3.4 WATER SUPPLY

3.4.1 INTRODUCTION

This section discusses the water supply available to the Lower Division states and Mexico under baseline conditions and the interim surplus criteria alternatives. It provides an evaluation of the effectiveness of meeting the water delivery objectives previously articulated by the Lower Division states and notes the states' contingency plans in the event of shortages. Water supply deliveries are the deliveries of Colorado River water by Reclamation to entities in the seven Basin States and Mexico, consistent with a body of documents often referred to as the *Law of the River*, as discussed in Section 1.3.4.1.

3.4.2 METHODOLOGY

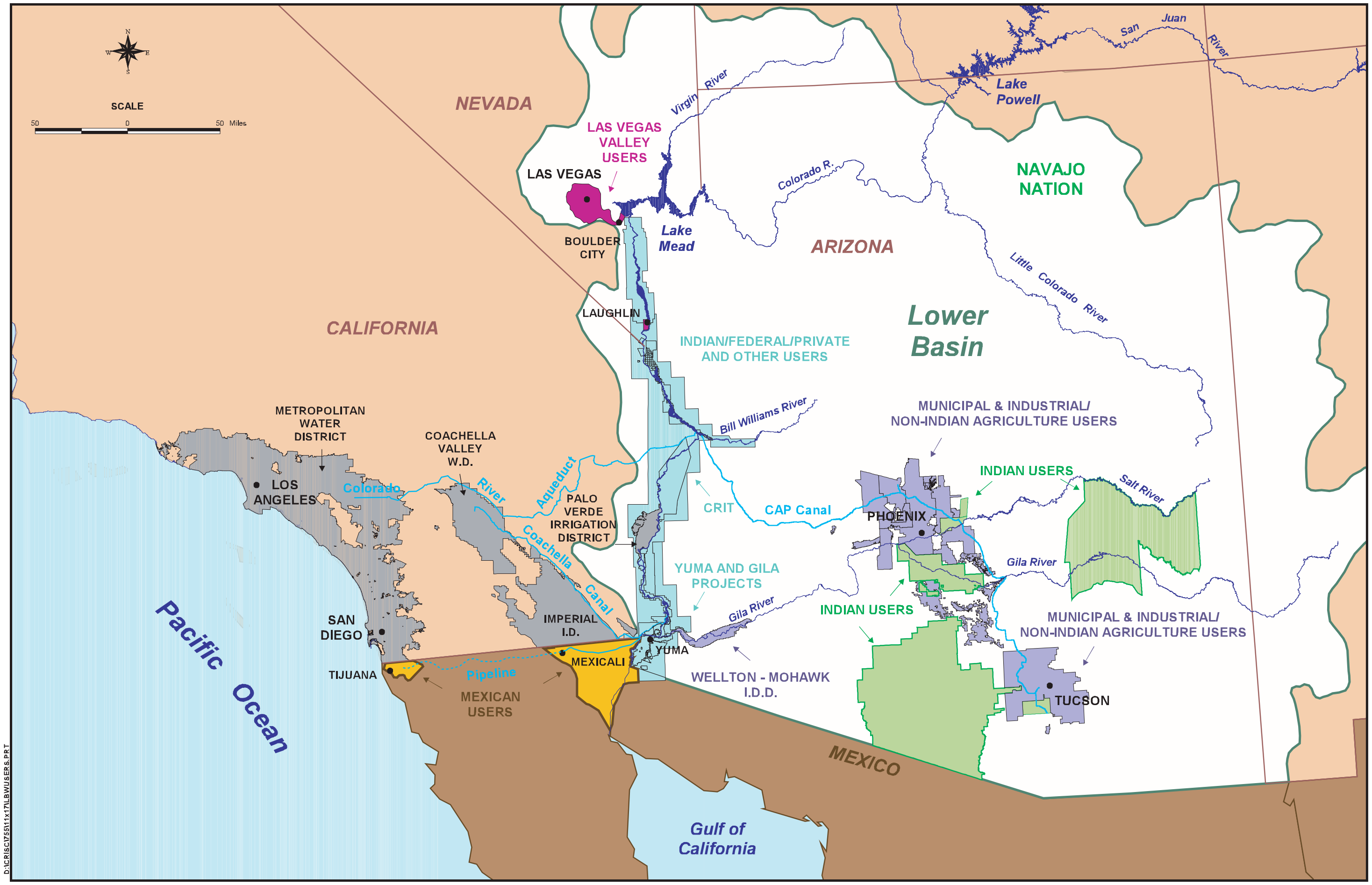
The model was used to produce estimates of future water supply deliveries for the Lower Division states and Mexico under the modeled hydrologic conditions. The modeled water demands of the Lower Division states reflect demand projections provided by the water users as described in Section 3.3.3. A copy of the demand schedules used to model the Lower Division states' depletions is included in Attachment H. The demand schedule used to model the Upper Division states' depletions is included in Attachment K.

The output from each model run included monthly and annual diversions, return flows and depletions for the Colorado River water users in af. The water supply data was analyzed using statistical methods and focused upon the comparison of the model results of the surplus alternatives to baseline conditions. See Section 3.3 for a further explanation of the modeling process.

3.4.3 AFFECTED ENVIRONMENT

The affected environment for water supply consists of the Colorado River from Lake Powell to the SIB, including the mainstream reservoirs. Geographically, the affected environment is bounded by the reservoir shorelines at maximum reservoir levels and the 100-year flood plain of the affected intervening sections of the Colorado River. This zone includes all the diversion points for water users in the Lower Division states and Mexico. Map 3.4-1 presents the water service areas in the Colorado River Lower Basin.

Map 3.4-1
Colorado River Water Service Areas in the Lower Basin



3.4.3.1 WATER USE PROJECTION PROCESS

Three Colorado River water supply conditions are recognized in the operation of the river system: surplus, normal and shortage conditions, as discussed in Section 1.3.4.1. The Basin States provided Reclamation with revised estimates of projected water use under each of the three water supply conditions for use in the modeling for this FEIS. Copies of the depletion schedules used to model the Upper and Lower Division states' demands are presented in Attachments K and H, respectively. Second level shortage amounts are computed within the model as described in Section 3.3.3.4. The states' requests are distributed among the major diversion points along the river system. The projections for normal water supply conditions reflect each state's water supply apportionment from the Colorado River.

3.4.3.2 STATE OF ARIZONA

The portions of Arizona in the Lower Basin that depend on Colorado River mainstream water consist of the following areas:

- The lower Colorado River from Lake Mead to the SIB;
- The Gila River Valley upstream from Yuma, Arizona; and
- A large area in the central part of the state served by facilities of the CAP.

Under the BCPA and the Decree, Arizona receives on annual apportionment of 2.8 maf from the Lower Division states' total of 7.5 maf.

In addition, Arizona can also use up to 50,000 afy of water pumped from Lake Powell under the State's Upper Basin apportionment. Numerous districts and other entities that divert and distribute the water administer the contractual arrangements for the use of Colorado River water in Arizona. The Central Arizona Water Conservation District (CAWCD) administers the CAP water diversions. The Director of the Arizona Department of Water Resources has state statutory authority to represent the state in Colorado River water supply matters.

