IID and CVWD)		0	0	0	0	0	0	0	0
		Subtotal	**0**	**0**	**0**	**186,000**	**232,500**	**279,000**	**325,500**	**325,500**
Nevada										
Priority	**Entitlement Holder**	**County**								
8 - Balance & Surplus	Southern Nevada Water Authority (SNWA)	Clark	8,000	21,000	25,000	27,000	27,000	27,000	27,000	30,000
8	Big Bend Water District	Clark	0	0	0	0	0	0	0	0
8	Robert B. Griffith Project	Clark	0	0	0	0	0	0	0	0
7	Southern Nevada Water Authority (Formerly Boy Scouts of America)	Clark	0	0	0	0	0	0	0	0
7	Bureau of Reclamation (includes Sportsman Park)	Clark	0	0	0	0	0	0	0	0
7	Nevada Dept. of Wildlife (formerly NV Dept of Game & Fish)	Clark	0	0	0	0	0	0	0	0
7	US Air Force (4,000af) (Delivery from SNWA)	Clark	0	0	0	0	0	0	0	0
6	Las Vegas Valley Water District	Clark	0	0	0	0	0	0	0	0
5	Lakeview Company (Hacienda Casino)	Clark	0	0	0	0	0	0	0	0
5	Pacific Coast Building Products, Inc. (PABCO)	Clark	0	0	0	0	0	0	0	0
4	Basic Water Company (formerly Basic Management, Inc.)	Clark	0	0	0	0	0	0	0	0
4	City of Henderson	Clark	0	0	0	0	0	0	0	0
4	Southern Nevada Water Authority (From Basic Water Company)	Clark	0	0	0	0	0	0	0	0
3	Boulder City	Clark	0	0	0	0	0	0	0	0
2	Lake Mead National Recreation Area4, Executive Order No. 5339	Clark	0	0	0	0	0	0	0	0
		Subtotal	**8,000**	**21,000**	**25,000**	**27,000**	**27,000**	**27,000**	**27,000**	**30,000**
		Total	**8,000**	**110,525**	**121,833**	**341,162**	**387,662**	**434,162**	**480,662**	**534,864**

Summary of Consumptive Use Impacts on Domestic Uses			Range of Analyzed Volumes of Total Shortage to Lower Division States (AF)							
Summary by County										
	Arizona	**# of Entitlement Holders /County**								
	Coconino County	1	0	0	0	0	0	0	0	0
	Gila County	2	0	0	0	156	156	156	156	390
	La Paz County	11	0	0	0	0	0	0	0	1
	Maricopa County	56	0	78,174	85,482	104,683	104,683	104,683	104,683	134,332
	Mohave County	18	0	0	0	0	0	0	0	3,314
	Pima County	13	0	7,317	7,317	17,986	17,986	17,986	17,986	34,031
	Pinal County	8	0	4,034	4,034	5,337	5,337	5,337	5,337	7,296
	Yuma County	16	0	0	0	0	0	0	0	0
	Subtotal Arizona Domestic	**125**	**0**	**89,525**	**96,833**	**128,162**	**128,162**	**128,162**	**128,162**	**179,364**
	California									
	Los Angeles, Orange, San Diego, Riverside, San Bernardino	6	0	0	0	186,000	232,500	279,000	325,500	325,500
	Subtotal California Domestic	**6**	**0**	**0**	**0**	**186,000**	**232,500**	**279,000**	**325,500**	**325,000**
	Nevada									
	Clark	15	8,000	21,000	25,000	27,000	27,000	27,000	27,000	30,000
	Subtotal Nevada Domestic	**15**	**8,000**	**21,000**	**25,000**	**27,000**	**27,000**	**27,000**	**27,000**	**30,000**

[1]This user also holds a PPR entitlement, which is not affected at these levels of shortages and it was not included here.

Note: PPRs are not affected at these levels of shortage.

Note: Orange highlights indicate the level at which available water for a user under this priority is reduced to zero.

Note: This analysis does not reflect an operational estimate of when water may cease to be physically available to certain users.

Disclaimer: These modeling results from the Shortage Allocation Model should only be used to compare the relative magnitude of effects reasonably expected to occur under the alternatives evaluated in this SEIS. Modeling assumptions should not be taken as agency position with respect to contract or statutory interpretation, and they are not intended to limit Secretarial discretion with respect to current or future policy. This model is not a substitute for the annual process of reviewing water orders and determining which can be filled, and it cannot replicate the precision required for that process.

E.3.5 Relationship between CRMMS and the Shortage Allocation Model

CRMMS was used to model a variety of river and reservoir parameters in the Colorado River Basin, including shortage amounts, reservoir elevations, and river flows (**Appendix D**, CRMMS Model Documentation). The Shortage Allocation Model provides a more detailed allocation of shortages to entitlement holders in the Lower Division States, specifically within Arizona.

The Shortage Allocation Model does not account for the use or conversion of ICS to meet DCP contributions, and it models DCP contributions as shortages to Lower Division States and users. CRMMS can model the conversion of Extraordinary Conversion ICS to DCP ICS for purposes of meeting DCP contributions without reducing diversions in a specific year.

In CRMMS, when Lake Mead is projected to decline to dead pool (elevation 895 feet) and all downstream water demands cannot be met, water users are modeled to be shorted “hydrologically”, i.e., upstream users access water before downstream users. In this case, system shortages are reported as a total for the entire Lower Basin because there are no explicit assumptions made in CRMMS associated with how these shortages are distributed in the Lower Basin. The Shortage Allocation Model does not attempt to represent the effect of potential system shortages and how these shortages might be distributed should such conditions occur, or the effect of physical limitations on access to water due to low river stage

Furthermore, the distribution of shortage within each state according to the Shortage Allocation Model is slightly different than CRMMS, because CRMMS uses projected water depletion schedules for distributing the available water supply to individual users in Arizona, California, and Nevada. For the first year of the model run, water depletion schedules use water orders that reflect the current year’s actual shortage conditions, DCP contributions, and other signed system conservation agreements. For the remaining years in the model run, default water depletion schedules reflect “normal” schedules, and they represent near-term historical trends in water use. For California and Nevada, the Shortage Allocation Model assumes entitlement holders in these states are using their full entitlements and distributes available water on that basis. For Arizona, the methods for distributing available water vary between priorities in the Shortage Allocation Model, but they are not based on CRMMS schedules.

E.4 Changes Made to the Shortage Allocation Modeling and this Appendix E After Publication of the Original Draft SEIS in April 2023

E.4.1 Water Transfer from GSC Farm, LLC to Town of Queen Creek

On April 28, 2023, a partial assignment and transfer of Arizona P4(i) Colorado River water was finalized from GSC Farm, LLC to the Town of Queen Creek. Tables E-5, E-14, and E-15 have been revised accordingly, and the Shortage Allocation Model reflects an updated proportionate share of the Arizona P4(i) entitlement pool for both GSC Farm, LLC and the Town of Queen Creek. (See **Section E.3.2.5.3** for more information.)

E.4.2 Removal of Previous Action Alternatives 1 and 2 From Consideration

As described in Chapters 1 and 2 of this Draft SEIS, shortages under the 2007 Interim Guidelines and contributions pursuant to the 2019 DCP are the basis for the alternatives now under consideration; accordingly, the Shortage Allocation Model results described in this Appendix E are limited to the effects of the 2007 Interim Guidelines and 2019 DCP.

E.4.3 Refinement to Attribution of California DCP Contributions

The Shortage Allocation Model described in this Appendix E attributes 7% of California's DCP contributions to Coachella Valley Water District pursuant to the May 20, 2019 Drought Contingency Plan Implementation Agreement Between Metropolitan Water District of Southern California and Coachella Valley Water District.

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Attachment E-1

Reclamation's September 14, 2022 letter notifying interested parties of a Tier 2 Shortage Condition and required DCP contributions in operational year 2023

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United States Department of the Interior

BUREAU OF RECLAMATION
P.O. Box 61470
Boulder City, NV 89006-1470

IN REPLY REFER TO:
LCB-4200
2.2.4.23

Subject: Notification of Tier 2 Shortage Condition and Drought Continency Plan (DCP) Contributions for the Lower Colorado River in Calendar Year (CY) 2023

Dear Interested Party:

On December 13, 2007, the Secretary of the Interior signed the Record of Decision for *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead* (2007 Interim Guidelines), which, among other things, identified operational strategies for managing the reservoirs of the Colorado River System under drought and low reservoir conditions. In accordance with the process set forth in the 2007 Interim Guidelines, the Secretary uses the August 24-Month Study projections for the following January 1 system storage and reservoir water surface elevations to determine Lake Mead operations for the following CY. In accordance with the 2007 Interim Guidelines, the Annual Operating Plan for Colorado River Reservoirs for CY 2023 will document the Secretary's determination, which affects the volume of mainstream Colorado River water available for use in CY 2023 within the Lower Division States of Arizona, California, and Nevada.

On August 16, 2022, the Bureau of Reclamation released its Colorado River Basin August 2022 24-Month Study, which projects Lake Mead's January 1, 2023, operating determination elevation to be 1,047.61 feet.[1] Following the release of the August 2022 24-Month Study, Reclamation announced that Lake Mead and the lower Colorado River will operate in a Tier 2 Shortage Condition in CY 2023, consistent with Section XI.G.2.D.1.b of the 2007 Interim Guidelines and in accordance with Article III(3)(c) of the *Criteria For Coordinated Long-Range Operation of Colorado River Reservoirs* and Article II(B)(3) of the 2006 Consolidated Decree of the United States Supreme Court in *Arizona* v. *California*. In addition, the *Lower Basin Drought Contingency Plan Agreement* (LB DCP Agreement) dated May 20, 2019, will also govern the operation of Lake Mead for CY 2023. The projected operation determination elevation of 1,047.61 feet is within the DCP elevation band of 1,045 and 1,050 feet and reflects what is commonly referred to a "Tier 2a" Shortage Condition.

In accordance with the 2007 Interim Guidelines and the LB DCP Agreement, the Tier 2a Shortage Condition results in the following mandatory shortage reductions and DCP Contributions in CY 2023:

[1]The CY 2023 operating determination elevation of 1,047.61 feet was calculated by taking Lake Mead's projected end of CY 2022 physical elevation of 1,040.78 feet, as reported in the August 2022 24-Month Study, and adding 480,000 acre-feet (AF) of water held back in Lake Powell to Lake Mead's capacity to maintain operational neutrality. For more information: https://www.usbr.gov/lc/region/g4000/24mo/.

