Water Development and Diversification: Southern Nevada's Past, Present, and Future Water Needs

PRESENTATION TO THE OFFICE OF THE NEVADA STATE ENGINEER

Prepared by

SOUTHERN NEVADA WATER AUTHORITY

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Water Development and Diversification: Southern Nevada's Past, Present, and Future Water Needs

Submitted to:
Jason King, P.E., State Engineer
State of Nevada
Department of Conservation & Natural Resources
Division of Water Resources
901 S. Stewart Street, Suite 2002
Carson City, Nevada 89701

Pertaining to:
Groundwater Applications 54003 through 54021 in
Spring Valley
and
Groundwater Applications 53987 through 53992 in
Cave, Dry Lake, and Delamar Valleys

June 2011

Prepared by:
Southern Nevada Water Authority
Water Resources Division
P.O. Box 99956
Las Vegas, Nevada 89193-9956

Richard B. Holmes — 6/20/11

Richard B. Holmes
Deputy General Manager of Engineering/Operations — Date

Kay Brothers — 6-15-11

Kay Brothers
Former Deputy General Manager of Engineering/Operations — Date

John J. Entsminger — 6.20.11

John J. Entsminger
Asst. General Manager Strategic Initiatives — Date

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ACRONYMS

AWBA	Arizona Water Banking Authority
BOR	Bureau of Reclamation
CBER	Center for Business and Economic Research
CRSS	Colorado River Simulation System
FEIS	Final Environmental Impact Statement
ICS	Intentionally Created Surplus
ISM	Indexed Sequential Method
IWPAC	Integrated Water Planning Advisory Committee
LVVWD	Las Vegas Valley Water District
MWD	Metropolitan Water District of Southern California
NSE	Nevada State Engineer
SNWA	Southern Nevada Water Authority

ABBREVIATIONS

af	acre-foot
afy	acre-feet per year
amsl	above mean sea level
ft	foot
gpcd	gallons per capita per day
maf	million acre-feet

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1.0 PURPOSE

Nevada Revised Statutes Chapter 533 (Adjudication of Vested Water Rights; Appropriation of Public Waters) Section 370 (Approval or rejection of application by Nevada State Engineer (NSE): Conditions; exceptions; considerations; procedure) Subsection 1 states that the NSE shall approve an application submitted in proper form which contemplates the application of water to beneficial use if the applicant provides proof satisfactory to the NSE of the applicant's intention in good faith and reasonable expectation actually to construct the work and apply the water to the intended beneficial use with reasonable diligence. Furthermore, Subsection 6 states that in determining whether an application for an interbasin transfer of groundwater must be rejected pursuant to this section, the NSE shall consider whether the applicant has justified the need to import the water from another basin.

The purpose of this report is to demonstrate that the Southern Nevada Water Authority (SNWA) has a good faith intention and reasonable expectation to construct the Clark, Lincoln, and White Pine Counties Groundwater Development Project (hereinafter referred to as the Project) and to justify the need for the Project. The Project is necessary to secure the present and future water demands in southern Nevada, replace temporary water supplies and help insure against drought and durability of the Colorado River.

In October 1989, the Las Vegas Valley Water District (LVVWD) filed 146 applications with the NSE to appropriate groundwater in 27 hydrographic basins in eastern and central Nevada. The LVVWD's intent was to import this water to southern Nevada to meet the region's increasing water demands due to unprecedented population growth. Importation of groundwater from other hydrographic basins to meet the growing needs of Las Vegas was identified as an option in Water for Nevada: Nevada Department of Conservation and Natural Resources, Water Planning Report No. 3 (Scott et al., 1971). In addition, an application to appropriate Virgin River surface water also was filed in 1989.

Since 1989, 49 of the original applications have been withdrawn or transferred to entities other than the SNWA, which was formed in 1991 to address southern Nevada's regional water resources and infrastructure needs. The remaining applications were conveyed to the SNWA. In 1994, the NSE granted to the SNWA the annual maximum diversion rights to Virgin River surface flows of 190,000 afy with a not to exceed amount of 113,000 af of annual average diversion (see Ruling #4151 [NSE, 1994]).

This report summarizes changes in water resource demands and supplies since the formation of the SNWA, with specific emphasis on the importance of the Project in the SNWA's water resource portfolio. The SNWA has documented in annual water resource plans the need for additional permanent water supplies, such as the Project. The SNWA's Water Resource Plans demonstrate the dynamic and uncertain nature of resource planning and acquisition. This, coupled with the uncertainty caused by drought and climate change, justifies the need for a permanent resource independent from the Colorado River. The Project is necessary to:

- Meet water demands that are projected to increase in future years – Although current economic conditions have reduced near-term demands and conservation has reduced future demands, long-term growth is anticipated to continue, which will require additional resources.

- Replace temporary supplies such as groundwater banks – While the SNWA has finite temporary supplies available to meet near-term demands, these supplies will expire and are not renewable, and all demands must instead be met with permanent water resources.

- Replace supplies reduced due to drought conditions – The longevity of the existing drought and possible future sustained drought conditions are unknown. Reductions in water resources throughout the Colorado River Basin are expected to continue due to drought and climate change.

Supplies currently available to southern Nevada will not meet expected demands. Furthermore, Colorado River Basin shortages, as quantified in existing agreements, are likely to be declared, with additional shortages in future years anticipated to be much larger than those quantified in existing agreements. The threat of future shortages has made developing a water supply independent of the Colorado River critical. Together, these challenges present a number of concerns to the region's water managers, which heighten the need to acquire additional, permanent long-term water resources.

To this end, the SNWA is actively pursuing the development of in-state water resources. The Project is being pursued as a necessary future water resource for southern Nevada, and is a critical component of southern Nevada's water resource portfolio to ensure that current and future water needs are met.

2.0 BACKGROUND

Since its establishment in 1991, the SNWA has worked to address southern Nevada's water needs on a regional basis. The SNWA is a Nevada joint powers agency and political subdivision of the State of Nevada, which is governed by a seven member Board of Directors comprised of the Big Bend Water District, the City of Boulder City, the City of Henderson, the City of Las Vegas, the City of North Las Vegas, the Clark County Water Reclamation District, and the LVVWD. Together, these agencies provide water and/or wastewater services to nearly 2 million residents in southern Nevada (SNWA Water Resource Plan, 2009a) and more than 36 million annual visitors (GLS, 2010). The SNWA's mission is to manage the region's water resources and develop solutions that will ensure adequate current and future water supplies for southern Nevada. The agency's responsibilities include:

- Managing regional water resources and conservation programs.
- Allocating and distributing Colorado River water and any other water that becomes available to southern Nevada's water purveyors.
- Long-term water resource planning.
- Presenting a unified position on water issues facing southern Nevada.
- Building and operating regional facilities to provide a reliable drinking water delivery system to all member agencies.
- Ensuring regional water quality as determined by state and federal standards.