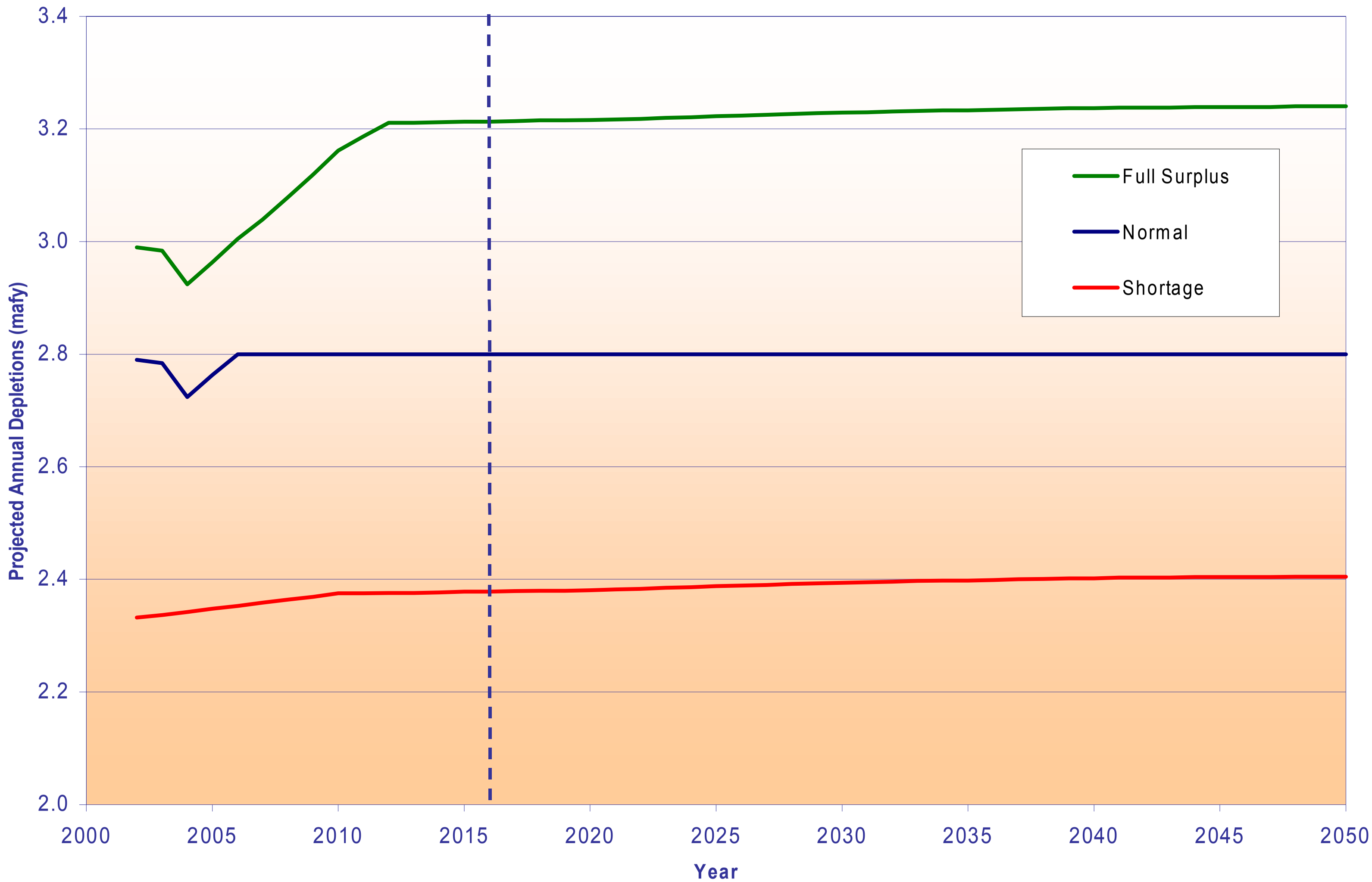
Arizona established the Arizona Water Banking Authority (AWBA) in 1996. The state legislation that authorized the AWBA states that it was created: 1) to increase Arizona's use of Colorado River water by delivering though the CAP system and storing water that otherwise would be unused by Arizona; 2) to ensure an adequate water supply to CAP municipal and industrial (M&I) users in times of shortages or disruptions of the CAP system; 3) to meet water management plan objectives of the Arizona state groundwater code; 4) to assist in settling Indian water rights claims; and 5) to provide an opportunity for authorized agencies in California and Nevada to store unused Colorado River water in Arizona for future use.

Arizona has numerous users of Colorado River water. The largest diversion of water is the CAP that delivers water to contractors in the central part of the state. CAP's diversion is located at Lake Havasu. The next three largest diversions are those of the Colorado River Indian Reservation at Headgate Rock Dam and the Gila and Yuma Projects, whose diversions are located at Imperial Dam. The remaining diversions serve irrigated areas and community development along the river corridor, including lands of the Fort Mojave Indian Reservation, water used by federal agencies in Arizona, the cities of Bullhead, Lake Havasu and Parker, Mojave Valley Irrigation District and Cibola Irrigation District. A portion of the water from the river corridor is also diverted by wells located along the river.

The CAP and other fourth priority Arizona users that contracted for Colorado River water after September 30, 1968, have the lowest priority. The exceptions are lower priority contractors that contracted for unused normal year entitlement and surplus year supplies when available. Included in the CAP category are Bullhead City, Lake Havasu City, Mojave Valley Irrigation District and others. For the most part, the non-CAP contracts total 164,652 afy. The non-CAP users include present perfected rights or other rights that predate the BCPA and users that contracted before September 30, 1968.

Under shortage conditions, initial shortages in the United States would be shared between Nevada and Arizona on a four and 96 percent basis, respectively. Within Arizona, if any use of water was occurring under contracts for unused entitlement, that use would be the first eliminated under shortage conditions. Any remaining reduction in Arizona would be shared prorata among the CAP and the non-CAP holders of fourth priority entitlements. More severe shortages would result in holders of higher priority entitlements having to incur reduction in their water use. For this FEIS, the analysis of Arizona's water supply under baseline conditions and the interim surplus criteria alternatives has been limited to an analysis of the effects of water availability on total Arizona diversions. Figure 3.4-1 presents a graphical illustration of Arizona's normal, full surplus and first level shortage condition depletion schedules that were used as input for the model. These data are presented in tabular form in Attachment H.

Figure 3.4-1
Arizona Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



Arizona's consumptive use of Colorado River water, including that used for groundwater banking, reached its normal year entitlement of 2.8 maf in 1997. However, its consumptive use since then has been less than this amount.

As shown on Figure 3.4-1, Arizona’s normal year depletion schedule is projected to reach 2.8 maf in 2006, and remains at that level thereafter. For the modeling, Arizona’s unused apportionment in 2002 through 2005 was distributed to MWD (73 percent) and SNWA (27 percent). The CAP’s projected normal year depletions are approximately 1.458 maf in 2002 and gradually decrease to 1.395 maf by 2050, which represent approximately one-half of the state’s total normal demand. The demands of Arizona’s non-CAP users meanwhile increase towards their full apportionment amount as time progresses making up the balance of Arizona’s normal 2.8 maf apportionment.

The state’s projected full surplus depletions increase from 2.99 maf in 2002 to approximately 3.24 maf in 2050. The projected CAP surplus condition demand rises steadily from 1.658 maf to approximately 1.835 maf in 2012. Thereafter, the CAP surplus condition depletion schedule remains flat at approximately 1.835 maf. First level shortage condition depletions for Arizona increases from 2.332 maf in 2002 to 2.405 maf by 2050.

The modeled Colorado River water deliveries under the baseline conditions and surplus alternatives assumed that all Arizona shortages would be assigned to the CAP, as discussed in Section 3.3.3.4. Although it is recognized that under the current Arizona priority framework there would be some sharing of Arizona shortages between the CAP and users at the same priority, modeling at this level of detail was not necessary to analyze deliveries on a statewide basis.

Arizona’s basic strategy for meeting short-term shortages in CAP M&I supply centers on reduced uses for recharge, reduced agricultural deliveries and an increased use of groundwater. In addition to naturally occurring groundwater, Arizona has established a groundwater bank and it is currently actively storing CAP water that is excess to its current needs for future withdrawal. As discussed above, the AWBA administers the groundwater bank. Groundwater banking is occurring with the intent of providing a source for withdrawal during periods when the amount of Colorado River water available for diversion under the CAP priority is curtailed by shortage conditions. Additionally, CAWCD has stored a substantial amount of CAP water in central Arizona.