- Arizona: a shortage reduction of 400,000 AF and DCP Contributions of 192,000 AF, for a total reduction of 592,000 AF, which is approximately 21 percent of the state's annual basic apportionment of 2.8 million AF of Colorado River water.
- Nevada: a shortage reduction of 17,000 AF and DCP Contributions of 8,000 AF, for a total reduction of 25,000 AF, which is 8 percent of the state's annual basic apportionment of 300,000 AF of Colorado River water.
- California: There is no shortage reduction or DCP Contributions required for California in CY 2023.

Additionally, in accordance with Minute 323 to the 1944 Water Treaty,[2] Mexico's Colorado River water delivery will be reduced in the amount of 70,000 AF and Mexico will contribute 34,000 AF of Mexico's Recoverable Water Savings to the Binational Water Scarcity Contingency Plan,[3] for a total Colorado River water delivery reduction of 104,000 AF, which is approximately 7 percent of Mexico's annual allotment of 1.5 million AF of Colorado River water.

<u>Arizona Operations in CY 2023</u>
In accordance with Section XI.G.2.D.1.b of the 2007 Interim Guidelines, 2.4 million AF is apportioned for consumptive use in the state of Arizona in CY 2023 (a reduction of 400,000 AF from its 2.8 million AF basic apportionment). Additionally, in accordance with Section III.B.1.a of Exhibit 1 to the LB DCP Agreement,[4] the state of Arizona will be required to make DCP Contributions in the total amount of 192,000 AF in CY 2023. Consistent with the Arizona mainstream Colorado River water priority system, there are no reductions to the water supply available to first, second and third priority entitlement holders for CY 2023.

Reclamation will implement the state of Arizona's August 6, 2009,[5] Arizona Shortage Sharing Recommendation and the "pool" approach described by letter dated January 25, 2021,[6] to distribute the available Arizona fourth priority Colorado River water supply. Consistent with the Arizona mainstream Colorado River water priority system, the pool approach recognizes that the fourth priority Colorado River water entitlements of the "on-river" mainstream users and the Central Arizona Project (CAP) are co-equal. The Arizona fourth priority Colorado River water available supply for CY 2023 is 1,078,962 AF,[7] which will be shared between the on-river mainstream entitlement holders and CAP. Reclamation anticipates that the available fourth priority supply will be sufficient to satisfy all on-river mainstream water orders, and is coordinating with the Central Arizona Water Conservation District on the distribution of available water supply within the CAP.

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[2] Referring to *Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin*. Available at: https://www.ibwc.gov/Files/Minutes/Min323.pdf.
[3]The implementing details of Mexico's Binational Water Scarcity Contingency Plan are provided in the *Joint Report of the Principal Engineers with the Implementing Details of the Binational Water Scarcity Contingency Plan in Colorado River Basin*. Available at: https://www.ibwc.gov/Files/joint_report_min323_bi_water_scarcity_contingency_plan_final.pdf.
[4] Referring to *Lower Basin Drought Contingency Operations*. Available at: https://www.usbr.gov/lc/region/g4000/dcpdocs/Attachment-B-Exhibit-1-LB-Drought-Operations.pdf.
[5] Available at: https://new.azwater.gov/sites/default/files/8-6-2009_ADWR_Shortage_%20ecommendation.pdf.
[6] Available at: https://new.azwater.gov/sites/default/files/01.25.21_ADWR_CAWCD_shortage_recommendationLetter.pdf.
[7] Calculated as Arizona's 2.8 million AF basic apportionment, less the average historical consumptive use by Arizona first, second, and third priority users (1,129,038 AF), less the required shortage reduction (400,000 AF), less the required DCP Contributions (192,000 AF). The average historical consumptive use by Arizona first, second, and third priority users is based on the four highest years of consumptive use during the five-year period from 2017-2021.

No unused Arizona mainstream water entitlement will be available for use by Arizona fifth priority mainstream water entitlement holders.

California Operations in CY 2023

In accordance with Section XI.G.2.D.1.b of the 2007 Interim Guidelines, 4.4 million AF is apportioned for consumptive use in the state of California in CY 2023 (no reduction from its basic apportionment). In accordance with Section III.B of Exhibit 1 to the LB DCP Agreement, the state of California is not required to make DCP Contributions in CY 2023.

Nevada Operations in CY 2023

In accordance with Section XI.G.2.D.1.b of the 2007 Interim Guidelines, 283,000 AF is apportioned for consumptive use in the state of Nevada in CY 2023 (a reduction of 17,000 AF from its 300,000 AF basic apportionment). Additionally, in accordance with Section III.B.2.a of Exhibit 1 to the LB DCP Agreement, the state of Nevada is required to make DCP Contributions in the total amount of 8,000 AF in CY 2023. The Southern Nevada Water Authority (SNWA) is the junior priority entitlement holder in the state of Nevada and SNWA and its member agencies hold entitlements of 276,000 AF per year of the state of Nevada's annual 300,000 AF basic apportionment. Pursuant to its cooperative agreement among its member agencies, as amended, SNWA may implement a shortage plan among its member agencies and can coordinate with them to absorb Colorado River water use reductions. SNWA does not, however, anticipate a need for shared reductions in Colorado River water deliveries in CY 2023 because Nevada's total annual consumptive use is anticipated to be lower than the reduced quantity of Colorado River water that will be available in CY 2023.

Lower Colorado River Basin-wide Considerations

Given the projections that Lake Mead's elevation will continue to decline in CY 2023, Reclamation encourages all Colorado River entitlement holders to prudently manage the use of available water supplies. Additionally, Reclamation would like to highlight that, in accordance with the *Inadvertent Overrun and Payback Policy*,[8] **accumulations of inadvertent overruns are not permitted in CY 2023 and are suspended as long as a Shortage Condition is in in effect**. To assist entitlement holders in monitoring their Colorado River water use to ensure they remain within available quantities, Reclamation will project diversions and consumptive use of Colorado River water during CY 2023 and will make these projections available daily on Reclamation's website.[9] Reclamation encourages Colorado River water entitlement holders to use the projections to adjust diversions to remain within their Reclamation-approved annual Colorado River water order.

[8] Available at: https://www.usbr.gov/lc/region/g4000/IOPP.pdf.

[9] Available at: https://www.usbr.gov/lc/region/g4000/hourly/forecast.pdf.

My staff will continue to monitor Colorado River hydrology and water use. We are available to work with you before and during shortage operations. Should you have questions, please contact Daniel A. Bunk, Chief, Boulder Canyon Operations Office, at (702) 293-8013 or dbunk@usbr.gov. Individuals in the United States, who are deaf, deafblind, hard of hearing, or have a speech disability may dial 711 (TTY, TDD, or TeleBraille) to access telecommunication relay services. Individuals outside the United States should use the relay services offered within their country to make international calls to the point-of-contact in the United States.

Sincerely,

JACKLYNN GOULD Digitally signed by JACKLYNN GOULD Date: 2022.09.14 13:54:52 -07'00'

Jacklynn L. Gould, P.E.
Regional Director

Attachment E-2

Reclamation's September 28, 2022 letter to the Central Arizona Water Conservation District announcing the operational year 2023 Available CAP Supply

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United States Department of the Interior

BUREAU OF RECLAMATION
P.O. Box 61470
Boulder City, NV 89006-1470

IN REPLY REFER TO:
PXAO-3000
2.2.4.21

VIA ELECTRONIC MAIL ONLY

Theodore C. Cooke
General Manager
Central Arizona Water Conservation District
23636 North 7th Street
Phoenix, AZ 85024

Subject: Calendar Year (CY) 2023 Announcement of Available Central Arizona Project (CAP) Supply

Dear Theodore C. Cooke:

As the Regional Director of the Lower Colorado Basin Region of the Bureau of Reclamation, who is delegated the authority and responsibility of the Secretary of the Interior, the "water master" on the lower Colorado River and the "Contracting Officer" for CAP contracts, I am hereby announcing the Available CAP Supply for the upcoming CY in accordance with contractual commitments. The Available CAP Supply for CY 2023 is 940,836 acre-feet (AF).

As you know, the Colorado River is the primary source of CAP water. Therefore, the Available CAP Supply for CY 2023 is primarily determined by and is subject to the availability of Colorado River water in CY 2023. The Secretary determines the water supply condition on the lower Colorado River for the upcoming year in accordance with the Consolidated Decree in *Arizona* v. *California* 547 U.S. 150 (2006), the *Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968 (Public Law 90-537)* as amended, and the procedures set forth in the *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operation for Lake Powell and Lake Mead* (2007 Guidelines) and the Lower Basin Drought Contingency Plan Agreement (LB DCP Agreement).

In its letter dated September 14, 2022 (enclosed), Reclamation announced that Lake Mead and the lower Colorado River will operate in a Tier 2a Shortage Condition in CY 2023 with Drought Contingency Plan (DCP) Contributions required, reducing the volume of Colorado River water available to the state of Arizona by 592,000 AF. As noted in the September 14th letter's overview of Arizona operations in CY 2023, the Arizona fourth priority Colorado River water available supply for CY 2023 is 1,078,962 AF on a consumptive use (CU) basis. Of that amount, 106,318 AF,[1] on a diversion basis, will be available for distribution among mainstream fourth priority or "P4(i)" entitlement holders for use in CY 2023 in accordance with the state of Arizona's August 6, 2009,[2] Arizona Shortage Sharing Recommendation and the "pool" approach described by letter dated January 25, 2021.[3] The remainder is available for diversion as fourth priority water by CAP to fulfill CAP contracts and subcontracts.

Contract No. 14-06-W-245, Amendment No. 2, Between the United States and the Central Arizona Water Conservation District for the Delivery of Water and Repayment of Costs of the Central Arizona Project, dated November 30, 2007, defines Available CAP Supply as "... for any given Year all Fourth Priority Water available for delivery through the Central Arizona Project, water available from CAP dams and reservoirs other than Modified Roosevelt Dam, and return flows captured by the Secretary for CAP use." Available CAP Supply, as calculated below for CY 2023, will be used in contractual determinations related to a CAP Time of Shortage and the distribution of water among CAP contractors and subcontractors.