In 1994, the SNWA began an integrated resource planning process to identify the appropriate combination of resources, facilities and conservation programs to meet southern Nevada's present and future water demands. Through public interaction and stakeholder advisory committees, this process resulted in a series of SNWA-adopted recommendations that guide future planning efforts. Those recommendations included: develop a water resource plan to project future demands; develop water resources to meet those demands with top priority on Colorado River water resources; and implement a conservation goal and conservation incentive program.

Although the SNWA received Virgin River water rights in 1994, the Bureau of Reclamation (BOR) interprets the "Law of the River" to consider Virgin River flows with a post-1929 priority date to be part of the Colorado River once it reaches Lake Mead. Therefore, to develop Virgin River water rights, the river must be diverted above Lake Mead and piped to Las Vegas and treated. Due to infrastructure and treatment costs, environmental concerns related to such a large diversion, and the stakeholder advisory committee's recommendation to place priority on Colorado River resources, a decision was made not to pursue development of the Virgin River at that time.

The recommendation to put top priority on development of Colorado River water resources led to discussions with Arizona regarding banking their unused apportionment for future use by Nevada, and discussions with the BOR and the seven Colorado River Basin States (Basin States) regarding using additional Colorado River water for municipalities during high storage conditions in lakes Powell and Mead. By 2000, these discussions had resulted in an agreement with the Arizona Water Banking Authority (AWBA) to use their best efforts to bank 1.25 maf for Nevada's future use, and in 2001 the BOR issued the Interim Surplus Guidelines, which establish a category of surplus called Domestic Surplus, that provided additional Colorado River supplies to the SNWA if the elevation of Lake Mead is over 1,125 ft amsl. Both this Domestic Surplus supply and the 1.25 maf banked in Arizona were temporary supplies to meet demands in southern Nevada while allowing time to develop other permanent supplies. The SNWA's plans for permanent supplies were the Project, and working with the other Basin States and the BOR to obtain approval to utilize Virgin River rights and purchased Muddy River rights by diverting them from Lake Mead at Saddle Island.

In 2000, the Colorado River began to experience drought conditions that have been more severe than any other in recorded history—in 2002, Colorado River Basin inflows were 25 percent of average. Given these persistent drought conditions, the probabilities for additional supplies from Domestic Surplus declined with the water level of Lake Mead. In response to the loss of these supplies and continued population and economic growth, the SNWA began to implement a Drought Plan (SNWA, 2005a) and to accelerate the development of in-state water resources, which included the Project.

In 2004, the SNWA's Board of Directors adopted a Concepts Document (SNWA, 2004b) to outline the development of in-state water resources, including the Project, and incorporated in-state water resources into their long-term planning efforts. Also, in December 2004, the SNWA's Board of Directors adopted an amendment to the agreement with Arizona that guaranteed Nevada 1.25 maf for future use while limiting the annual amount available to 40,000 afy, consumptive use. The reason for the annual limitation was Arizona's concern regarding Nevada's reliance on this water. A limitation assured that Nevada had to quickly develop a permanent replacement. The SNWA also convened an Integrated Water Planning Advisory Committee (IWPAC) that included 29 stakeholder representatives from the metropolitan Las Vegas area, as well as representatives from Lincoln, Nye and White Pine counties, and the Moapa and Virgin Valley water districts. The committee worked for more than a year to explore various options and scenarios for in-state water resource development. The committee finalized 22 recommendations that were presented to the SNWA's Board of Directors in November 2005. Pursuing development of all in-state water resources, including the Project, was one of the recommendations from the committee. Also in this time frame, the SNWA was participating with the BOR and the Basin States to amend the Interim Surplus Guidelines to include shortage criteria and operating criteria for the major reservoirs.

In 2007, the Secretary of the Interior signed and issued a Record of Decision, thereby creating the first set of guidelines in the history of the Colorado River Compact to manage Lower Basin shortages and coordinate operation of lakes Powell and Mead (Record of Decision concerning Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, DOI, 2007). Known as the "Interim Guidelines," the decision provides an opportunity for Lower Basin States to convey water resources to the Colorado River for Intentionally Created Surplus (ICS) credits. The SNWA is participating in four ICS projects, including Virgin/Muddy River Tributary Conservation ICS, Coyote Spring Valley Groundwater Imported ICS, Brock Reservoir

System Efficiency ICS, and the Yuma Desalting Plant System Efficiency ICS. Of these, only the Tributary Conservation ICS and Imported ICS projects are available during shortage and are therefore considered permanent resources for southern Nevada.

As mentioned above, tributaries to the Colorado River, such as the Virgin River, are considered by the BOR and various Basin States to become Colorado River water when they join the main stem of the Colorado River. Some Basin States even consider tributaries to be a part of their state's Colorado River allocation. As part of the negotiations for the Interim Guidelines, the BOR and other Basin States agreed to let Nevada receive credit for Virgin and Muddy River rights that were granted prior to the effective date of the Boulder Canyon Project Act in 1929. As stated above, these credits are called Tributary Conservation ICS. In return for this consideration, and the consideration that Nevada would receive the first 75,000 af of water resulting from any project to augment the Colorado River, Nevada agreed not to pursue its 1994 Virgin River surface water rights until at least 2014 (see Section 8, *Agreement Concerning Colorado River Management and Operations*, on p. 9). This was a significant compromise in the negotiations surrounding the Interim Guidelines.

Since the first Water Resource Plan, the SNWA has been working to develop the Project as a necessary resource to meet the region's existing and projected water demands. In 2004, the SNWA submitted a right-of-way application to the U.S. Department of the Interior, Bureau of Land Management to construct, operate, and maintain the Project, which includes pipelines, pumping stations, flow regulation/storage facilities, a treatment and storage reservoir facility, pressure reducing stations, power lines, and electrical substations. The Project would develop and convey up to 217,655 af of water per year, including up to 184,655 afy of the SNWA's water rights and applications (with the remaining capacity provided for Lincoln County).