It is projected that CAP water will be used for groundwater recharge until about 2040 under normal and surplus conditions. This use will be terminated first in case of shortage. For other interim and long term contract users, agriculture has the lowest priority. Therefore, irrigation users will be reduced before CAP M&I or Indian users in case of shortage conditions. Most irrigation users have rights to pump groundwater as a replacement supply. The increased use of the groundwater supplies and the management of the groundwater basins are expected to be consistent with the state’s groundwater management goals.

When CAP diversions are limited to 1.0 maf during first-level shortage conditions, the impact before year 2020 would be to both groundwater recharge and agricultural users. After 2020, CAP M&I users would also be impacted by shortage conditions.

3.4.3.3 STATE OF CALIFORNIA

The Colorado River supplies about 14 percent of the water used in California by agriculture, industry, commercial businesses and residential customers. All of the Colorado River water used by California is used in the southern California region. Colorado River water is by far the most important source of water for southern California, accounting for over 60 percent of its water supply. During the last several years, the Colorado River has supplied up to 5.2 maf of the 8.4 maf of water used annually in southern California.

Under the BCPA and the Decree, 7.5 maf of Colorado River water is apportioned for consumptive use in the Lower Division states (California, Nevada and Arizona). In 1964, a United States Supreme Court decree established California's normal apportionment of 4.4 maf from within the Lower Division states' 7.5 maf apportionment. The 1979 and 1984 Supplemental Decrees also awarded present perfected water rights to Indian reservations along the Colorado River. The 1964 Decree granted California, Arizona and Nevada respectively 50 percent, 46 percent, and four percent shares of any surplus water the Secretary determines to be available for use by the Lower Division states.

In California, a priority system for the principal parties that claimed rights to Colorado River water was established by the *California Seven-Party Agreement of August 31, 1931*. The priority system allows water apportioned but unused by a senior priority holder to cascade down to the next lower priority. The *Seven-Party Agreement* limits a priority holder's use of this water to beneficial use exclusively on lands within the priority holder's service area. The water transfers that are being proposed to be implemented under California's *Colorado River Water Use Plan* will work within the framework of the *Seven-Party Agreement* and within the framework of the agreements that are executed to carry out those transfers.

Agriculture and present perfected rights have highest priority to about 90 percent of California's entitlement. The balance goes to the MWD, which provides wholesale water service to most of the communities within the southern California coastal plain. California's largest agricultural water agencies that rely on Colorado River water include the IID, Palo Verde Irrigation District (PVID) and the Coachella Valley Water District (CVWD).

Three major structures divert water from the Colorado River to California. Parker Dam impounds Lake Havasu, which supplies water for MWD's Colorado River Aqueduct on the California side of the state line and for the Central Arizona Project on the Arizona side of the state line. Palo Verde Diversion Dam supplies water to PVID's canal system. Imperial Dam diverts water to the All American Canal on the California side of the state line and to the Gila Gravity Main Canal on the Arizona side of the state line. The AAC is used to deliver water to the Yuma Project, IID and the CVWD.

California has relied on the Secretary's release of unused Nevada and Arizona Colorado River apportionments in accordance with Article II(B)(6) of the Decree for more than three decades. In recent years, Nevada and Arizona depletions have approached their apportionment amounts as a result of the completion of the CAP and rapid population growth in these states. Additionally, Arizona has started to bank its water (such as by groundwater storage) to protect against future shortages. As a result, there is currently not enough Nevada and Arizona unused apportionment to meet California's demand. Since 1996, California has received as much as 800,000 af above its annual 4.4 maf normal apportionment due to determinations by the Secretary of surplus conditions on the Colorado River through the AOP process.

The California Department of Water Resources projects that over the next several decades, California's overall demand for water will continue to increase. Urban demand is expected to outweigh projected declines in agricultural demand. For example, the Department's 1993 California Water Plan projected that urban water demand will increase by 60 percent from 1990 to 2020. However, California's ability to access Colorado River water beyond its normal apportionment may be limited for the following two reasons:

- Since Arizona and Nevada will be using their normal apportionment's, California's access to any substantial amount of water above its normal apportionment will depend on surplus determinations by the Secretary on a year-by-year basis. Under current Colorado River system management practices, such determinations are not certain, as they depend on conditions which change each year—namely snowpack runoff and reservoir storage.

- Even with a surplus determination, California's access is limited by the capacity of its delivery systems. Currently, the existing delivery system to urban users—the Colorado River Aqueduct—is operating at near capacity (approximately 1.3 maf per year).

If the amount of Colorado River water available for use in California was limited to the 4.4 maf normal apportionment, the immediate impact would fall mainly on the MWD because much of the allocation to California above normal apportionment now goes to urban users serviced by MWD. MWD (or its customers) would have to look to: 1) other California users of Colorado River water, namely the agriculture agencies, or 2) other sources—such as northern California water supplies—for about 700,000 af of the approximate two maf of MWD's normal annual water deliveries, which ranged between 1.5 maf and 2.6 maf during the 1990s.

California faces other issues that may impact the quantity or quality of the supply of Colorado River water to certain users. In particular, listing of additional endangered bird and fish species could reduce the amount of water available for non-environmental purposes. Also, Colorado River salinity control projects could impact the quantity and quality of future Colorado River water. Both the type of crops produced (high market value crops generally require water that is low in salinity) and the quality of southern California drinking water could change.

The Colorado River Board of California developed a plan for California to live within its normal apportionment of 4.4 maf. The Board's draft plan was previously referred to as the California 4.4 Plan (dated August 11, 1997) and addressed various water supply management issues that are focused on changes in the use, supply or transfer of Colorado River water. The draft plan was updated, renamed and re-released in May 2000 as the *California Colorado River Water Use Plan* (CA Plan). The CA Plan relies first on a variety of intrastate measures that either conserve water or increase water supplies. The plan also relies on measures that would make extra water available to California. (A discussion of the Colorado River Board's CA Plan and the various water supply and water resources management measures contemplated therein are presented in Section 1.4.1.)

California's use of Colorado River water reached a high of 5.4 maf in 1974 and has varied from 4.5 to 5.2 maf per year over the past 10 years. Limiting California to 4.4 maf per year would reduce California's annual water supply by approximately 800,000 afy. All or most of this reduction will be borne by MWD. While the water supply analysis under the FEIS is focused on the total California depletions, the assumption is made that the surplus deliveries that may become available would be managed and distributed by and between the California users in accordance with the proposed provisions of the CA Plan, the corresponding "Quantification Agreement" and associated cooperative programs. Most of these cooperative programs are between MWD or one of its member agencies and the agricultural water agencies. Under these programs, MWD will be able to use its basic Colorado River water apportionment plus water made available under water conservation and groundwater storage programs. These programs include the following:

- **Coachella Groundwater Storage Program -** Cooperative program with the Desert Water Agency and the CVWD that exchanges their State Water Project (SWP) entitlements for MWD's Colorado River water and provides storage of Colorado River water for future extraction by these two agencies.

- **Water Conservation Program with Imperial Irrigation District** - MWD and the IID entered into a water conservation agreement in December 1988. The agreement called for IID to implement various projects to conserve water including improving its water distribution system and on-farm management of water.

- **Test Land Fallowing Program in the Palo Verde Valley** - MWD and the PVID implemented a two-year test land-fallowing program from August 1, 1992 through July 31, 1994.

- **Demonstration Project on Underground Storage of Colorado River Water in Central Arizona** - Under a cooperative program with the CAP, MWD has placed 89,000 af and the SNWA has placed 50,000 af of unused Colorado River water in underground storage (groundwater banking) in central Arizona.