Determinant of Available CAP Supply	**AF of CU for CY 2023**
Fourth Priority Supply	1,078,962
Minus P4(i) Available Supply (CU Equivalent of 106,318 AF)	- 65,917
Minus Other Use in Arizona[4]	- 809
Equals Fourth Priority Water Available to CAP Contractors and Subcontractors at the CAP Point of Diversion	**= 1,012,236**
Minus CAP System Loss Associated with Fourth Priority CAP Project Water	- 71,400
Plus Water Available from CAP Dams and Reservoirs other than Modified Roosevelt Dam	+ 0
Plus Return Flows Captured by the Secretary for CAP Use	+ 0
Equals Available CAP Supply	**= 940,836**

The Available CAP Supply is the amount of fourth priority water that Reclamation estimates will be available and can be committed for delivery to CAP contractors and subcontractors in CY 2023. However, the Central Arizona Water Conservation District must adjust its CY 2023 CAP Colorado River water diversion as needed to remain within the diversion volume approved by Reclamation that reflects uses by higher priority Colorado River water entitlement holders as they occur during CY 2023. As Reclamation works throughout the basin to adapt to these unprecedented drought conditions, the Lower Colorado Basin Regional Office and the Phoenix Area Office are committed to ongoing coordination with CAP stakeholders.

[1] The P4(i) pool will receive 9.85% of the Arizona fourth priority Colorado River water available for CY 2023, calculated as 164,652 AF divided by the difference between Arizona's 2,800,000 AF basic apportionment and the average historical consumptive use by Arizona first, second, and third priority users (1,129,038 AF). The average historical consumptive use by Arizona first, second, and third priority users is based on the four highest years of consumptive use during the five-year period from 2017-2021.

[2] Available at: https://new.azwater.gov/sites/default/files/8-6-2009_ADWR_Shortage_%20ecommendation.pdf.

[3] Available at: https://new.azwater.gov/sites/default/files/01.25.21_ADWR_CAWCD_shortage_recommendationLetter.pdf.

[4] Three-year average of consumptive use on Cibola Island and outside Present Perfected Right No. 7

Should you have questions, please contact Alexander B. Smith, Deputy Area Manager, Phoenix Area Office, at (623) 773-6215 or alexandersmith@usbr.gov. Individuals in the United States, who are deaf, deafblind, hard of hearing, or have a speech disability may dial 711 (TTY, TDD, or TeleBraille) to access telecommunication relay services. Individuals outside the United States should use the relay services offered within their country to make international calls to the point-of-contact in the United States.

Sincerely,

Acting for STACY WADE Digitally signed by STACY WADE Date: 2022.09.28 09:44:46 -07'00'

Jacklynn L. Gould, P.E.
Regional Director

Enclosure

cc: Thomas Buschatzke
Director
Arizona Department of Water Resources
1110 W. Washington Street, Suite 310
Phoenix, AZ 85007

Attachment E-3

Exhibit 5.3.4.1 to the Tohono O'odham Settlement Agreement, *Secretary's Approach for Determining the Amount of Water Available to the Nation During a Time of Shortage Under 1980 Contract*

EXHIBIT 5.3.4.1

SECRETARY'S SHORTAGE SHARING APPROACH

UNDER THE 1980 CONTRACT

Secretary's Approach for Determining
The Amount of Water Available to the Nation
During a Time of Shortage Under 1980 Contract

If the Available CAP Supply is insufficient to fill all orders for CAP water, the Secretary shall take the following steps, in succession, as necessary to match the available supply with orders for the delivery of CAP water in each of the categories described below:

1. First, miscellaneous uses of CAP water are reduced, pro rata. If, after eliminating all miscellaneous uses of CAP water, there is still insufficient available CAP water to meet outstanding orders for the delivery of CAP water, the Secretary shall take the following measure.
2. Uses of CAP NIA Priority Water are reduced, pro rata. If, after eliminating all uses of CAP NIA Priority Water, there is still insufficient available CAP water to meet outstanding orders for delivery of CAP water, then the Secretary shall take the following measure.
3. Uses of CAP M&I Priority Water in excess of 510,000 acre-feet are reduced, pro rata. If, after eliminating all uses of CAP M&I Priority Water in excess of 510,000 acre-feet, there is still insufficient available CAP water to meet outstanding orders for delivery of CAP water, then the Secretary shall take the following measure.
4. If the preceding reductions do not bring CAP water orders in line with the Available CAP Supply, uses of CAP Indian Priority Water in excess of 291,574 acre-feet are reduced, in accordance with the Secretarial Decision published in the Federal Register on March 24, 1983.

5. If the preceding reductions do not bring CAP water orders in line with the Available CAP Supply, the available CAP water supply will be allocated between users of CAP Indian Priority Water and users of CAP M&I Priority Water on a 36.37518 and 63.62482 percentage basis, respectively.

6. If step 5 is implemented, the amount of water available for the Nation shall be determined by multiplying the amount of CAP Indian Priority Water by the ratio of the amount of water delivered pursuant to the Nation's CAP Water Delivery Contract in the latest non-shortage Year relative to the total quantity of water delivered to all CAP Contracts for Indian Priority Water in that same Year.

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Appendix F

Potential DROA Contributions Sensitivity Analysis on Proposed Action

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Contents

Table

Figures

Attachment

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Appendix F. Potential DROA Contributions Sensitivity Analysis on Proposed Action

F.1 Introduction

Potential DROA contributions are analyzed in this appendix to provide a comparative analysis of the effects of potential DROA contributions on the Proposed Action.

F.2 Modeling Approach

This section summarizes the assumptions that were used in the hydrologic modeling and metrics used to compare the Proposed Action (with no DROA contributions) with the Proposed Action with potential DROA contributions (hereafter referred to as Proposed Action, DROA). Future Colorado River system conditions during the analysis period for both alternatives were simulated using the June 2023 CRMMS.

F.2.1 Modeling Assumptions

The following section summarizes the assumptions for the Proposed Action, DROA. The Proposed Action is described in **Chapter 2** with detailed modeling assumptions in **Section 3.3.4** and **Appendix D**.

The hydrologies used in this appendix are derived from the June 2023 Colorado Basin River Forecast Center Ensemble Streamflow Prediction (ESP) Upper Basin forecast and associated Lower Basin intervening flows. Three sets of ESPs are used in the SEIS modeling:

- 100 percent ESP: no adjustment to the streamflow forecasts
- 90 percent ESP: streamflow forecasts are reduced by 10 percent
- 80 percent ESP: streamflow forecasts are reduced by 20 percent

Detailed hydrology inputs, initial conditions, and other modeling assumptions not described in the following sections are consistent with assumptions included in the Proposed Action (see **Appendix D**).

Assumptions for the Proposed Action with Potential DROA Contributions

Modeling assumptions are consistent with the Proposed Alternative assumptions in **Section 3.3.4**. Additional assumptions for potential DROA contributions are summarized below. Detailed assumptions for CRMMS can be found in **Appendix D**.

- The modeling assumption regarding potential DROA contributions of up to 500,000 af per DROA year (May 1–April 30) will conform to the DROA and its implementing documents; the assumption also will be made only to help protect a Lake Powell elevation of 3,500 feet. These potential DROA contributions of zero to 500,000 af are modeled to occur if the projected Lake Powell end-of-water-year pool elevation is less than 3,525 feet for 2024 through 2026.

F.2.2 Comparison Metrics

The Proposed Action and Proposed Action, DROA are compared in **Section F.4** using the following metrics:

Lake Powell

- Monthly pool elevation
- Percentages of traces that fall below an elevation of 3,490 feet in any month in a water year
- Annual water year release

Lake Mead

- Monthly pool elevation
- Percentages of traces that fall below an elevation of 1,020 feet in any month in a calendar year
- Annual calendar year release

F.3 Modeling Results

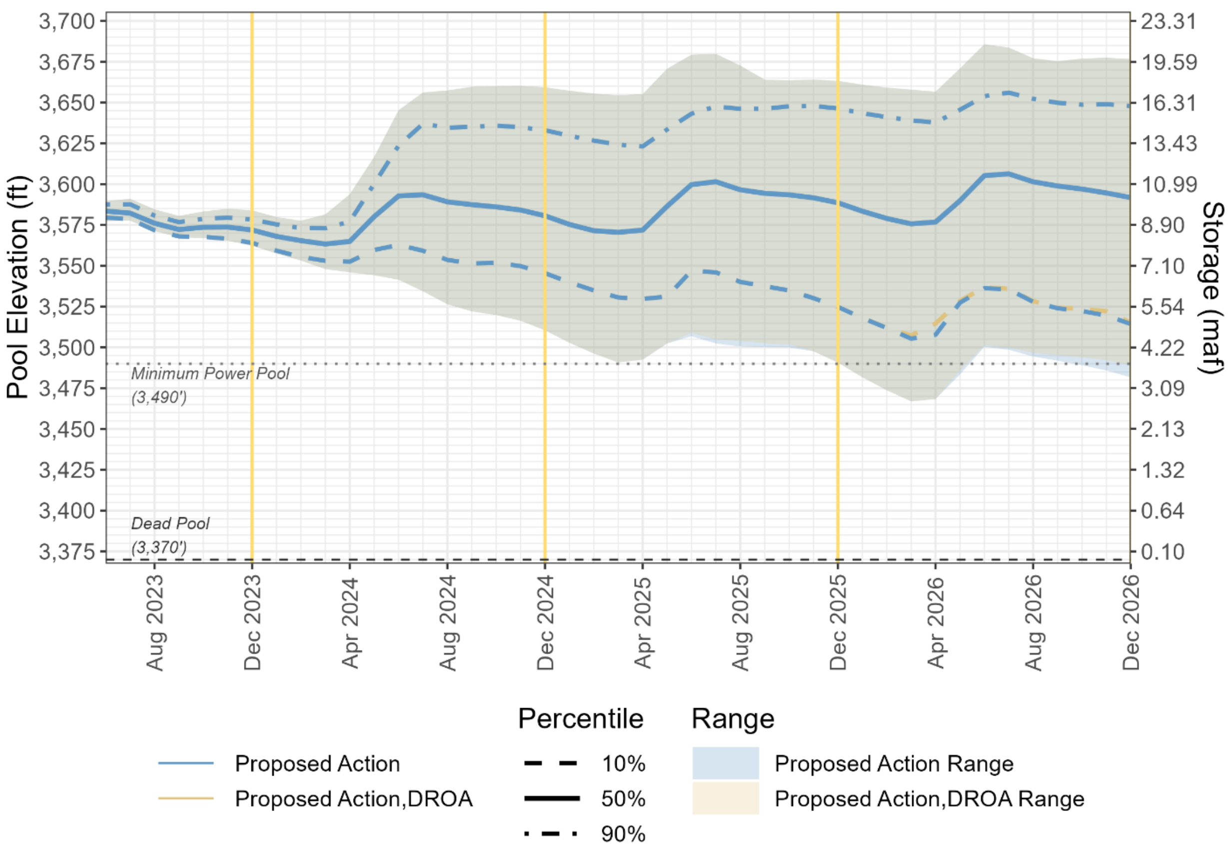
This section compares the Proposed Action with the Proposed Action, DROA. All statistics calculated reflect the hydrology scenarios and other assumptions used in modeling; they are not intended to suggest actual probabilities of any events occurring. However, it is meaningful to compare statistics across alternatives to differentiate performance. See **Appendix D** for more information about the hydrology scenarios used and modeling assumptions.