Under normal Colorado River conditions, the SNWA has concluded, in its 2009 Water Resource Plan (SNWA, 2009a), that Project water would not be needed until 2020. However, this report concludes that if severe drought conditions in the Colorado River Basin persist, resulting in greater shortages than provided for in existing agreements, a significant portion of the SNWA's Colorado River water resources could become unavailable. For the analysis found in Appendix A and the discussion in Section 8.0 of this report, an "Extended Shortage" would occur during the third consecutive year of shortage; under this circumstance, this report assumes Nevada's basic Colorado River apportionment would be reduced by 40,000 afy of consumptive use and that water from the Arizona Water Bank would not be available. In this case, the Project water will be critical and needed immediately for southern Nevada.

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3.0 WATER RESOURCE PORTFOLIO

This section includes an overview of the resources included in the SNWA's water resource portfolio. The various water resource plans are discussed in later sections.

3.1 Permanent Supplies

3.1.1 Colorado River Water

- Nevada Basic Apportionment: Through the Boulder Canyon Project Act and later affirmed in the U.S. Supreme Court's decision in *Arizona v. California* 373 U.S. 546 (1964), Nevada is allotted 300,000 afy of Colorado River water for consumptive use. The amount contracted to the SNWA and its member agencies is approximately 272,000 afy, plus all surpluses.

- Return-flow Credits: Water that is withdrawn from the Colorado River system but later returned, primarily as highly-treated wastewater flows, is credited for future use. These "return flows" allow the SNWA to extend the use of its Colorado River water supplies by approximately seventy percent, and represent a significant portion of the region's permanent Colorado River water resources.

- Intentionally Created Surplus:

  - Virgin/Muddy River Tributary Conservation ICS: The SNWA can develop the full, consumptive use of up to 95 percent of its purchased and leased Muddy and Virgin rivers water rights with a priority date that precedes the Boulder Canyon Project Act (i.e. 1929). Although agreements allow for the SNWA to develop up to 50,000 afy of its Virgin/Muddy River water rights, which does not include 1994 Virgin River rights, the SNWA anticipates that approximately 30,000 afy of consumptive use rights will be acquired on the Muddy and Virgin Rivers and conveyed to Lake Mead for ICS credits. In 2009, the SNWA delivered slightly less than 27,000 af of Virgin/Muddy River water for credit. Tributary Conservation ICS can be created and used during any Colorado River operating conditions, including shortages.

  - Coyote Spring Valley Groundwater Imported ICS: Although agreements allow for the SNWA to develop up to 15,000 afy of groundwater for the development of Imported ICS credits, the SNWA anticipates that approximately 9,000 afy will be developed. To date, the SNWA has 9,000 af of groundwater in Coyote Spring Valley.

3.1.2 Groundwater

The SNWA has acquired and continues to develop a significant number of groundwater resources. These resources are intended to provide southern Nevada with a more balanced mix of Colorado River water and non-Colorado River water than currently exists.

- Las Vegas Valley Groundwater: Municipal groundwater rights are a critical component of southern Nevada's water resource portfolio. The Las Vegas Valley Groundwater Basin is fully appropriated with little opportunity to seek additional water rights. The City of North Las Vegas and the LVVWD have permanent groundwater rights totaling 5,711 afy and 40,629 afy, respectively. These groundwater rights are instrumental in meeting peak summer water demands.

- In-state Groundwater: The SNWA and its member agencies have a number of other groundwater permits and applications in southern and eastern Nevada, which include:

  - 2,200 afy of groundwater rights in Garnet and Hidden valleys are held by the LVVWD, most of which has been leased to dry-cooled power plants.

  - 10,600 afy* of groundwater rights in Three Lakes Valley North and South and Tikaboo Valley North and South. The SNWA is working to develop options for development of these groundwater permits in Three Lakes Valley North and South, and Tikaboo Valley South.

  - 184,655 afy* of groundwater rights and applications that would be developed under the Project. The 184,655 afy is the sum of 91,224 afy Spring Valley applications; 8,000 afy Spring Valley agricultural water rights; 11,584 afy Cave Valley applications; 11,584 afy Dry Lake Valley applications; 11,584 Delamar Valley applications; and 50,679 afy Snake Valley applications. The specific amount of water requested at these hearings is found in Burns and Drici (2011).

  *Groundwater rights utilized in the Las Vegas Valley equate to 1.7 times the right due to return flow credit methodology. Therefore, these amounts would equate to 18,020 afy and 313,914 afy.

3.1.3 Reclaimed Resources

Direct reuse of reclaimed Colorado River water, which provides advantages in terms of environmental sustainability and costs, does not extend southern Nevada's Colorado River allocation. The reason for this is that an increase in reuse will offset or reduce the amount of water available for return-flow credit.

3.1.4 Conservation

The community has adopted permanent conservation measures (land use development codes, tiered water rates, and water use ordinances), as well as implemented a number of conservation education and incentive programs that focus on reducing water use. This combination of regulation, education, water pricing and incentives has contributed to a reduction in consumptive use of approximately 80,000 af between 2002 and 2010, despite the addition of approximately 400,000 residents during that time. While conservation is a vital tool in reducing overall demands and extending available supplies, it does not reduce the region's dependence on Colorado River water supplies.

3.1.5 Colorado River Augmentation

As part of the Basin States Agreement, the SNWA has agreed to put development of its 1994 Virgin River water rights on hold until at least 2014 in exchange for agreement with the other Basin States to cooperatively pursue 75,000 afy of permanent water supplies to augment the Colorado River for Nevada, and for the establishment of Tributary and Imported ICS. If SNWA deems that reasonable progress is being made in those areas, SNWA will continue to forego development of its 1994 Virgin River water rights in favor of this augmentation water.

3.2 Colorado River Transfers and Exchanges

Water transfers involve moving water resources from willing sellers to willing buyers. Full-scale transfers and exchanges are still in the distant future. To put this in perspective, the Interim Guidelines, which are in effect through 2026, do not provide for state-to-state transfer of ICS. The state that develops the ICS must utilize it in the future. There still is great apprehension within the Basin States regarding transfers or exchanges among states. Examples of transfers and exchanges include desalination, both seawater and brackish water, and transfers of conserved water. While Colorado River water resources are an important and indispensable part of the SNWA's water resource portfolio, developing additional Colorado River water resources will not resolve supply shortages associated with drought conditions and climate change. All Colorado River water resource options, including transfers and exchanges for desalinated water and other innovative water resource options, require that there be sufficient water levels in Lake Mead to support the SNWA's withdrawal and use of these water resources. Climate change impacts on the Colorado River are potentially significant and could further limit the availability of the resource.