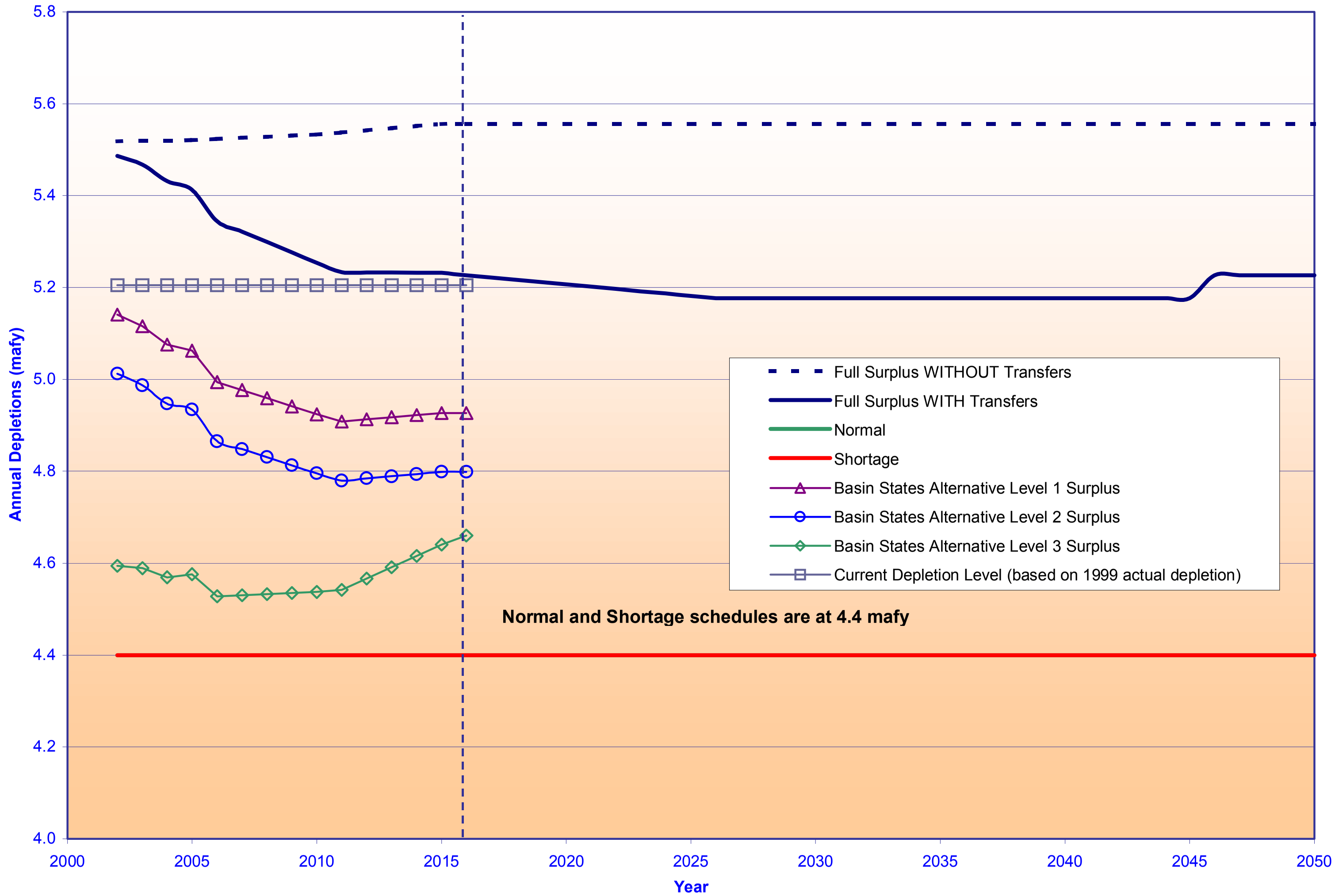
- **Agricultural-to-Urban Intrastate Water Transfers –** The SDCWA and IID have negotiated an agreement by which IID will transfer (sell) agricultural water conserved through various conservation and efficiency programs to SDCWA for urban use – where demand is growing. The agreement contemplates transfer of up to 200,000 afy. A number of bills have been introduced in the California Senate that attempt to address this and other similar intrastate water transfers, including SB 1011 (Costa), SB 1082 (Kelley), SB 1335 (Polanco) and AB 554 (Papan). To date, the legislature has enacted only SB 1082 which would facilitate a transfer of water between the IID and the SDCWA.

Figure 3.4-2 presents a graphical illustration of California's full surplus, normal and first level shortage demand schedules that were used as input to the model. Two full surplus depletion schedules are shown (with and without transfers). The sensitivity analysis that evaluated a baseline condition without intrastate transfers is provided in Attachment L. These two surplus schedules consider the fact that California anticipates a continued need for surplus water, when available, in order to implement the conjunctive use programs (e.g., groundwater banking) that will assist California in reducing its projected Colorado River depletion toward its normal apportionment of 4.4 mafy.

However, California’s full surplus schedule that considers the proposed intrastate water transfers is substantially less than the full surplus schedule without the transfers over time. This reflects the additional cooperative programs that would increase the amount of water transferred from agricultural agencies to MWD. Therefore, as a result of the Quantification Agreement, the cooperative programs, and the proposed increased intrastate transfers, the full surplus depletion schedules for California are reduced while at the same time, allowing MWD to continue to meet its users’ needs.

As illustrated by the graph, the Basin States Alternative provides an opportunity to manage the surplus deliveries coincident with the management of Lake Mead water levels while at the same time, providing a structure whereby total deliveries to California are reduced. These reductions are significant when compared to California’s current depletion level of 5.2 mafy, also shown on Figure 3.4-2. Both California’s normal and Level 1 shortage condition water depletion schedules are at 4.4 maf throughout the period of analysis.

Figure 3.4-2
California Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



3.4.3.4 STATE OF NEVADA

The portion of Nevada that depends on Colorado River water is limited to southern Nevada, primarily the Las Vegas Valley and the Laughlin area further south. The Colorado River Commission and SNWA manages Nevada's Colorado River water supply. The SNWA coordinates the distribution and use of the water by its member agencies whose systems provide retail distribution.