F.3.1 Lake Powell

Monthly Pool Elevations

Figure F-1 presents a comparison of the 10th, 50th, and 90th percentiles of modeled Lake Powell elevations for both alternatives as dashed, solid, and dash-dotted lines, respectively. It also shows "clouds" representing the full ranges of modeled elevations for the alternatives through 2026.

Figure F-1
Lake Powell End-of-Month Pool Elevations



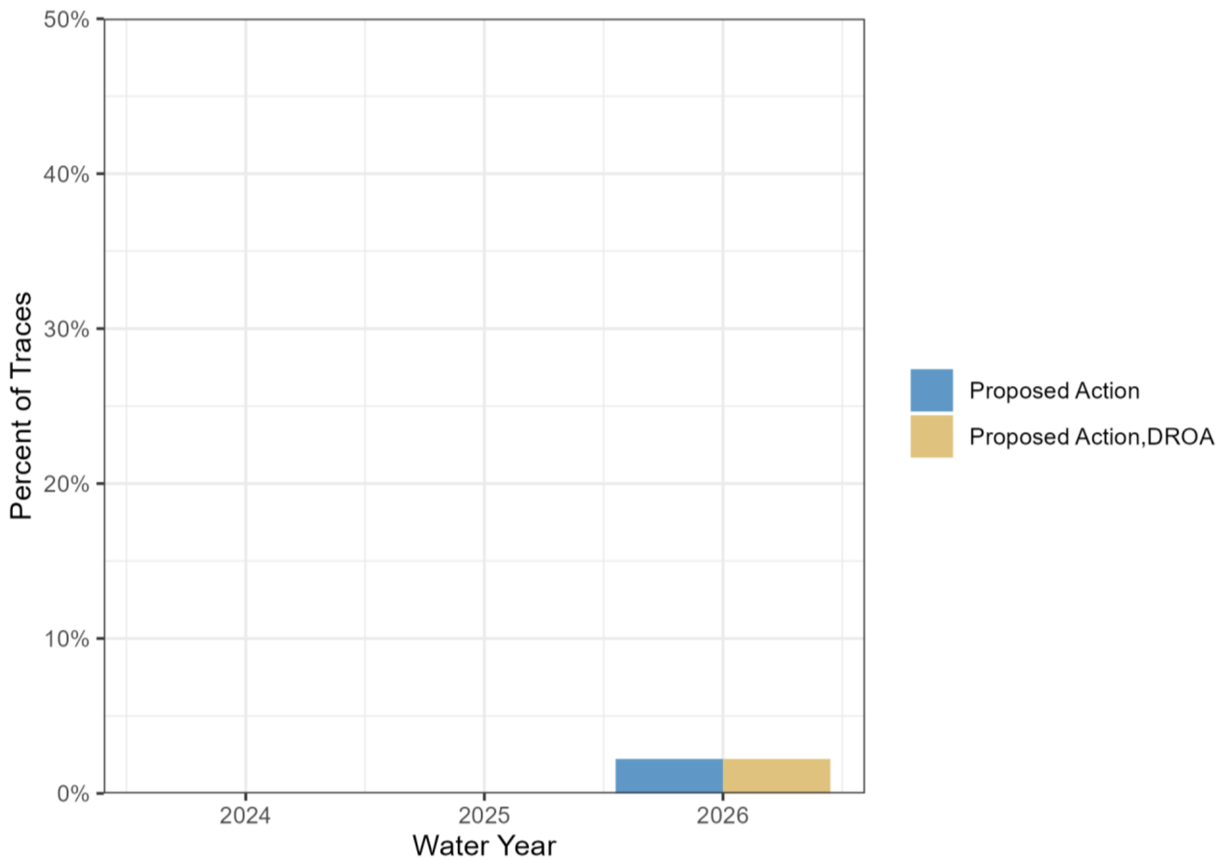
The median, 90th percentile, and highest modeled Lake Powell elevations in **Figure F-1** are exactly the same for the Proposed Action and the Proposed Action, DROA. The 10th percentile and minimum modeled pool elevations show slight differences as the pool elevations drop to 3,525 feet, which triggers DROA contributions. Modeled DROA releases are triggered in 3 percent of traces in 2025 and 9 percent of traces in 2026. In 2026, the Proposed Action, DROA has a slightly higher pool elevation at the 10th percentile—with a minimum in March 2026 of 3,507 feet compared to 3,505 feet under the Proposed Action—resulting from increased inflow into Lake Powell from modeled DROA releases.

Percentages of Traces below Critical Elevations

Figure F-2 shows the percentage of modeled traces that fall below a Lake Powell elevation of 3,490 feet at any time during a year for 2024 through 2026. Remaining above 3,490 feet is critical to ensuring that Glen Canyon Dam can continue to operate as designed.

Figure F-2 shows the same percentage of traces drop below a Lake Powell pool elevation of 3,490 feet for both alternatives. Under the Proposed Action and Proposed Action, DROA, , 2 percent of traces in 2026 result in the Lake Powell pool elevation dropping below 3,490 feet.

Figure F-2
Lake Powell Minimum Water Year Elevation, Percentage of Traces Less than an Elevation of 3,490 feet

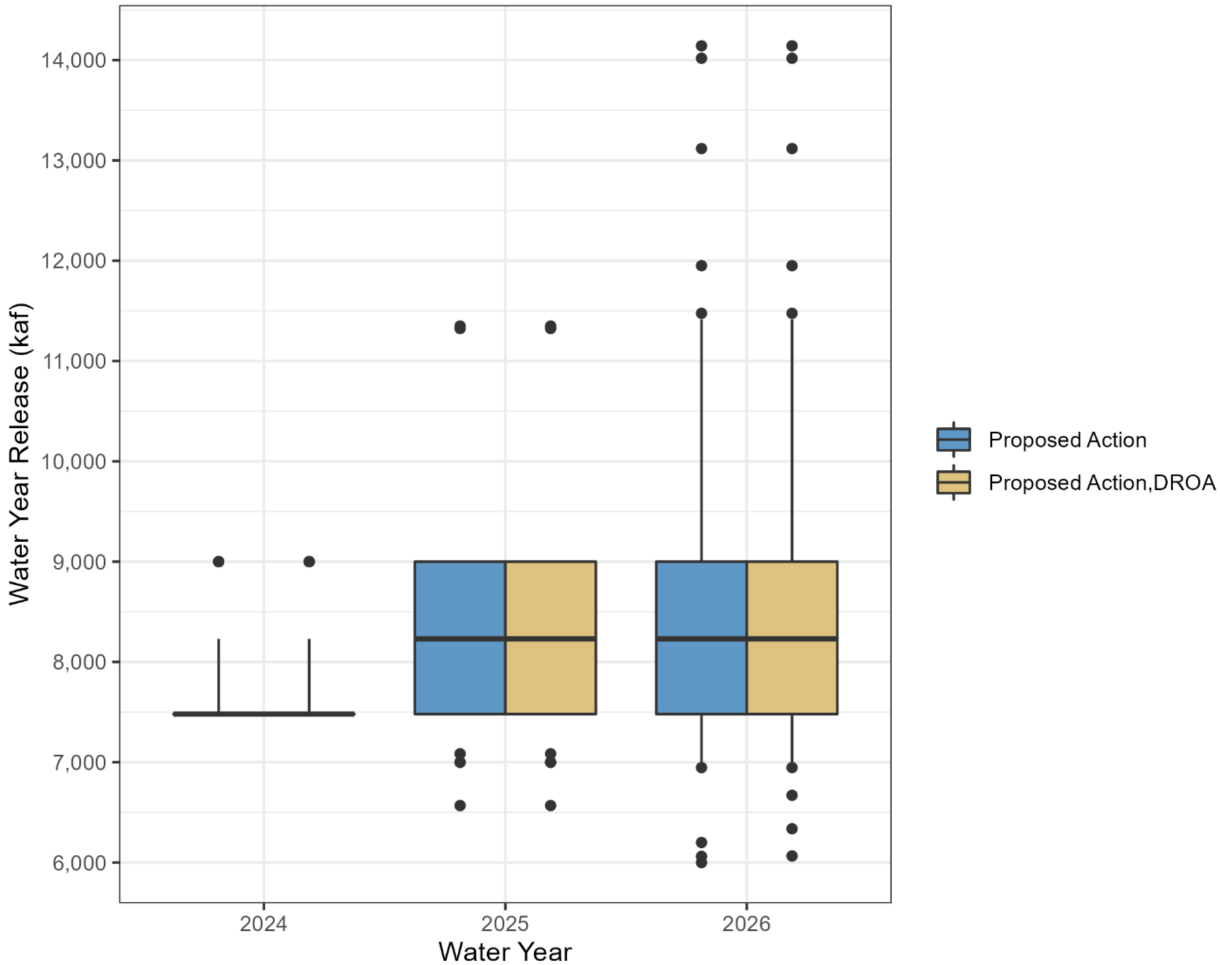


Annual Releases

Figure F-3 shows the distributions of modeled Glen Canyon Dam water year releases in 2024, 2025, and 2026. The top and bottom of each box capture the 25th to 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, the whiskers extend to the 5th and 95th percentiles, and the outliers are represented as dots beyond these lines.