3.3 Temporary Supplies

A number of the supplies currently outlined in the SNWA's water resource portfolio are not permanent, long-term supplies for the community. Rather, these temporary supplies are used to bridge supply gaps until additional long-term renewable water resources are available. Outlined below is an overview of the SNWA's temporary water supplies, as well as several additional options planned for future development:

3.3.1 Unused Apportionment

Under the Law of the River, Lower Basin States are allowed to use the unused basic apportionment of another state. Arizona and California plan on using or banking all of their apportionment in the future, thus the SNWA is not planning on the availability of other states' unused apportionment. The SNWA also has a right to Nevada's unused Colorado River water. In recent years, a portion of Nevada's apportionment contracted to other Nevada users has been unused, and the SNWA has utilized this water. However, availability of this water is expected to decline in the long-term.

3.3.2 Flood Control Surpluses

When surpluses are available on the Colorado River, either through a federal declaration or unused apportionments, Nevada is entitled to utilize these unused resources. If Colorado River water in excess of 7.5 maf is forecasted to be available for release for the Lower Basin States, the Secretary of the Interior can declare a surplus condition. Typically, surpluses have been historically limited to "flood control" surpluses, allowing the Lower Basin States to utilize excess water to control flooding.

3.3.3 Domestic Surplus

In response to years of high storage content in Colorado River reservoirs, the Secretary of the Interior implemented the Interim Surplus Guidelines in 2001, which were later modified and extended in 2007 by the Secretary of the Interior, to manage additional supplies within the Basin. The Interim Surplus Guidelines provided for Domestic Surplus, which provides Nevada with surplus water resources when Lake Mead reaches specific elevations.

3.3.4 Brock Reservoir System Efficiency ICS

The Brock Reservoir (formerly named Drop 2 Reservoir) was constructed in California to recover and store Colorado River water that was ordered but not diverted, and that would otherwise go unused and flow into Mexico. The SNWA has agreed to fund a portion of the project in return for a portion of the water resources that would be saved by this facility. The water available for use by southern Nevada is limited (up to 40,000 afy and a total of 400,000 af), and is considered a temporary supply until the amount is exhausted or until 2036, whichever is sooner. This resource is not available during declared shortages.

3.3.5 Arizona Water Bank

The SNWA acquires storage credit by paying the AWBA to bank a portion of Arizona's Colorado River allocation, or other available Colorado River water, in Arizona's underground aquifer. Currently, southern Nevada has access to 1.25 maf of water in this bank, which the SNWA could recover up to 40,000 afy consumptive use (until the banked reserves have been fully exhausted). To recover this water, Arizona uses the banked resources and exchanges an equal amount of its Colorado River water to the SNWA, which is diverted from existing facilities at Lake Mead.

3.3.6 California Water Bank

Through agreements with the Metropolitan Water District of Southern California (MWD) and the BOR, the SNWA may direct a portion of Nevada's unused Colorado River water for storage with MWD until it is needed. Nevada can recover up to 30,000 afy from the banked reserve, with recovery beginning in 2022 unless Colorado River shortage conditions warrant earlier recovery. The SNWA has banked 70,000 af in the California Water Bank through 2010.

3.3.7 Southern Nevada Water Bank

Nevada's unused Colorado River water is artificially recharged to the Las Vegas Valley Groundwater Basin using recharge wells during the winter months or via in lieu credit by pumping of available permanent groundwater rights. Approximately 360,000 af of water has been recharged in the Las Vegas Valley Groundwater Basin, which has resulted in groundwater levels rising, recovering about 100 ft amsl in the central Las Vegas Valley from past overpumping. This water will be used as needed to meet future regional demands, but will most likely be limited to about 20,000 afy.

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4.0 HISTORY OF WATER RESOURCE PLANS

The SNWA's Cooperative Agreement (SNWA, 2002a) requires that a Water Resource Plan and Water Budget be approved annually by its Board. The Water Resource Plan is the planning document that assures purveyor members that there are sufficient resources to meet future demands to allow continued development in their jurisdictions. It also serves as the document the NSE utilizes to sign subdivision maps as required by Nevada Water Law.

Because of the importance of the Water Resource Plan as a planning document, the SNWA has employed an expert staff of planners, water resource managers, and engineers to evaluate and develop future supplies, as well as prepare the annual resource plan. The SNWA approved the first Water Resource Plan in 1996 (SNWA, 1996). The 2009 Water Resource Plan (SNWA, 2009a) represents the eighth revision in 15 years. During those 15 years, the Project has taken on various levels of importance and priority in the Water Resource Plan, with the criticality and importance increasing as unprecedented growth continued in southern Nevada. Growth was projected to require additional water supplies in spite of conservation efforts. The 2009 Water Resource Plan (SNWA, 2009a) demonstrates that the Project is critical to meet future demands as a replacement for temporary Colorado River water supplies, a supply for future growth, and a supply to buffer future reductions of Colorado River water resources due to shortages resulting from drought. In November 2010, the SNWA's Board of Directors voted to adopt the 2009 Water Resource Plan (SNWA, 2009a) for another year, as it continues to demonstrate the flexibility to meet expected future demands.

The following briefly discusses the evolution of the water resource plans, and the various factors that resulted in the changing of resource priorities in the plans and the importance of the Project.

4.1 1996 Water Resource Plan (SNWA, 1996)

This first Water Resource Plan (SNWA, 1996) projected needing additional water supplies around 2007. Demands between 2007 and about 2026 were going to be met with Arizona's unused Colorado River allocation. Arizona was not planning to use all of their Colorado River water allocation until around 2030. Virgin River and Muddy River water supplies, as well as the Project (then termed the Cooperative Water Project, which included many more applications and hydrographic basins than the current Project) were the primary water supplies to be developed to begin meeting demands in 2026.

Because of the BOR's interpretation of the "Law of the River," as discussed earlier, Virgin River resources were to be captured by diverting the river into an off-stream reservoir in the Mesquite, Nevada area, and treating and piping the water 70 miles to the Las Vegas area. Costs to construct these facilities were estimated at $638 million in 1992 dollars. In the 1996 plan (SNWA, 1996), it states that the SNWA had chosen not to pursue further construction of Virgin River facilities because of associated costs and environmental issues surrounding a large diversion. Instead, the SNWA would pursue additional Colorado River resources.