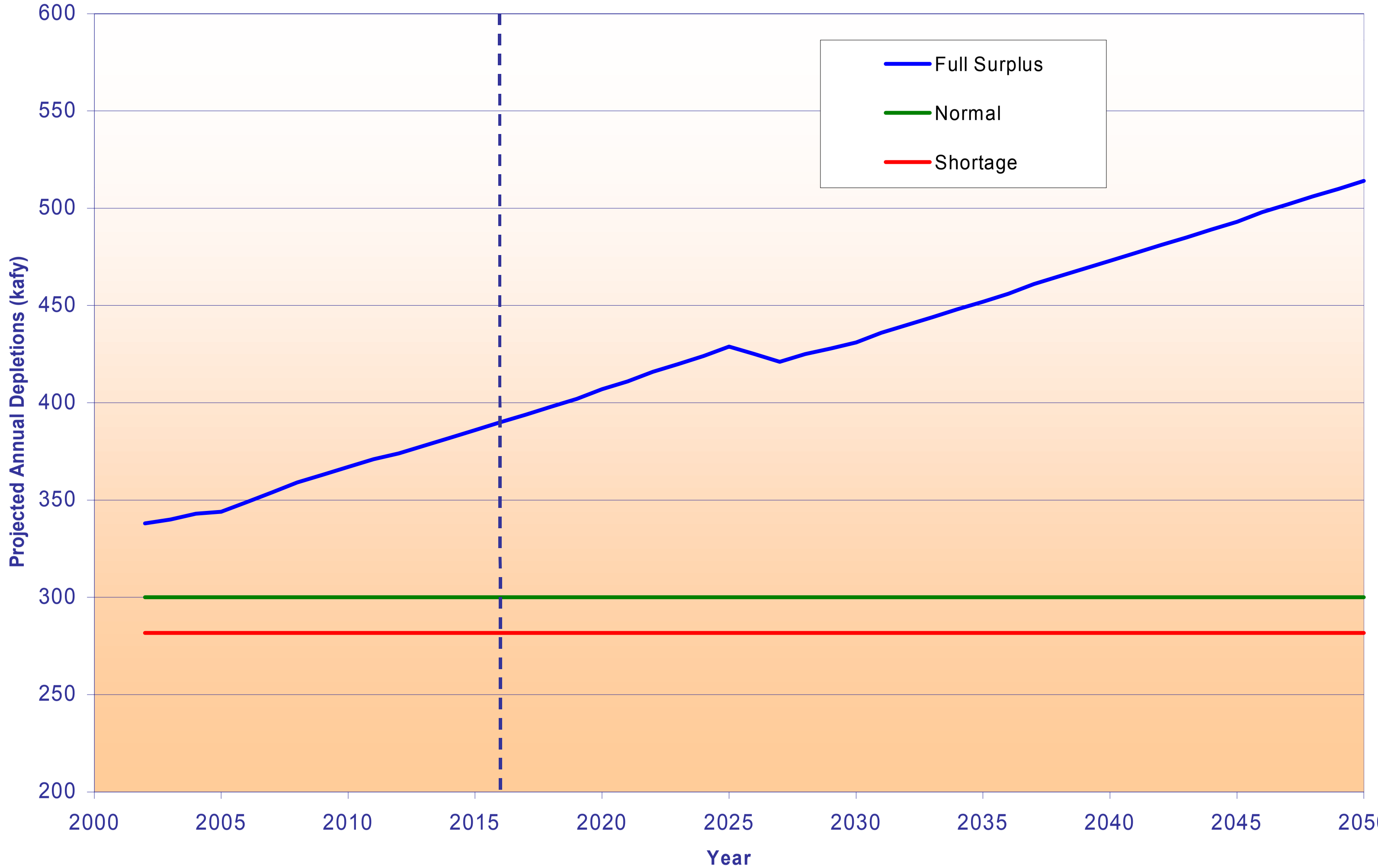
Nevada has five principal points of diversion for Colorado River water. The largest of these is the Las Vegas Valley that pumps water from Lake Mead at Saddle Island (on the west shore of the lake's Boulder Basin) through facilities of SNWA. The water is pumped at two adjacent pumping plants. The Lake Mead minimum water surface elevations for each intake are 1050 feet msl and 1000 feet msl, respectively. The pumped water is treated before being distributed to the Las Vegas Valley and to Boulder City water distribution systems. Three other diversion points are downstream of Davis Dam. They serve the community of Laughlin, Southern California Edison's coal fired Mohave Generating Station and uses on that portion of the Fort Mojave Indian Reservation lying in Nevada. The fifth diversion consists of water used by federal agencies in Nevada, primarily the National Park Service and its concessionaires at various points on lakes Mead and Mohave.

Nevada’s current Colorado River water demand is on the threshold of reaching its Colorado River normal water apportionment under the BCPA and the Decree of 300,000 afy. SNWA depletions represent approximately 90 percent of this amount. Figure 3.4-3 presents a graphical illustration of the full surplus, normal and first level shortage demand schedules for Nevada that were used as input to the model.

Nevada's water demand projections for full surplus years rise steadily from a current value of approximately 338,000 af to approximately 514,000 af in 50 years, the end of the period of analysis for this FEIS. Projected depletions under shortage conditions are approximately 282,000 afy over the period of analysis, reflecting the fact that Nevada’s reduction in consumptive use of Colorado River water is four percent of the total shortage during shortage years.

SNWA's Integrated Resource Plan calls for optimizing both the use of Colorado River water and the use of the Las Vegas Valley shallow aquifer before developing water from additional sources, including the lower Virgin River and Muddy River. The SNWA has been supporting groundwater recharge in the Las Vegas Valley through facilities of member agencies. The artificial recharge of Colorado River water into the Las Vegas Valley groundwater basin is intended to help meet summer peak demands, provide an interim future water supply and stabilize declining groundwater tables. Water agencies in the valley will be able to withdraw water to meet temporary shortfalls in supply. However, such withdrawals would be coupled with the opportunity for replenishment of the aquifer.

Figure 3.4-3
Nevada Projected Colorado River Water Demand Schedules
(Full Surplus, Normal and Shortage Water Supply Conditions)



Nevada also proposes to bank water in Arizona through arrangements with the AWBA using available groundwater storage capacity as described above in the discussion of alternate supplies for Arizona.

3.4.3.5 UPPER BASIN STATES

The depletions for the Upper Basin states were developed and submitted by the Upper Colorado River Commission (Commission) to Reclamation in December 1999. These depletions were then modified in coordination with the Commission to include updated Indian Tribe depletions provided by Keller-Bliessner Engineering, acting on behalf of the Indian Tribes with Colorado River water rights (see Attachment Q). Figure 3.3-4 shows that the Upper Basin depletions are approximately at 4.273 maf in 2002 and increase gradually to approximately 5.325 maf by 2050. These depletions do not include the evaporation losses that occur within the Upper Basin and that are estimated to be approximately 574,000 afy. The Upper Division depletion schedule that includes the estimated evaporation losses are presented in tabular form in Attachment K. The modeled depletions as shown on Figure 3.3-4 and presented in Attachment K are consistent with the Upper Division states' apportionment of Colorado River water.