The modeled Glen Canyon Dam water year releases shown in **Figure F-3** reflect small differences in Glen Canyon Dam's annual release that result from potential DROA releases from the Upper Basin Upper Initial Units. The releases for 2024 and 2025 are the same, reflecting that DROA releases do not impact Glen Canyon Dam releases during these years. In 2026, when Glen Canyon Dam releases were reduced below 7.0 maf to protect 3,500 feet, the lowest 5 percent of releases were affected by potential DROA contributions. In these modeled traces, extra inflows to Lake Powell from potential DROA contributions slightly increased Lake Powell's storage, allowing for more water to be released.

Figure F-3
Glen Canyon Dam Water Year Release



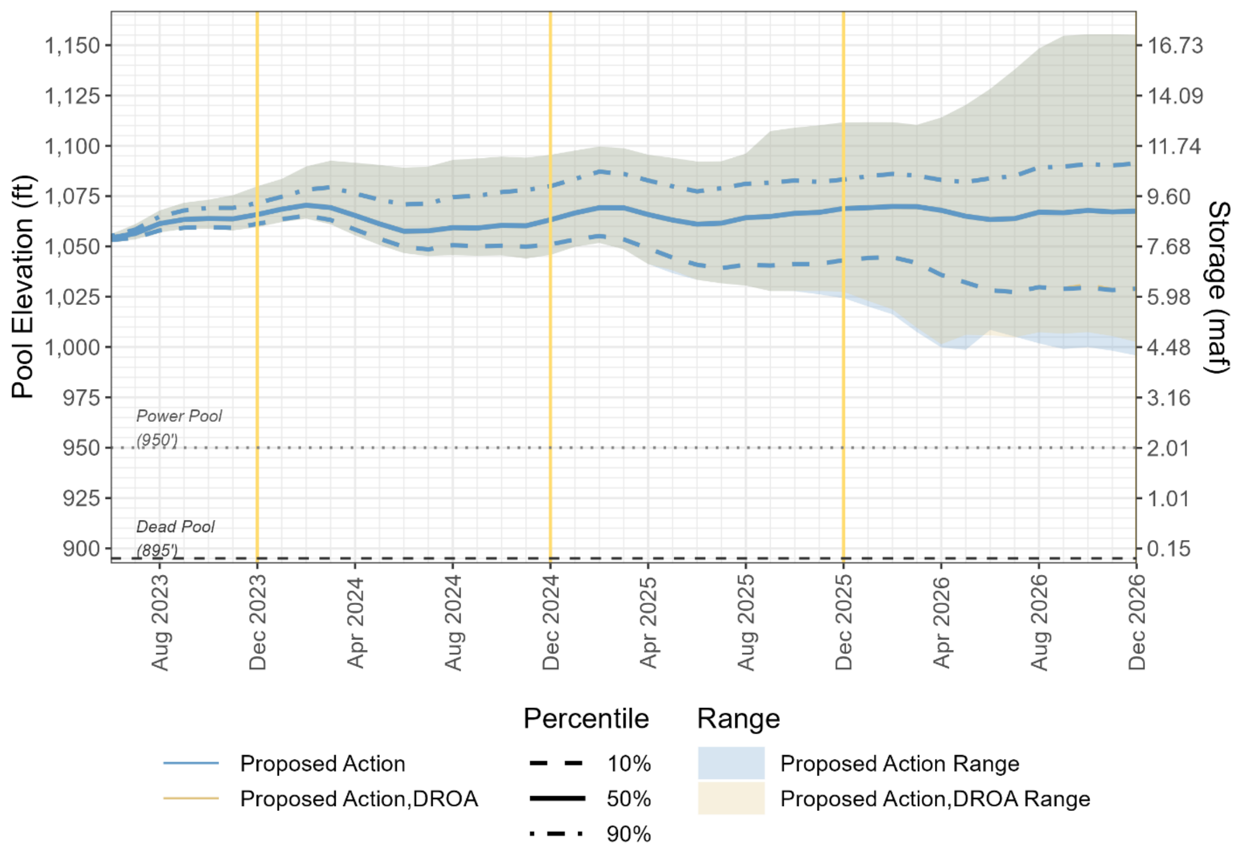
F.3.2 Lake Mead

Monthly Pool Elevations

Figure F-4 presents a comparison of the 10th, 50th, and 90th percentiles of modeled Lake Mead elevations for all alternatives as dashed, solid, and dash-dotted lines, respectively. It also shows clouds representing the full ranges of modeled elevations for the alternatives through 2026.

In **Figure F-4**, the only differences between the modeled Lake Mead elevation occur at the lower bound or minimum pool elevation starting in water year 2026. The Proposed Action, DROA pool elevations are slightly higher than those for the Proposed Action by 7 feet at the end of 2026; this is due to changes in Glen Canyon Dam's release.

Figure F-4
Lake Mead End-of-Month Pool Elevations

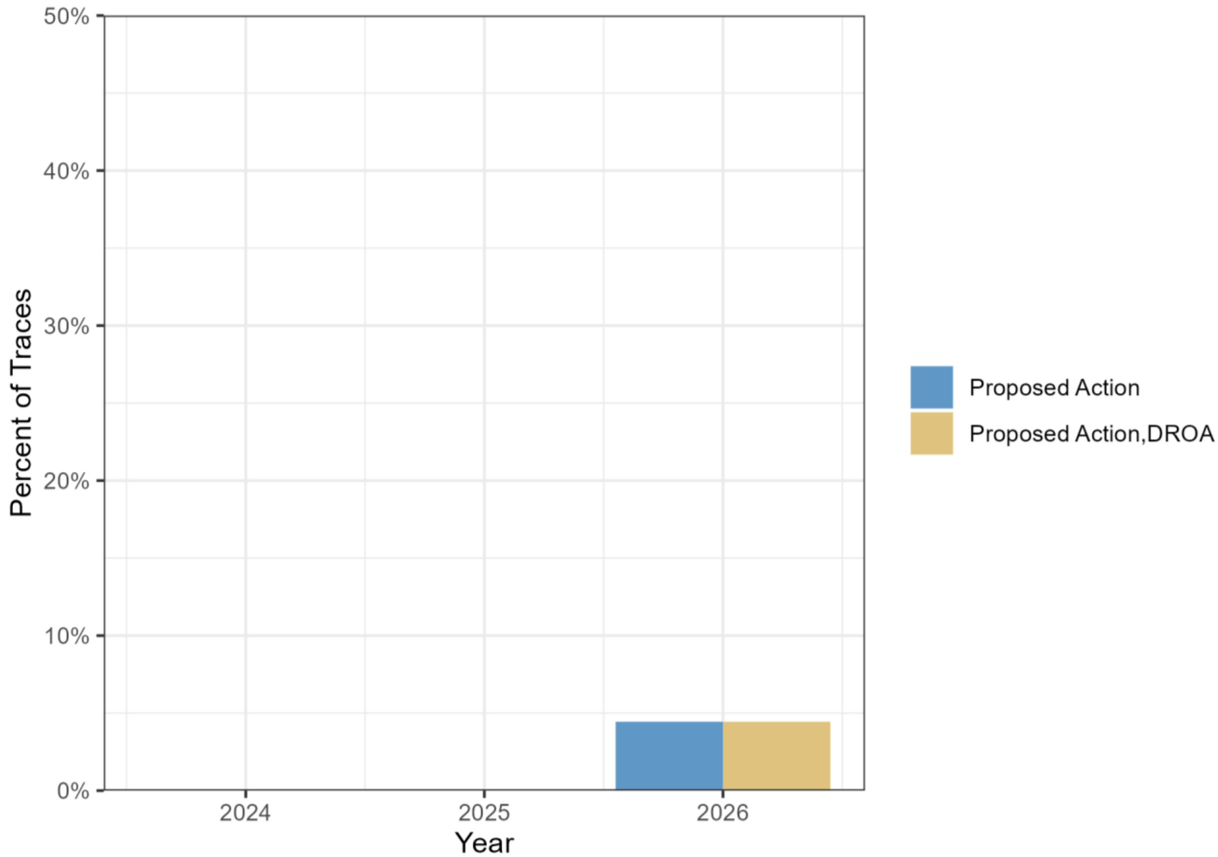


Percentages of Traces below Critical Elevations

Figure F-5 shows the percentage of modeled traces that fall below a Lake Mead elevation of 1,000 feet at any time during a year for the period of analysis. An elevation of 1,020 feet was identified as a critical elevation in the 2019 DCP.

In **Figure F-5**, the Proposed Action and Proposed Action, DROA have no modeled traces falling below a Lake Mead elevation of 1,020 feet in 2024 and 2025. In 2026, both alternatives show 4 percent of traces falling below 1,020 feet; this shows that DROA releases do not affect the percentage of traces dropping below 1,020 feet at Lake Mead.

Figure F-5
Lake Mead Minimum Calendar Year Elevation, Percentage of Traces Less than Elevation of 1,020 feet