In 1996, the SNWA was beginning discussions with the Muddy River Irrigation Company and the Moapa Valley Water District regarding purchasing Muddy River water rights that were allocated before 1905. Because of environmental issues and construction and treatment costs, the preferred method to divert both the Virgin and Muddy rivers rights was from Lake Mead through the SNWA's Saddle Island facilities.

Water demands were projected to be 619,400 af in 2020 and 635,400 af in 2030 (Figure 4-1). Recommendations by the Integrated Resource Planning Advisory Committee were adopted by the SNWA's Board of Directors in 1995 (IRPAC, 1996) that placed top priority on developing future Colorado River water resources even though these water resources would be finite or temporary.

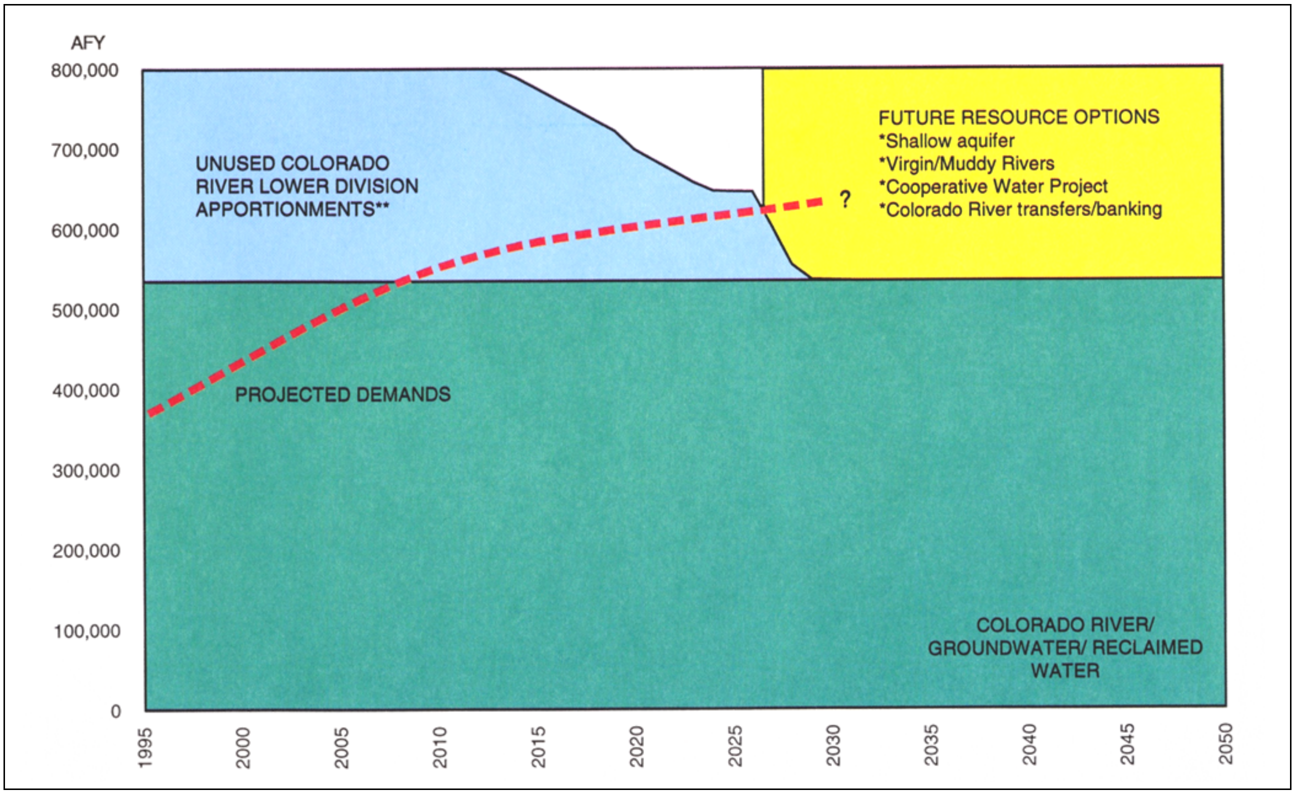


Figure 4-1
Meeting Demands 1996 Water Resource Plan

4.2 1997 Water Resource Plan (SNWA, 1997)

In 1996, the AWBA was formed to bank Colorado River water in Arizona for future use by Arizona municipalities in times of shortages on the Colorado River. Arizona has to take shortages before California, as a result of legislation that authorized the Central Arizona Project. This resulted in much less unused Arizona apportionment available to Nevada to meet future demands.

The SNWA was planning to rely on Colorado River water banked in the Las Vegas Valley and in Arizona in the early 1990s as a demonstration project to make up some of the difference. However, the AWBA provided an opportunity to bank Arizona's unused apportionment for other Lower Basin States. The SNWA began to discuss banking opportunities to meet a part of the SNWA's future demands. After 2026, the primary resources the plan showed the SNWA developing were Virgin River and Muddy River water, the Arizona Water Bank and the Southern Nevada Water Bank.

Please note, the preferred development of the Virgin and Muddy rivers rights after 2026 were to be "wheeled," or allowed to enter Lake Mead and diverted through the SNWA's intakes. The SNWA began purchasing Muddy River rights in 1997. Again, the BOR and some other Basin States did not consider this in compliance with the "Law of the River." The Virgin River pipeline and the Cooperative Water Project were listed as the last priority in future resource development. Water demands were projected to be 658,000 af in 2020 and 714,700 af in 2030 (Figure 4-2).