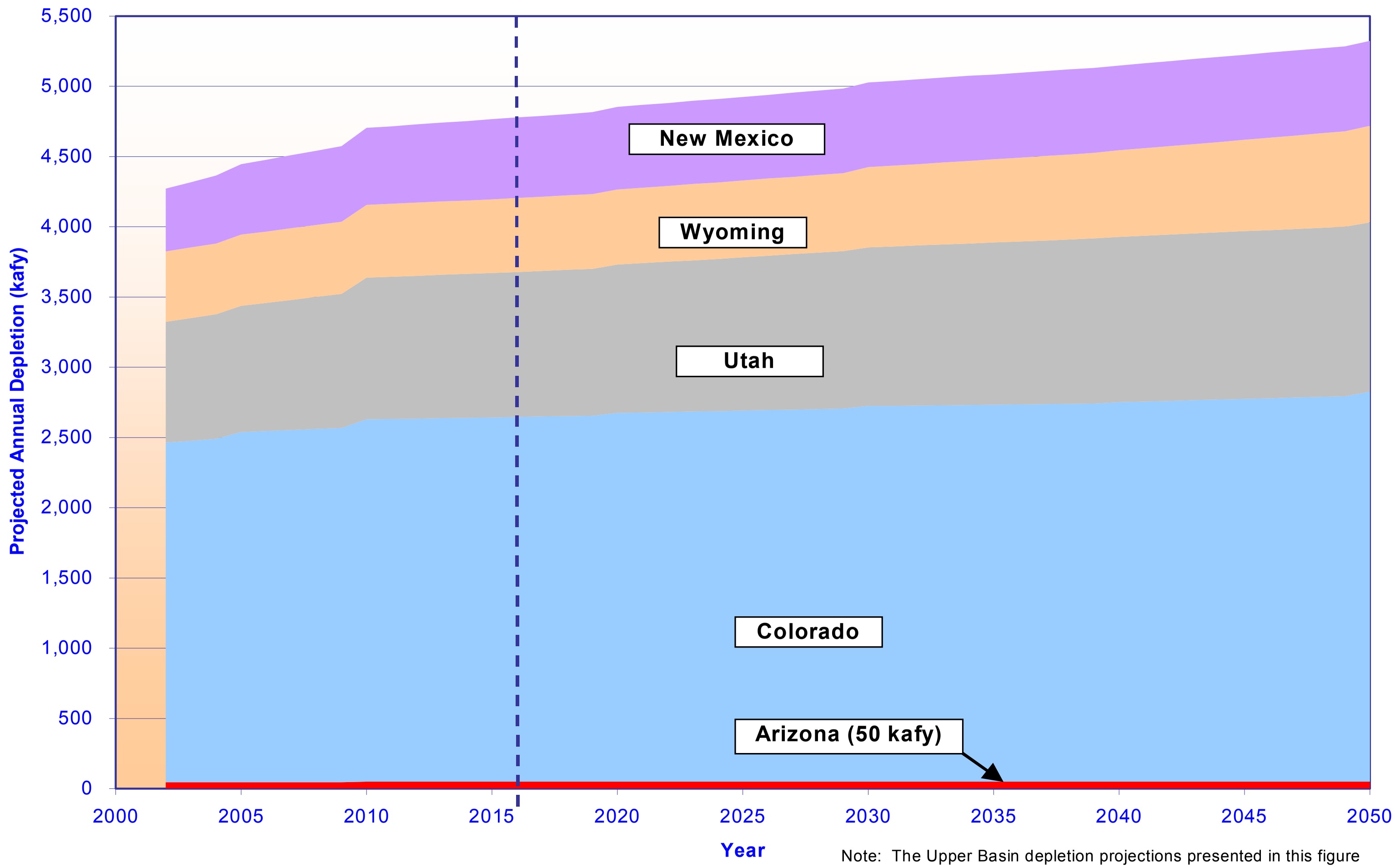
3.4.3.6 MEXICO

As discussed earlier in Section 1.3.2.2.3, Mexico has a Treaty entitlement to Colorado River water. This entitlement is set forth in Article 10 of the Treaty that states the following:

"Of the waters of the Colorado River, from any and all sources, there are allotted to Mexico:

(a) A guaranteed annual quantity of 1,500,000 af (1,850,234,000 cubic meters) to be delivered in accordance with the provisions of Article 15 of this Treaty.

Figure 3.4-4
Upper Basin Depletion Projections
(Based on 1998 Depletion Schedule)



Note: The Upper Basin depletion projections presented in this figure do not include the evaporation losses that are estimated to be approximately 574,000 afy.

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

Additionally, Minute 242 provides, in part, that the United States will deliver to Mexico approximately 1,360,000 acre-feet (1,677,545,000 cubic meters) annually upstream of Morelos Dam and approximately 140,000 acre-feet (172,689,000 cubic meters) annually on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Dam. It should be noted that while a portion of Mexico's 1.5 maf annual apportionment is actually delivered below Morelos Dam, the entire delivery to Mexico was modeled at Morelos Dam. This basic assumption, while different than actual practice, served to simplify and facilitate the analysis of water deliveries to Mexico under the baseline conditions and surplus alternatives.

3.4.4 ENVIRONMENTAL CONSEQUENCES

The following discussion is based on the results of analysis of water supply data generated by the model. The data evaluated consisted principally of data relating to the amount of water available for consumptive use in the Lower Division states under baseline conditions and the surplus alternatives during the 50-year period of analysis. Because differences between alternatives are at times small in relation to the quantities and time periods, it was necessary to compare the data in precise terms. However, it should be noted that the analysis is based on assumptions of water supply and operation conditions, as described earlier in Section 3.3, and that the results described below represent approximations of probable future conditions that become increasingly uncertain over time.

The time period for the analysis is 2002 through 2050. The analysis is based on depletion schedules for those years provided by the states and Tribes. Protection was provided for the water level of Lake Mead at elevation 1083 feet msl. As discussed earlier in Section 3.3, the elevation of 1083 feet msl is assumed to be the lower elevation at which the Hoover Powerplant can produce power efficiently.

The results are portrayed graphically in two ways. As discussed earlier in Section 3.3, the modeling process involved making 85 separate runs (traces) which were then examined for the range of water supply available in a given year under baseline conditions and the alternatives. One way that these results can be portrayed graphically is to plot the 90th percentile values (meaning that 90 percent of the values produced by the model were less than shown), the 50th percentile values (the median value) and the 10th percentile values (that 10 percent of the values produced by the model were less than shown). Plots of the maximum and minimum depletion values produced by the model for any given year were added to this "90-50-10" array. The plots for the annual depletions for the Lower Division states and Mexico under baseline conditions are presented in this section. The plots that depict the annual depletions under each of the five surplus alternatives are included in Attachment O.

A second way that the results are portrayed is derived by first ranking all the values for the entire interim surplus criteria period (2002 through 2016) and the subsequent period (2017 through 2050). The depletion values can then be plotted versus the percent of values that are greater than or equal to. This type of plot provides a cumulative distribution of the respective state's depletion and allows for a generalized comparison of the water supply available under baseline conditions and the surplus alternatives, for each period of time.

An important modeling assumption needs to be restated to provide a better understanding of the model results for the alternatives. The interim surplus criteria used for the Basin States, Flood Control, Six States, California and Shortage Protection alternatives become null and void after year 2016. At year 2017, the operating criteria for these surplus alternatives revert to a process that approximates the baseline conditions (modeled as the 70R surplus strategy). The criteria used to model the baseline conditions is effective throughout the 50-year period of analysis.

3.4.4.1 STATE OF ARIZONA

This section presents the simulated water deliveries to Arizona under the baseline conditions and surplus alternatives. The analysis of Arizona's water supply concentrated on total Arizona water depletions.

3.4.4.1.1 Baseline Conditions

The water deliveries to Arizona are projected to fluctuate throughout the 50-year period of analysis reflecting variations in hydrologic conditions. The 90th, 50th and 10th percentile ranking of modeled water deliveries to Arizona under the baseline conditions are presented in Figure 3.4-5.

With the exception of the first year modeled (2002), the 90th percentile line coincides with Arizona's depletion schedule during full surplus water supply conditions. As indicated by this 90th percentile line, the probability that the baseline conditions would provide Arizona's full surplus depletion schedule is at least 10 percent throughout the 50-year period of analysis.

The 50th percentile line represents the median annual depletion values. This 50th percentile line generally coincides with Arizona's projected depletion schedule under normal water supply conditions through year 2026 (see Figure 3.4-1). After 2026, the median values drop to approximately 2.39 maf and remains at approximately that level for the remainder of the analysis period. As previously noted and as reflected by the graph, Arizona's demands are not anticipated to reach its 2.8 maf entitlement until 2006.

As noted in Section 3.4.3.2, under shortage conditions, Arizona would bear 96 percent of the reduction and Nevada would bear four percent. In Arizona, the reduction would be shared prorata among CAP and non-CAP holders of fourth priority entitlements. To simplify the modeling process, the model sets the CAP's shortage condition deliveries at 1.0 maf when the Lake Mead water level is between elevation 1000 feet msl and the assumed shortage protection line as discussed in Section 3.3.3.4. This modeling assumption kept Arizona's annual deliveries above 2.3 maf until further cuts to the CAP were necessary to maintain the Lake Mead water level above the 1000 feet msl elevation (a Level 2 shortage condition). Under the baseline conditions, deliveries to Arizona below 2.3 maf were not observed to occur during the 15-year interim surplus criteria period. However, deliveries below 2.3 maf were observed during years 2017 to 2050 and occurred less than five percent of the time.