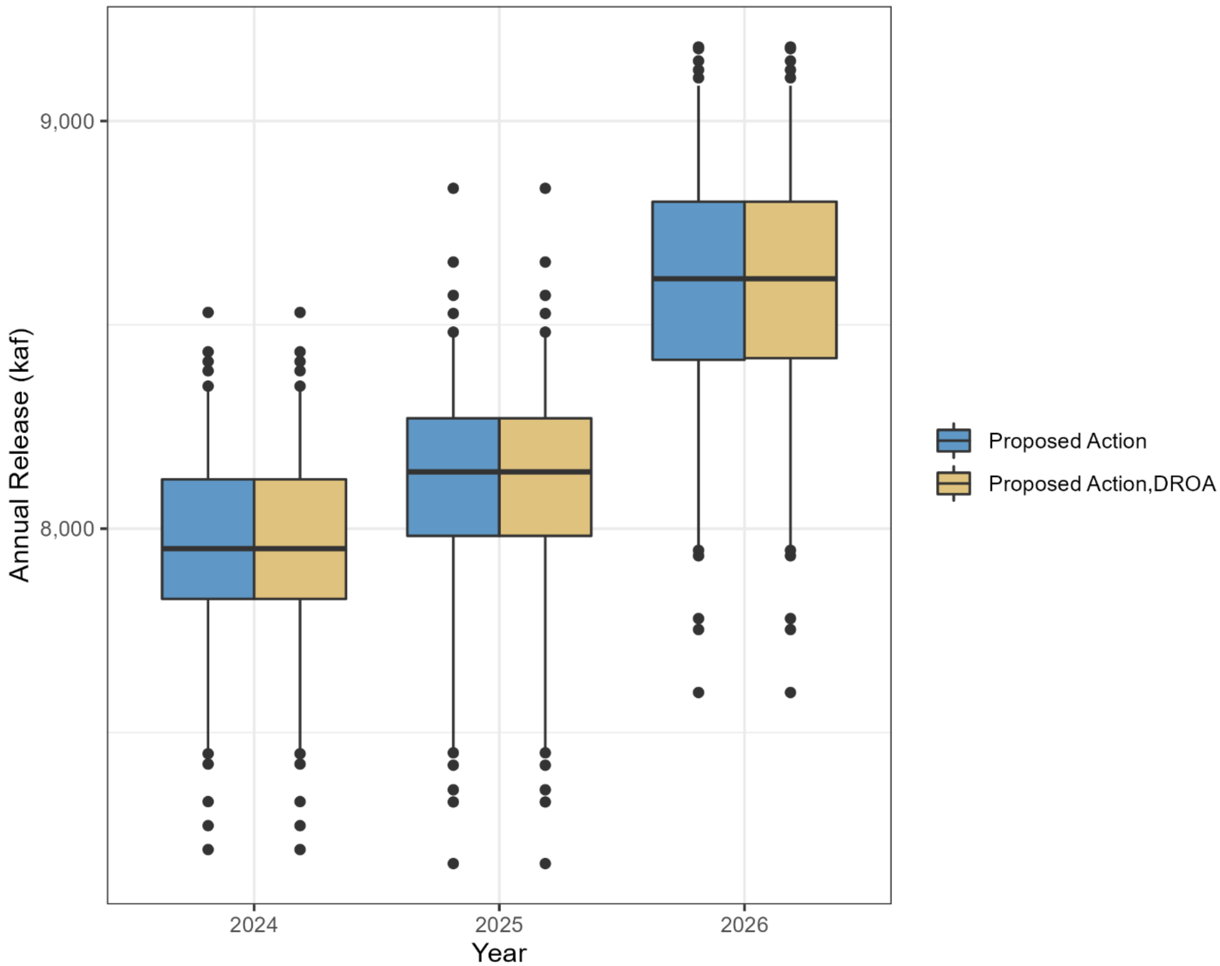


Annual Releases

Figure F-6 shows the distributions of modeled annual releases from Hoover Dam in 2024, 2025, and 2026. The top and bottom of each box capture the 25th to 75th percentile, respectively, of the modeled elevations. The median is the mid-line of the box, the whiskers extend to the 5th and 95th percentiles, and the outliers are represented as dots beyond these lines.

Figure F-6 shows that modeled releases from Hoover Dam in 2024 to 2025 are the same. In 2026, there are some minor differences in Lake Mead's release. Due to slightly increased Glen Canyon Dam releases resulting from DROA contributions, 2 percent of modeled traces result in lower shortage and DCP contributions in 2026.

Figure F-6
Hoover Dam Calendar Year Release



F.4 Summary

The potential DROA contributions have a minimal impact on Lake Powell and Lake Mead operations, except under the driest modeled traces. In the driest traces, which reduce Glen Canyon Dam's releases below 7.0 maf to protect 3,500 feet, the potential DROA contributions increase Lake Powell pool elevations and releases from Glen Canyon Dam compared to the Proposed Action. At Lake Mead, the Proposed Action, DROA has slightly higher pool elevations for traces projecting the minimum Lake Mead pool elevations. This affects the shortage tier and DCP contributions in 2026; 2 percent of traces have lower reductions resulting from increased releases from Glen Canyon Dam.

Attachment F-1

CRMMS Modeling Assumptions

Attachment F-1. CRMMS Modeling Assumptions

This attachment describes the CRMMS modeling assumptions for potential DROA contributions.

F-1.1 Potential DROA Contribution Assumptions

CRMMS includes modeling assumptions for potential DROA contributions to Lake Powell for DROA Years 2024 through 2026 (that is, May 2024 through the end of the simulation). Potential DROA contributions range from zero to 500,000 af per DROA Year when Lake Powell is projected to be below 3,525 feet at the end of the operating year, depending on the water available for potential DROA contributions from Flaming Gorge, Navajo, and Blue Mesa Reservoirs. Potential DROA contributions are distributed proportionally across Flaming Gorge, Navajo, and Blue Mesa Reservoirs based on each reservoir's storage above key reservoir elevation targets.

In CRMMS, the potential DROA contribution is calculated in August of run cycle 4. The rules are a higher priority than the Lake Powell operations; therefore, they solve after the Lake Powell operating tier and operating year releases have been calculated. The potential DROA contributions are only assumed to occur if Lake Powell is projected to be below 3,525 feet during Lake Powell's initial calculation in the Lower Elevation Balancing Tier. The potential DROA contributions' rules then distribute up to an additional 500,000-af release from Flaming Gorge, Blue Mesa, and Navajo Reservoirs.

To determine the portion of the 500,000-af additional release applied to Flaming Gorge, Blue Mesa, and Navajo Reservoirs, the available storage that can be released from all three reservoirs is calculated. For Flaming Gorge Reservoir, the storage available for a DROA contribution is calculated by taking the difference between the projected storage at the end of the DROA year (that is, April in the following operating year) and the storage at 5,890 feet (19 feet above minimum power pool). For Blue Mesa Reservoir, the storage available for a DROA contribution is calculated by taking the difference between the storage at the end of December of the following year and the storage at 7,412 feet (19 feet above minimum power pool). For Navajo Reservoir, the storage available for a DROA contribution is calculated by taking the difference between the projected storage at the end of September of the following year and the storage at 6,050 feet (60 feet above the Navajo Indian Irrigation Project diversion intake).

The total available storage for DROA contributions is calculated as the sum of each reservoir's available storage volume. If the total available storage for DROA contributions is less than 500,000 af, then the potential DROA contribution is set to the volume of available storage. Each reservoir's storage available for a DROA contribution is constrained to be nonnegative.

The percentages of the potential DROA contributions from Flaming Gorge, Blue Mesa, and Navajo Reservoirs are calculated as:

$$PotentialContributionPercent_i = \frac{AvailableStorage_i}{\sum_i AvailableStorage_i}$$

where i is each reservoir (Flaming Gorge, Blue Mesa, and Navajo).

The potential DROA contributions are released over the DROA Year using the monthly proportions in **Table F-1-1**. These monthly distributions are based off the monthly distribution of DROA releases in past planned DROA releases (that is, DROA Year 2022 for Flaming Gorge Reservoir and 2021 for Blue Mesa and Navajo Reservoirs).

Table F-1-1
Monthly Distribution of Potential DROA Contributions

Month	Flaming Gorge Reservoir	Blue Mesa Reservoir	Navajo Reservoir
	Percent	Percent	Percent
January	8.58	0.00	0.00
February	7.78	0.00	0.00
March	8.58	0.00	0.00
April	4.79	0.00	0.00
May	21.56	0.00	0.00
June	2.40	0.00	0.00
July	3.59	0.00	0.00
August	9.78	38.89	0.00
September	9.58	50.00	0.00
October	7.58	11.11	0.00
November	7.19	0.00	50.00
December	8.59	0.00	50.00

In the calculation of monthly releases for the DROA year, the additional DROA contribution is added to the reservoir's current release. The new projected release is then constrained to ensure it would not cause the reservoir to drop below dead pool or below the Navajo Indian Irrigation Project diversion at Navajo. Morrow Point and Crystal Reservoirs are then resolved for the DROA Year since their inflow has been adjusted due to the potential DROA contributions. These reservoirs adjust their outflow to ensure they stay at their storage targets, passing the DROA contribution from Blue Mesa Reservoir.