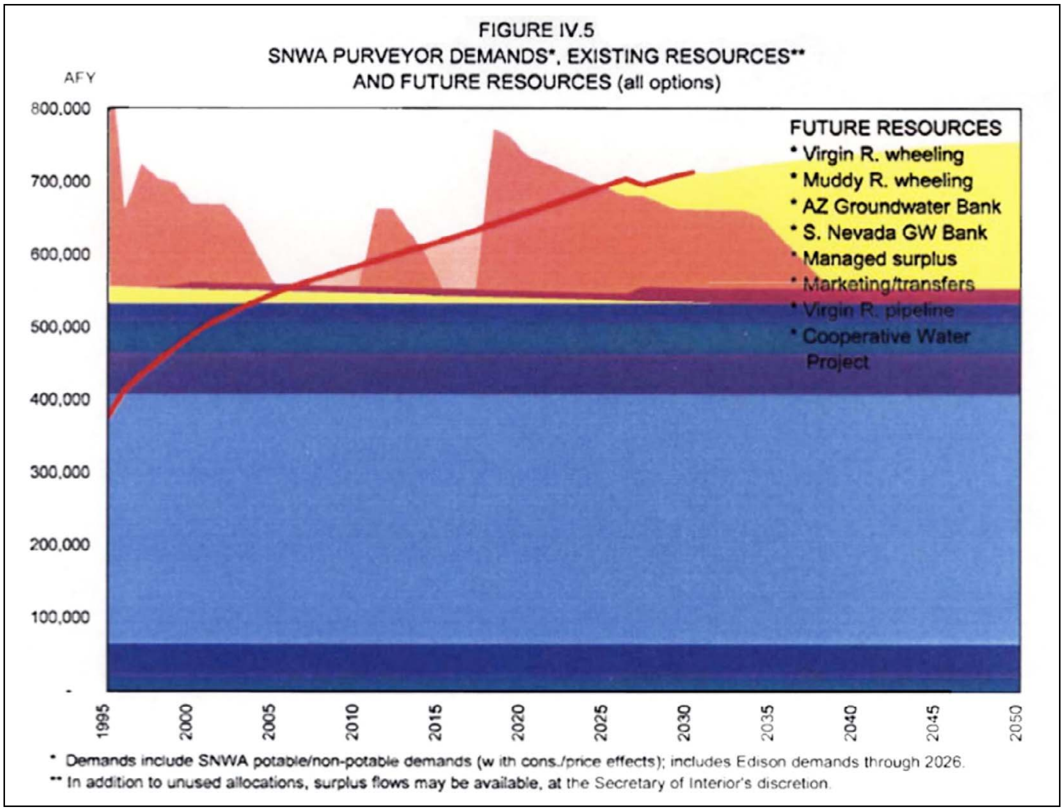


Figure 4-2
Meeting Demands 1997 Water Resource Plan

4.3 1999 Water Resource Plan (SNWA, 1999)

By 1999, the Basin States and the BOR were finishing agreements and regulations related to the Interim Surplus Guidelines, which provided for the use of Domestic Surplus Colorado River supplies. Domestic Surplus was a temporary supply that was expected to meet all or a portion of the SNWA's additional demands through 2016 as long as Lake Mead was above elevation 1,125 ft amsl. In 1999 and 2000, Lake Mead was above elevation 1,200 ft amsl.

Unused Arizona apportionment, the Arizona Water Bank, Virgin River water, Muddy River water, and the Southern Nevada Water Bank were to meet demands through 2050. Please note that all of these water supplies are temporary, except for the Virgin and Muddy rivers rights. While the Cooperative Water Project was not listed in the 1999 Water Resource Plan (SNWA, 1999), the need to replace temporary supplies in the future was apparent. Water demands were projected to be 640,100 af in 2020 and 660,500 af in 2030. The 1999 Water Resource Plan (SNWA, 1999) considered a reduction in demand, or conservation due to price elasticity, which resulted in a slightly smaller demand than the 1997 Water Resource Plan (SNWA, 1997) (Figure 4-3).

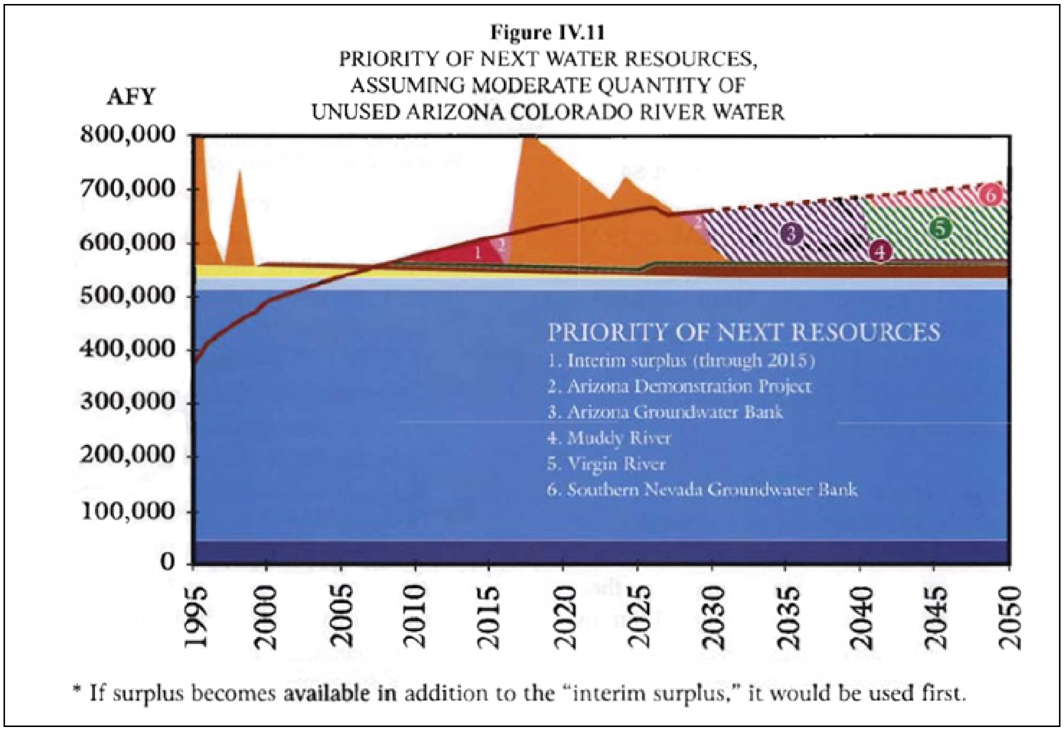


Figure 4-3
Meeting Demands 1999 Water Resource Plan

4.4 2002 Water Resource Plan (SNWA, 2002b)

The priority of major resources in the 2002 Water Resource Plan (SNWA, 2002b) was Domestic Surplus through 2016, the development of Clark County Groundwater (groundwater from Three Lakes North and South, Tikaboo South and Coyote Spring hydrographic basins), the Arizona Water Bank, the Muddy River, the Virgin River, the Southern Nevada Water Bank, and Colorado River transfers and marketing. Only groundwater from the above referenced basins was included in the 2002 plan.