Figure 3.4-5
Arizona Modeled Annual Depletions Under Baseline Conditions
90th, 50th and 10th Percentile Values

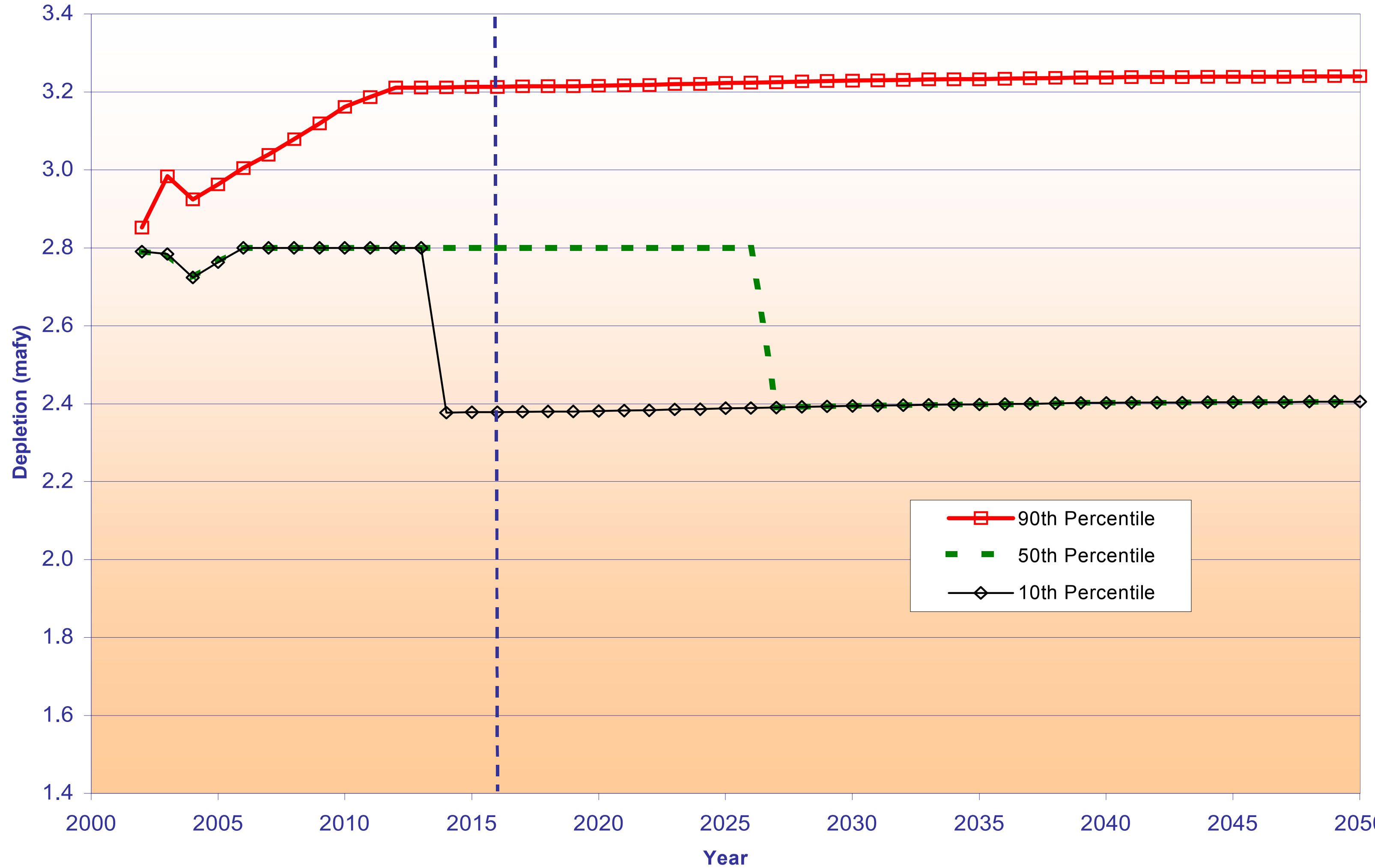


Figure 3.4-6 provides a comparison of the cumulative distribution of Arizona's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016). This type of graph is used to represent the frequency that annual deliveries of different magnitudes occur in the respective period. The results presented in Figure 3.4-6 indicate a 96 percent probability that Arizona's depletions would meet its normal depletion schedule during this period under the baseline conditions. The probability that Arizona would receive surplus condition deliveries during this period was approximately 29 percent. The maximum surplus condition depletions under the baseline conditions were 3.213 maf during this period. The probability that Arizona would receive shortage condition deliveries was less than four percent. The minimum shortage condition depletion was 2.375 maf.

Figure 3.4-7 provides a comparison of the cumulative distribution of the water deliveries to Arizona under the surplus alternatives to those of the baseline conditions for the 34-year period (years 2017 to 2050) that would follow the interim surplus criteria period. The results presented in Figure 3.4-7 indicate a 50 percent probability that water deliveries to Arizona would meet its normal depletion schedule during this period under the baseline conditions. The probability that Arizona would receive surplus condition deliveries during this same period under the baseline conditions was approximately 21 percent. The maximum surplus condition depletions under the baseline conditions were 3.24 maf during this period. The probability that Arizona would receive shortage conditions deliveries was approximately 50 percent. The minimum shortage condition depletion was 1.596 maf, representing second level shortage conditions that occurred less than five percent of the time during this period.

Figure 3.4-6
Arizona Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2002 to 2016