Appendix G

Table of Sensitive Species

Appendix G. Table of Sensitive Species

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Fish								
Bluehead sucker	*Catostomus discobolus*	BLM AZ BLM UT	—	X	X	X	—	Yes
Bonytail	*Gila elegans*	Endangered BLM NV	X (rare, stocked)	—	—	X (stocked)	—	Yes
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered	X	—	—	—	—	Yes
Desert pupfish	*Cyprinodon macularis*	Endangered	—	—	—	—	—	No
Desert sucker	*Catostomus clarkii*	BLM AZ	—	—	—	X	—	Found only in tributaries—not in the project area
Flannelmouth sucker	*Catostomus latipinnis*	BLM AZ BLM UT	X	X	X	X	—	Yes
Gila longfin dace	*Agosia chrysogaster chrysogaster*	BLM AZ	—	—	—	X	—	No; found in tributaries, not in the project area
Humpback chub	*Gila cypha*	Threatened	—	X	X	—	—	Yes; present in inflow to Lake Mead
Pahrump poolfish	*Empetrichthys latos*	BLM NV	—	—	—	—	—	Not present in the project area
Razorback sucker	*Xyrauchen texanus*	Endangered BLM NV	X	X	X	X	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Roundtail chub	*Gila robusta*	BLM AZ BLM UT	X	X	X	X	—	Not in the project area; does not occur downstream of Mesquite, Nevada
Sonora sucker	*Catostomus insignis*	—	—	—	—	X	—	No; found in tributaries, not in the project area
Speckled dace	*Rhinichthys osculus*	BLM AZ	X	X	X	X	—	No; found in tributaries
Virgin spinedace	*Lepidomeda mollispinis*	BLM Sensitive	—	—	X	—	—	Not in the project area; this species does not occur downstream of Mesquite, Nevada
Woundfin	*Plagopterus argentissimus*	—	—	—	X	—	—	Not present in the project area; does not occur downstream of Mesquite, Nevada
Birds								
American peregrine falcon	*Falco peregrinus*	BLM AZ BLM NV	—	X	X	X	X	No. This species forages over diverse habitat types, and it nests on exposed cliffs and buildings, which will not be impacted by any alternative.
American white pelican	*Pelicanus erythrorhynchos*	BLM UT	X	—	—	X	X	Yes
Arizona Bell's vireo	*Vireo bellii arizonae*	BLM CA	—	—	—	X	—	Yes
Arizona grasshopper sparrow	*Ammodramus savannarum ammolegus*	BLM AZ	—	X	X	X	—	No. This species utilizes dry upland grassland habitat for foraging and nesting, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Bald eagle	*Haliaeetus leucocephalus*	BLM AZ BLM NV BLM UT	X	X	X	X	—	Yes
Bank swallow	*Riparia riparia*	BLM CA	—	—	—	X	—	No. This species is a migrant that does not breed in the analysis area. It would not be impacted by any alternative.
Bendire's thrasher	*Toxostoma bendirei*	BLM CA	—	—	—	X	—	No. This species utilizes dry grassland and desert habitat for foraging and nesting, which will not be impacted by any alternative.
Black swift	*Cypseloides niger*	BLM UT	X	—	—	—	—	No. This species forages over diverse habitat types. It nests behind waterfalls, which will not be impacted by any alternative.
Burrowing owl	*Athene cunicularia*	BLM UT BLM NV	X	—	X	X	X	No. This species utilizes dry grassland and desert habitat for foraging and nesting, which will not be impacted by any alternative.
Cactus ferruginous pygmy owl	*Glaucidium brasilianum cactorum*	BLM AZ	—	X	X	X	—	No. This species utilizes desert habitat with cacti for foraging and nesting; these will not be impacted by any alternative.
California black rail	*Laterallus jamaicensis coturniculus*	BLM AZ BLM CA	—	—	—	X	X	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
California brown pelican	*Pelecanus occidentalis californicus*	BLM CA	—	—	—	X	—	No. This species is rarely detected.
California condor	*Gymnogyps californianus*	BLM AZ	X	X	—	—	—	Yes
Crissal thrasher	*Toxostoma crissale*	BLM CA	—	—	—	X	X	Yes
Elf owl	*Micrathene whitneyi*	BLM CA	—	—	—	X	—	Yes
Ferruginous hawk	*Buteo regalis*	BLM UT	X	—v	—	—	—	No. This species forages over diverse habitat types. It nests on exposed cliffs or solitary trees or infrastructure, which will not be impacted by any alternative.
Gila woodpecker	*Melanerpes uropygialis*	BLM CA	—	—	—	X	—	Yes
Gilded flicker	*Colaptes chrysoides*	BLM AZ BLM CA	—	—	—	X	—	Yes
Golden eagle	*Aquila chrysaetos*	BLM UT BLM AZ	X	X	X	X	—	Yes
Least bittern	*Ixobrychus exilis*	BLM NV	—	—	X	X	X	No. This species is not found in habitat that would be impacted by any alternatives.
LeConte's thrasher	*Toxostoma lecontei*	BLM AZ	—	X	X	X	—	No. This species utilizes dry and desert habitat types for foraging and nesting; these will not be impacted by any alternative.
Lucy's warbler	*Vermivora luciae*	BLM CA	—	—	—	X	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Mountain plover	*Charadrius montanus*	BLM CA	—	—	—	X	X	Yes
Northern goshawk	*Accipiter gentilis*	BLM AZ	—	X	—	—	—	No. This species utilizes upland forested habitat with high canopy cover for foraging and nesting; this habitat will not be impacted by any alternative.
Phainopepla	*Phainopepla nitens*	BLM NV	—	—	X	X	—	No. This species utilizes habitat that would not be impacted by any alternative.
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered BLM AZ BLM CA BLM NV	X	—	X	X	—	Yes
Swainson's hawk	*Buteo swainsoni*	BLM CA	—	—	—	X	—	No. This species forages over diverse habitat types, which will not be impacted by any alternative.
Tricolored blackbird	*Agelaius tricolor*	BLM CA	—	—	—	X	—	Yes
Western snowy plover	*Charadrius nivosus nivosus*	BLM NV	—	—	X	—	—	No. This species is not present in any habitat that would be impacted by any of the alternatives.
Western yellow-billed cuckoo	*Coccyzus americanus*	Threatened BLM AZ BLM CA BLM NV	X	X	X	X	—	Yes
White-tailed kite	*Elanus leucurus*	BLM CA	—	—	—	X	X	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Yuma Ridgeway's rail	*Rallus obsoletus yumaniensis*	Endangered BLM AZ BLM CA BLM NV	—	X	X	X	X	Yes
Mammals								
Allen's big-eared bat	*Idionycteris phyllotis*	BLM AZ BLM NV BLM UT	X	—	X	—	—	Yes
Allen's lappet-browed bat	*Idionycteris phyllotis*	BLM AZ	—	X	—	—	—	Yes
Arizona myotis	*Myotis occultus*	BLM AZ	—	X	X	X	—	Yes
Big brown bat	*Eptesicus fuscus*	BLM NV	X	X	X	X	—	Yes
Big free-tailed bat	*Nyctinomops macrotis*	BLM NV	—	—	X	X	—	Yes
California leaf-nosed bat	*Macrotus californicus*	BLM AZ BLM NV	—	—	X	X	—	Yes
California myotis	*Myotis californicus*	BLM NV	X	X	X	X	—	Yes
Canyon bat	*Parastrellus hesperus*	BLM NV	X	X	X	X	—	Yes
Cave myotis	*Myotis velifer*	BLM AZ BLM NV	X	X	X	X	—	Yes
Desert bighorn sheep	*Ovis canadensis nelsoni*	BLM CA	X	X	X	X	—	Yes
Fringed myotis	*Myotis thysanodes*	BLM UT BLM NV	X	—	X	—	—	Yes
Hoary bat	*Lasiurus cinereus*	BLM NV	—	—	X	X	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Houserock Valley chisel-toothed kangaroo rat	*Dipodomys microps leucotis*	BLM AZ	—	X	—	—	—	No. This species utilizes dry and desert habitat types for foraging; these will not be impacted by any alternative.
Kit fox	*Vulpes macrotis*	BLM UT	X	—	—	—	—	No. This species utilizes dry and desert habitat types for foraging and denning; these will not be impacted by any alternative.
Long-eared myotis	*Myotis evotis*	BLM CA	—	—	—	X	—	Yes
Mexican free-tailed bat	*Tadarida brasiliensis*	BLM NV	X	X	X	X	—	Yes
Mexican long-tongued bat	*Choeronycteris mexicana*	BLM AZ	—	X	—	X	—	Yes
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	BLM AZ	X	X	X	X	—	Yes
Pallid bat	*Antrozous pallidus*	BLM NV	X	X	X	X	—	Yes
Palm Springs pocket mouse	*Perognathus longimembris bangsi*	BLM CA	—	—	—	X	—	No. This species utilizes dry and desert habitat types for foraging; these will not be impacted by any alternative.
Palm Springs round-tailed ground squirrel	*Xerospermophilus tereticaudus chlorus*	BLM CA	—	—	—	X	—	No. Not in the project area.
Silver-haired bat	*Lasionycteris noctivagans*	BLM NV	X	X	X	X	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Spotted bat	*Euderma maculatum*	BLM AZ BLM NV BLM UT	—	X	—	X	—	Yes
Townsend's big-eared bat	*Corynorhinus townsendii*	BLM AZ BLM CA BLM NV BLM UT	X	—	X	X	—	Yes
Western mastiff bat	*Eumops perotis*	BLM NV	—	X	X	X	—	Yes
Western red bat	*Lasiurus blossevillii*	BLM NV BLM UT	—	—	X	X	—	Yes
Western small-footed myotis	*Myotis ciliolabrum*	BLM CA BLM NV	—	—	X	X	—	Yes
Yuma myotis	*Myotis yumanensis*	BLM CA BLM NV	X	X	X	X	—	Yes
Reptiles and Amphibians								
Arizona striped whiptail	*Aspidoscelis arizonae*	BLM AZ	—	X	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Arizona toad	*Anaxyrus microscaphus*	BLM UT BLM NV	—	—	—	X	—	Yes
Banded Gila monster	*Heloderma suspectum cinctum*	BLM NV	—	—	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Coast horned lizard	*Phrynosoma blainvillii*	BLM CA	—	—	—	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Coronado skink	*Plestiodon skiltonianus interparietalis*	BLM CA	—	—	—	X	—	No. This specie's range is outside of areas impacted by any alternatives.
Couch's spadefoot	*Scaphiopus couchii*	BLM CA	—	—	—	X	—	Yes
Desert box turtle	*Terrapene ornata luteola*	BLM AZ	—	X	X	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Desert tortoise	*Gopherus agassizii*	BLM NV	—	X	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Flat-tailed horned lizard	*Phrynosoma mcallii*	BLM AZ	—	—	—	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Foothill yellow-legged frog (south coast DPS)	*Rana boylii*	BLM CA	—	—	—	X	—	No. This specie's range is outside of areas impacted by any alternatives.
Lowland burrowing treefrog	*Smilisca fodiens*	BLM AZ	—	X	X	X	—	No. This specie's range is outside of areas impacted by any alternatives.
Lowland leopard frog	*Rana yavapaiensis*	BLM AZ BLM CA	—	—	X	X	—	Yes
Mohave fringe-toed lizard	*Uma scoparia*	BLM AZ	—	X	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Northern leopard frog	*Lithobates [=Rana] pipens*	BLM AZ	X	X	—	—	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location: Lake Powell	Location: Glen Canyon Dam to Lake Mead	Location: Lake Mead	Location: Hoover Dam to the SIB	Location: Salton Sea	Potential Species Impacts?
Northern Mexican gartersnake	*Thamnophis eques megalops*	Threatened	—	—	—	X	—	Yes
Relict leopard frog	*Rana onca*	BLM AZ BLM NV	—	—	X	X	—	Yes
Sinaloan narrow-mouthed toad	*Gastrophryne mazatlanensis*	BLM AZ	—	X	X	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Sonoran green toad	*Bufo retiformis*	BLM AZ	—	X	X	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Two-striped Gartersnake	*Thamnophis hammondii*	BLM CA	—	—	—	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Western pond turtle	*Emys marmorata*	BLM CA	—	—	—	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Western spadefoot	*Spea hammondii*	BLM CA	—	—	—	X	—	No. This species does not occur in habitat that would be impacted by any alternative.
Yuman desert fringe-toed lizard	*Uma rufopunctata*	BLM AZ	—	X	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Invertebrates								
Apache springsnail	*Pyrgulopsis arizonae*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Gila tyronia	*Tryonia gilae*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Grand wash springsnail	*Pyrgulopsis bacchus*	BLM NV	—	X	X	X	—	No. This species is only found in a watershed feeding Lake Mead; this watershed will not be influenced by project operations.
Kingman springsnail	*Pyrgulopsis conica*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
MacNeill's sooty-winged skipper	*Hesperopsis gracielae*	BLM NV	—	—	X	X	—	No. This species utilizes upland habitat, which will not be impacted by any alternative.
Mojave gypsum bee	*Andrena balsamorhizae*	BLM NV	—	—	X	—	—	No. This species is restricted to areas with its host plant, the sunray, which is an upland plant species.
Mojave poppy bee	*Perdita meconis*	BLM NV	—	—	X	—	—	Yes
Monarch butterfly	*Danaus plexippus plexippus*	BLM NV	—	X	X	X	—	Yes
Sonoran talussnail	*Sonorella magdalenensis*	BLM AZ	—	X	X	X	—	No. This species utilizes upland talus and rocky slopes, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Thorne's hairstreak	*Callophrys thornei*	BLM CA	—	—	—	X	—	No. This species relies on tecate cypress, which will not be impacted by any alternative.
Plants								
Alkali mariposa lily	*Calochortus striatus*	BLM NV	—	—	X	—	—	No. This species' range is outside of areas impacted by any alternatives.
Aravaipa sage	*Salvia amissa*	BLM AZ	—	X	X	X	—	No. This species grows in habitat with silt or sand in dry canyon bottoms; this habitat will not be impacted by any alternative.
Aravaipa woodfern	*Thelypteris puberula* var. *sonorensis*	BLM AZ	—	X	—	—	—	No. This species is only known from locations that will not be impacted by any alternatives.
Arizona eryngo	*Eryngium sparganophyllum*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Arizona Sonora rosewood	*Vauquelinia californica* ssp. *sonorensis*	BLM AZ	—	X	X	X	—	No. This species grows in upland desert habitat, which will not be impacted by any alternative.
Bartram stonecrop	*Graptopetalum bartramii*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.