The near term demands were to be met by temporary water supplies while allowing development of permanent water supplies, such as the Virgin River. The issues surrounding the Virgin River rights; legal aspects of wheeling; costs of infrastructure to divert and treat; and environmental impacts were still of concern. Water demands were projected to be 675,000 af in 2020 and 702,600 af in 2030 (Figure 4-4).

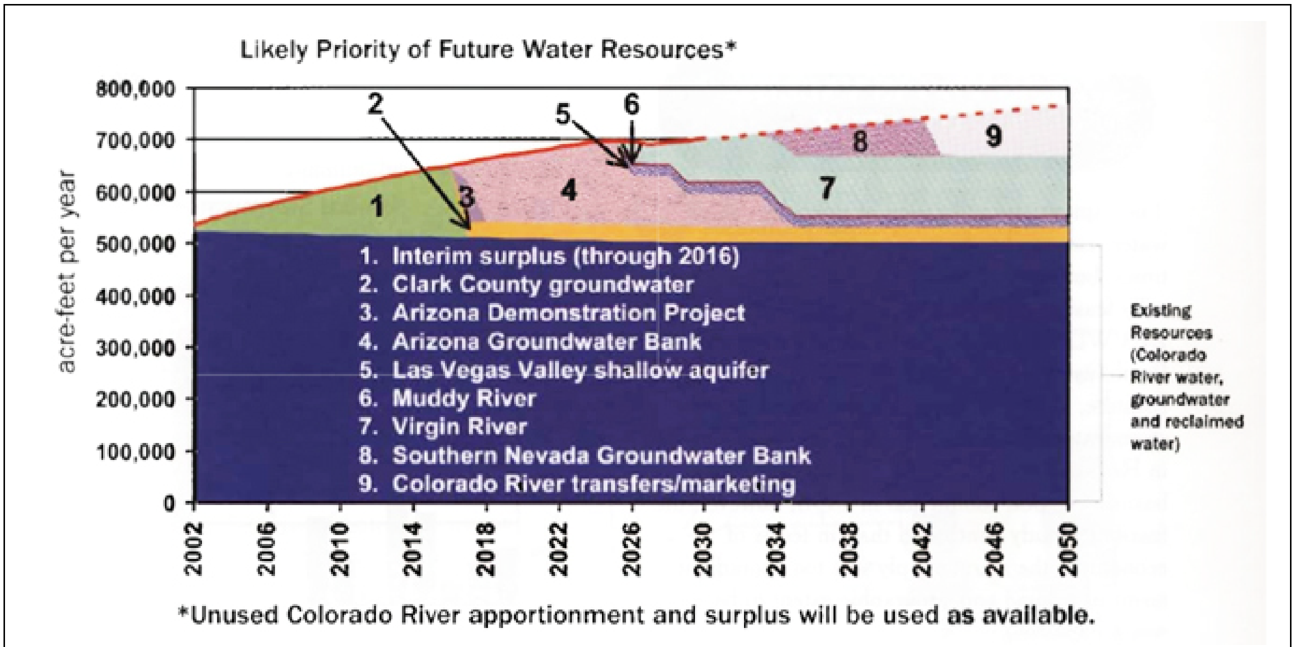


Figure 4-4
Meeting Demands 2002 Water Resource Plan

4.5 2004 Water Resource Plan (SNWA, 2004a)

The existing drought, now in its eleventh year, began in 2000. In 2002, snowpack and the resulting runoff in the Colorado River Basin was 25 percent of normal, the lowest year since record keeping began in 1906. By mid-2003, the probabilities that Lake Mead would be at necessary elevations to provide Domestic Surplus supplies were declining. In the summer 2003, local water purveyors, municipalities and Clark County implemented service rules and ordinances to support enforcement of the SNWA's Drought Plan (SNWA, 2005a). To meet near term demands (2004-2016), the SNWA was looking to Domestic Surplus supplies (if available) balanced by savings from the Drought Plan (termed drought response), as well as recovery from the Arizona and Southern Nevada water banks.

Extreme priority was put on developing the Project (noted as in-state resources), and exploring the possibility of utilizing Virgin and Muddy rivers rights through Lake Mead. In December 2004, the SNWA's Board of Directors approved an amendment to the existing agreement with the AWBA, which guaranteed Nevada 1.25 maf of water in the Arizona Water Bank. This Water Resource Plan (SNWA, 2004a) had upper and lower demand scenarios; the lower water demands were projected to be 675,000 af in 2020 and 703,000 af in 2030 (Figure 4-5).

4.6 2005 Water Resource Plan (SNWA, 2005b)

In 2005, the SNWA's Board of Directors accepted the Integrated Water Planning Advisory Committee's recommendations regarding how best to integrate in-state water resources into the SNWA's water resource planning and management activities. These recommendations included setting a new conservation goal of 245 gpcd by 2035 with the caveat to investigate the potential for further gallons per capita per day reductions. Another key recommendation because of