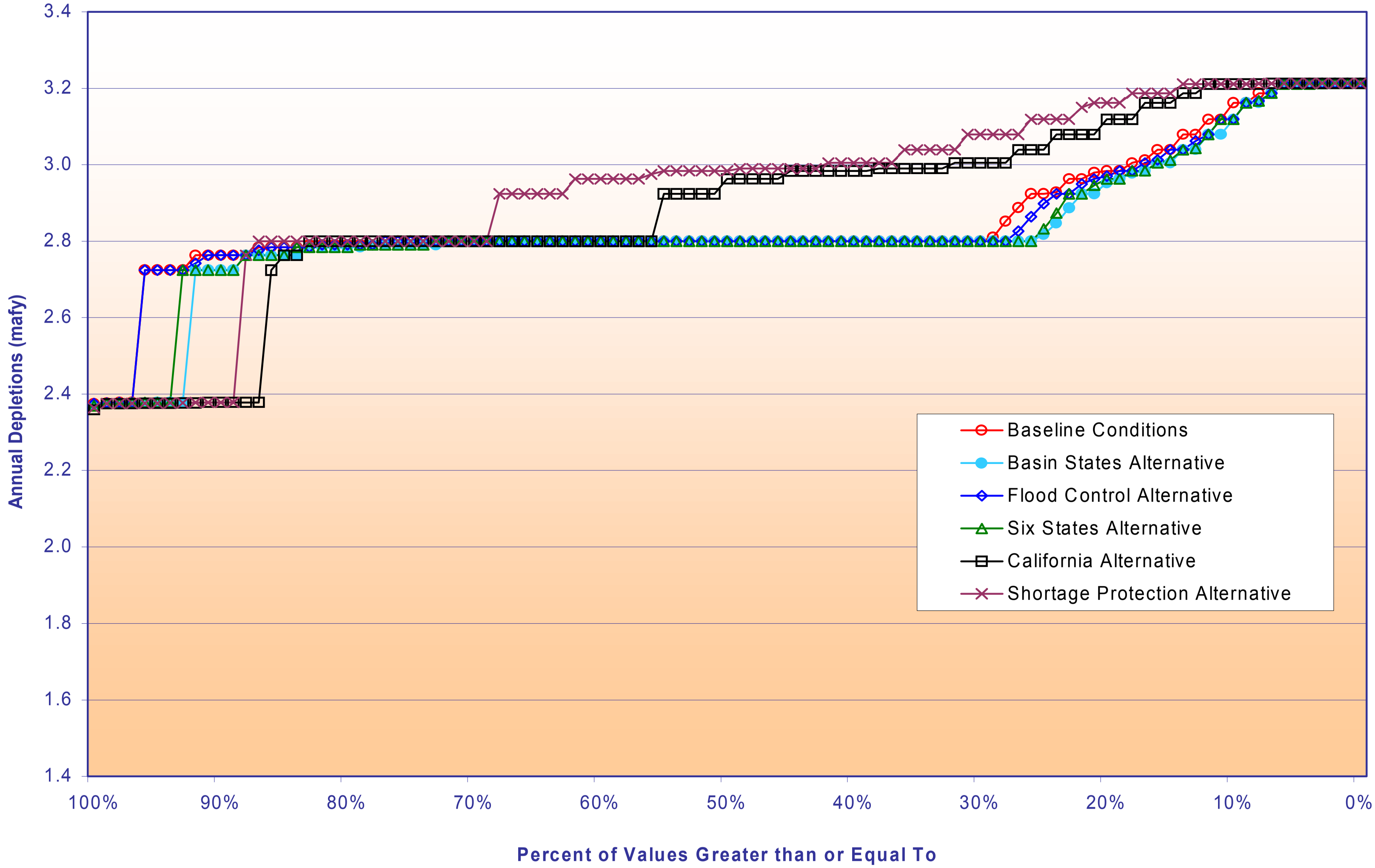
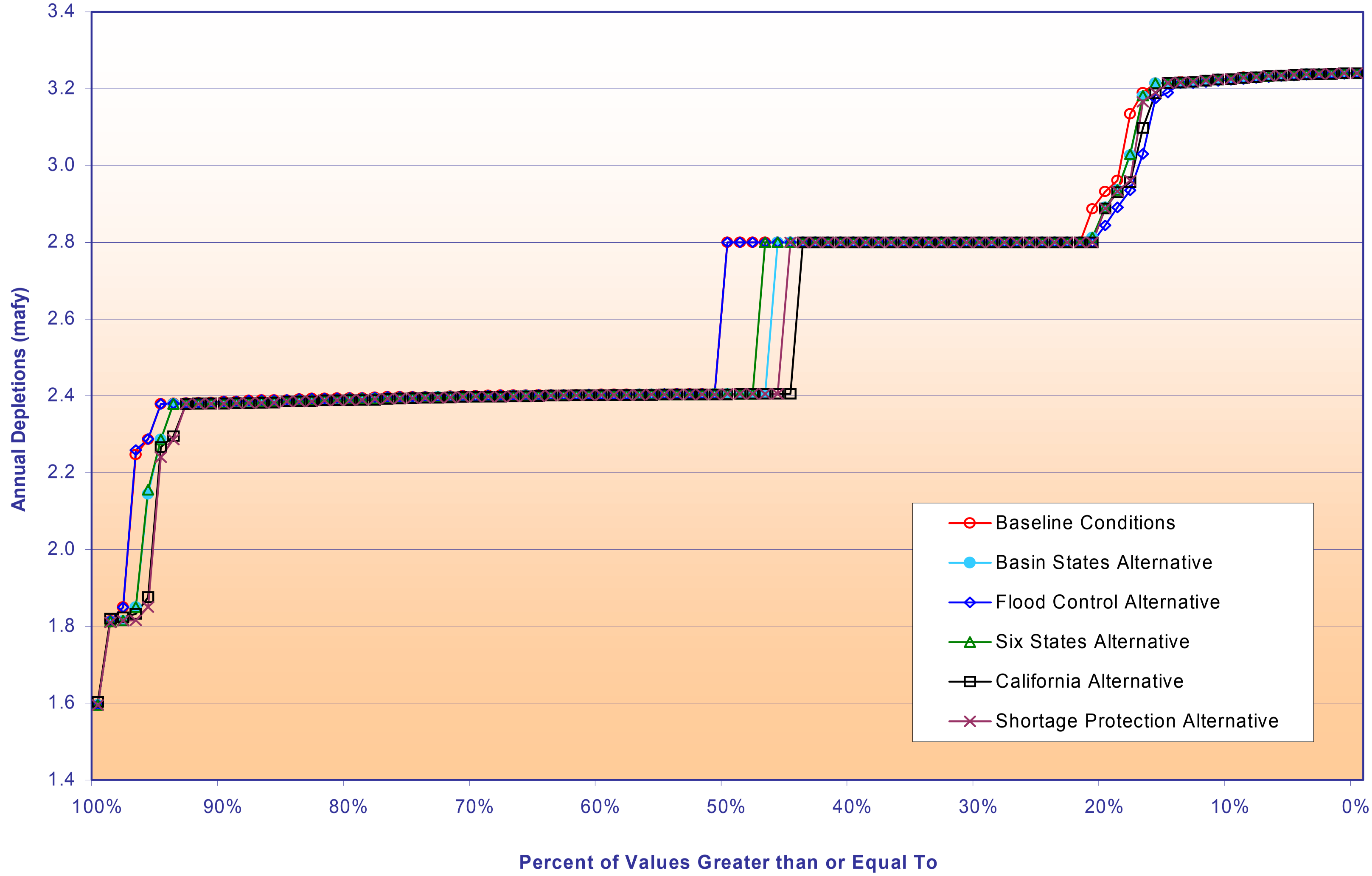


Figure 3.4-7
Arizona Modeled Depletions
Comparison of Surplus Alternatives to Baseline Conditions
Years 2017 to 2050



3.4.4.1.2 Comparison of Surplus Alternatives to Baseline Conditions

Figure 3.3-8 provides a comparison of the 90th, 50th and 10th percentile values for Arizona's modeled depletions under the baseline conditions to those of the surplus alternatives. As noted in Figure 3.4-8, there is little difference in the 90th percentile lines resulting from the surplus alternatives to those of the baseline conditions. The 90th percentile lines generally coincide with Arizona's surplus depletion schedule.

The 50th percentile lines for the baseline conditions, Basin States, Flood Control and Six States alternatives are essentially the same during the interim surplus criteria period and coincide with Arizona's normal depletion schedule. The 50th percentile lines for the California and Shortage Protection alternatives are identical to each other during the initial eight years and coincide with Arizona's surplus depletion schedule. The 50th percentile line for the Flood Control Alternative continues to coincide with the normal depletion schedule through year 2011. After 2011, the 50th percentile lines for the baseline conditions and all surplus alternatives are the same until 2023. Thereafter, the median values for the baseline conditions and surplus alternatives begin to fall due to increasing probability of the Level 1 shortages.

The 10th percentile lines for the baseline conditions and the surplus alternatives are essentially at or above Arizona's normal depletion schedule through year 2009. In 2010, the California and Shortage Protection alternatives drop to the Level 1 shortage depletion values followed by the Basin States and Six States alternatives and finally in year 2013, the baseline conditions and Flood Control alternatives. Thereafter, the 10th percentile lines for the baseline conditions and the surplus alternatives remain at this level through 2050.

Figures 3.4-6 and 3.4-7 presented comparisons of the cumulative distribution of Arizona's depletions under the surplus alternatives to those of the baseline conditions during the interim surplus criteria period (years 2002 to 2016) and the 34-year period that follows the interim surplus criteria (years 2017 to 2050), respectively. These graphs best illustrate the frequency that different amounts of annual Arizona water deliveries occur over these time frames. Table 3.4-1 provides a summary of the comparison for these two periods.

Table 3.4-1
Summary of Arizona Modeled Annual Depletions
Comparison of Surplus Alternatives to Baseline Conditions

Alternative/Conditions	Years 2002 to 2016			Years 2017 to 2050		
	Normal*	Surplus	Shortage	Normal*	Surplus	Shortage
Baseline Conditions	> 96%	29%	< 4%	50%	21%	50%
Basin States	> 92%	25%	< 8%	> 46%	> 21%	< 54%
Flood Control	>96%	27%	< 4%	50%	20%	50%
Six States	> 93%	25%	< 7%	> 47%	21%	< 53%
California	> 86%	55%	< 14%	> 44%	20%	< 56%
Shortage Protection	> 88%	68%	< 12%	> 45%	20%	< 55%

*The values under normal represent the total percentage of time that depletions would be at or above the normal depletion conditions.

The percentage values presented under the column heading labeled "Normal" in Table 3.4-1 represent the total percentage of time that depletions under the noted conditions would be at or above the normal depletion schedule amount. The values presented under the column labeled "Surplus" represent the total percentage of time that depletions under the noted conditions exceed the normal depletion schedule amount. The values presented under the column labeled "Shortage" represent the total percentage of time that depletions under the noted conditions would be below the normal depletion schedule amount.