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			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Beaver dam breadroot	*Pediomelum castoreum*	BLM NV	—	—	X	—	—	No. This species grows in upland desert habitat, which will not be impacted by any alternative.
Blue diamond cholla	*Cylindropuntia X multigeniculata*	BLM NV	—	—	X	—	—	No. This species grows in dry gypsiferous limestone, which will not be impacted by any alternative.
Blue sand lily	*Triteleiopsis palmeri*	BLM AZ	—	X	X	X	—	No. This species grows on sand dunes, which will not be impacted by any alternative.
California flannelbush	*Fremontodendron californicum*	BLM AZ	—	X	X	X	—	No. This species grows in well-draining rocky hillsides and ridges, which will not be impacted by any alternative.
California screw moss	*Tortula californica*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
Chaparral sand-verbena	*Abronia villosa var. aurita*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Cochise sedge	*Carex ultra*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Coulter's goldfields	*Lasthenia glabrata ssp. coulteri*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Deane's milkvetch	*Astragalus deanei*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Decumbent goldenbush	*Isocoma menziesii var. decumbens*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Delicate clarkia	*Clarkia delicata*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Dunn's mariposa lily	*Calochortus dunnii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Fish creek fleabane	*Erigeron piscaticus*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Felt-leaved monardella	*Monardella hypoleuca ssp. lanata*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Gander's pitcher sage	*Lepechinia ganderi*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Gander's ragwort	*Packera ganderi*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Gold butte moss	*Ceratodon purpureus*	BLM NV	—	—	X	—	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Grand Canyon rose	*Rosa stellata* var. *abyssa*	BLM AZ	—	X	—	—	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Harrison's barberry	*Berberis harrisoniana*	BLM AZ	—	X	X	X	—	No. This species grows on talus slopes on and along canyon sides, which will not be impacted by any alternative.
Harwood's eriastrum	*Eriastrum harwoodii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Hohokam agave	*Agave murpheyi*	BLM AZ	—	X	X	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Horn's milk-vetch	*Astragalus hornii var. hornii*	BLM CA	—	—	—	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Huachuca golden aster	*Heterotheca rutteri*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Lace-leaved rockdaisy	*Perityle ambrosiifolia*	BLM AZ	—	X	X	X	—	No. This species is only known from a few locations that will not be influenced by project operations.
Lakeside ceanothus	*Ceanothus cyaneus*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Las Vegas bearpoppy	*Arctomecon californica*	BLM NV	—	—	X	—	—	No. This species grows in upland desert in gypsum soils, which will not be impacted by any alternative
Las Vegas buckwheat	*Eriogonum corymbosum* var. *nilesii*	BLM NV	—	—	X	—	—	No. This species grows in upland gypsum soils, which will not be impacted by any alternative.
Latimer's woodland-gilia	*Saltugilia latimeri*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Lincoln rockcress	*Boechera lincolnensis*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Little San Bernardino Mtns. linanthus	*Linanthus maculatus ssp. maculatus*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Long-spined spineflower	*Chorizanthe polygonoides var. longispina*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Marble Canyon milkvetch	*Astragalus cremnophylax* var. *hevronii*	BLM AZ	—	X	—	—	—	No. This species grows along canyon edges, which will not be impacted by any alternative.
Mecca-aster	*Xylorhiza cognata*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Mojave indigo bush	*Psorothamnus arborescens*	BLM AZ	—	X	—	—	—	No. This species grows in upland desert, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Mojave tarplant	*Deinandra mohavensis*	BLM CA	—	—	—	X	—	Yes
Mokiak milkvetch	*Astragalus mokiacensis*	BLM NV	—	—	X	—	—	Yes
Mount Trumbull beardtongue	*Penstemon distans*	BLM AZ	—	X	—	—	—	No. This species grows in upland forest/woodland habitat, which will not be impacted by any alternative.
Nuttall's scrub oak	*Quercus dumosa*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Oil neststraw	*Stylocline citroleum*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Orcutt's brodiaea	*Brodiaea orcuttii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Orocopia Mountains spurge	*Euphorbia jaegeri*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Otay manzanita	*Arctostaphylos otayensis*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Otay Mountain ceanothus	*Ceanothus otayensis*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Parish's meadowfern	*Limnanthes alba ssp. parishii*	BLM CA	—	—	—	X	—	Yes

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Parish's phacelia	*Phacelia parryi*	BLM NV	—	—	X	—	—	No. This specie's range is outside of areas impacted by any alternatives.
Parry's spineflower	*Chorizanthe parryi var. parryi*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Parry's tetracoccus	*Tetracoccus dioicus*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Pima Indian mallow	*Abutilono parishii*	BLM AZ	—	X	X	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Pinto beardtongue	*Penstemon bicolor* ssp. *roseus*	BLM AZ	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Polished blazing star	*Mentzaelia laevicaulis*	BLM NV	—	—	X	—	—	No. This species grows in upland sandy and rocky habitat, which will not be impacted by any alternative.
Rainbow manzanita	*Arctostaphylos rainbowensis*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Ramona horkelia	*Horkelia truncata*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Reveal's buckwheat	*Eriogonum contiguum*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.

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			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Robinson's monardella	*Monardella robisonii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Rosy twotone beardtongue	*Penstemon bicolor* ssp. *roseus*	BLM NV	—	—	X	—	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Salt marsh bird's-beak	*Chloropyron maritimum ssp. maritimum*	BLM CA	—	—	—	X	—	No. This species grows in coastal salt marsh habitat, which will not be impacted by any alternative.
San Bernadino milk-vetch	*San Bernardino milk-vetch*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
San Diego goldenstar	*Bloomeria clevelandii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
San Diego gumplant	*Grindelia hallii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
San Diego milk-vetch	*Astragalus oocarpus*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Sandfood	*Pholisma sonorae*	BLM AZ	—	X	X	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
San Jacinto mariposa-lily	*Calochortus palmeri var. munzii*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.

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			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
San Luis Obispo sedge	*Carex obispoensis*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
San Miguel savory	*Clinopodium chandleri*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
Sanford's arrowhead	*Sagittaria sanfordii*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
Santa Lucia dwarf rush	*Juncus luciensis*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
Scaly sandplant	*Pholisma arenarium*	BLM AZ	—	X	X	X	—	No. This species grows in upland sand and dune habitat, which will not be impacted by any alternative.
Shevock's copper moss	*Mielichhoferia shevockii*	BLM CA	—	—	—	X	—	No. This species' range is outside of areas impacted by any alternatives.
Siler fishhook cactus	*Sclerocactus sileri*	BLM AZ	—	X	—	—	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Silverleaf sunray	*Enceliopsis argophylla*	BLM AZ BLM NV	—	X	X	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Small wirelettuce	*Stephanomeria exigua* ssp. *exigua*	BLM AZ	—	X	X	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.

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			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Snake cholla	*Cylindropuntia californica var. californica*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Spring Mountain milkvetch	*Astragalus remotus*	BLM NV	—	—	X	—	—	No. This species grows in upland talus and rocky slopes, which will not be impacted by any alternative.
Sticky buckwheat	*Eriogonum viscidulum*	BLM AZ BLM NV	—	—	X	—	—	Yes
Sticky dudleya	*Dudleya viscida*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Sticky ringstem	*Anulocaulis leiosolenus*	BLM NV	—	—	X	—	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Summer holly	*Comarostaphylis diversifolia ssp. diversifolia*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Tecate cypress	*Hesperocyparis forbesii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Tecate tarplant	*Deinandra floribunda*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Threecorner milkvetch	*Astragalus geyeri* var. *triquetrus*	BLM NV	—	—	X	—	—	No. This species grows in upland sand and dune habitat, which will not be impacted by any alternative.

Common Name	Scientific Name	Listing Status	Location					Potential Species Impacts?
			Lake Powell	Glen Canyon Dam to Lake Mead	Lake Mead	Hoover Dam to the SIB	Salton Sea	
Tumamoc globeberry	*Tumamoca macdougalii*	BLM AZ	—	X	X	X	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Variegated dudleya	*Dudleya variegata*	BLM CA	—	—	—	X	—	Yes
White bearpoppy	*Arctomecon merriamii*	BLM NV	—	—	X	—	—	No. This species grows in upland desert, which will not be impacted by any alternative.
Whitemargined beardtongue	*Penstemon albomarginatus*	BLM NV	—	—	X	—	—	No. This species grows in upland sand and dune habitat, which will not be impacted by any alternative.
White-bracted spineflower	*Chorizanthe xanti var. leucotheca*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Wiggins' croton	*Croton wigginsii*	BLM CA	—	—	—	X	—	No. This species grows in upland sand and dune habitat, which will not be impacted by any alternative.
Yellow twotone beardtongue	*Penstemon bicolor* ssp. *bicolor*	BLM NV	—	—	X	—	—	No. This species grows in upland habitat, which will not be impacted by any alternative.
Yucaipa onion	*Allium marvinii*	BLM CA	—	—	—	X	—	No. This species grows in upland habitat, which will not be impacted by any alternative.