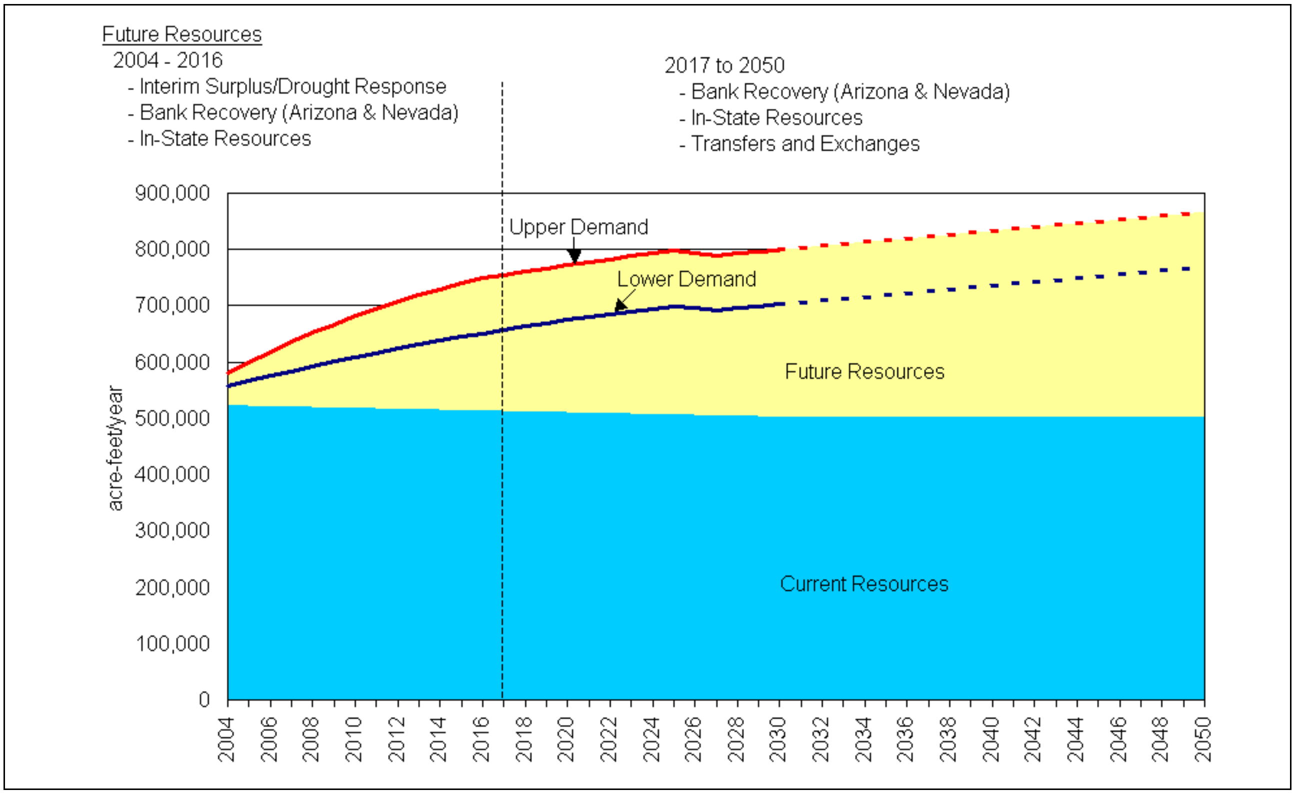


Figure 4-5
Meeting Demands 2004 Water Resource Plan

unprecedented growth projections was pursuing the development of all water resource options, including the Project.

Because of drought and resulting Lake Mead water level, Domestic Surplus supplies were unavailable and the 2005 Water Resource Plan (SNWA, 2005b) showed recovery from the Arizona Water Bank in 2008 and developing in-state water resources, which included the Project, by 2012. SNWA staff was investigating all possibilities to construct the Project as quickly as possible to meet future demands. Water demands were projected to be 724,000 af in 2020 and 808,000 af in 2030 (Figure 4-6).

4.7 2006 Water Resource Plan (SNWA, 2006)

Because of markedly higher population projections, demand projections increased significantly in the 2006 Water Resource Plan (SNWA, 2006). In addition to the Arizona Water Bank, supplies from the Southern Nevada and California water banks were needed to meet demands until 2012 when in-state water resources, which included the Project, were brought on line. The Project was to be constructed as quickly as possible to meet near term demands and was a high priority. Drought continued in 2006 with snowpack and the resulting runoff in the Colorado River Basin at 73 percent of normal. Water demands were projected to be 814,000 af in 2020 and 902,000 af in 2030 (Figure 4-7).

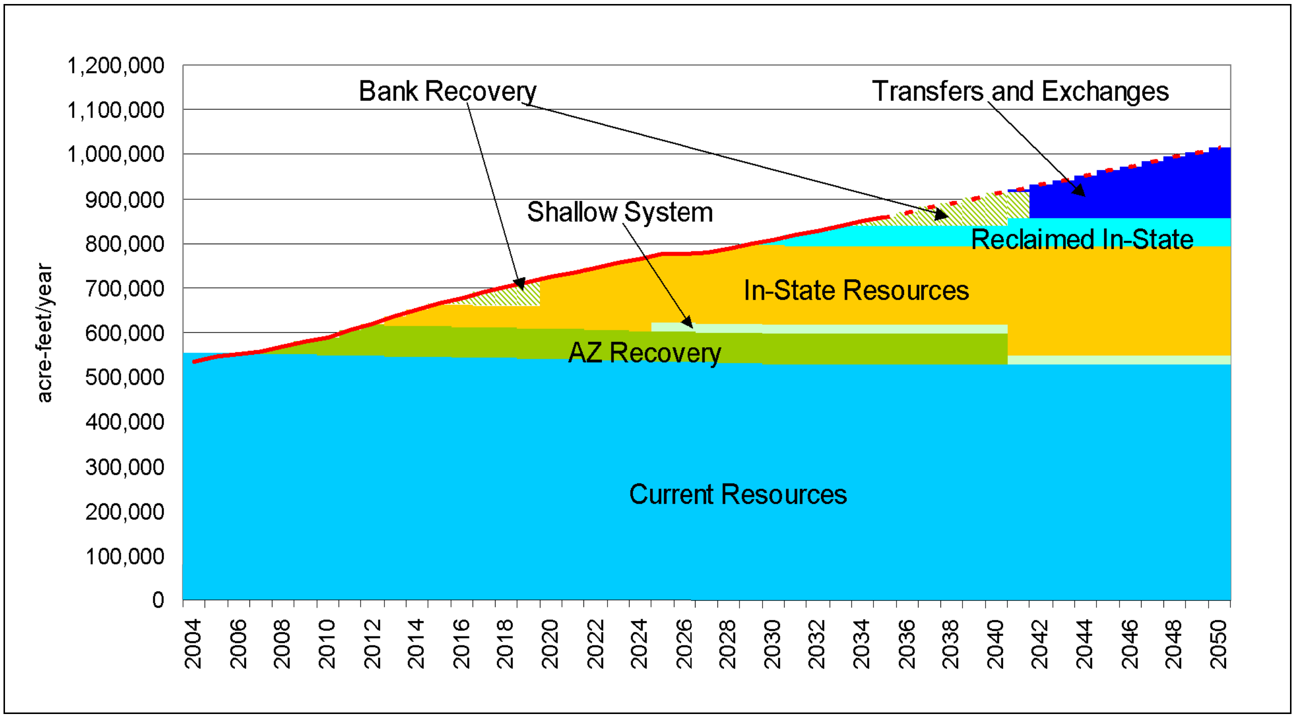


Figure 4-6
Meeting Demands 2005 Water Resource Plan

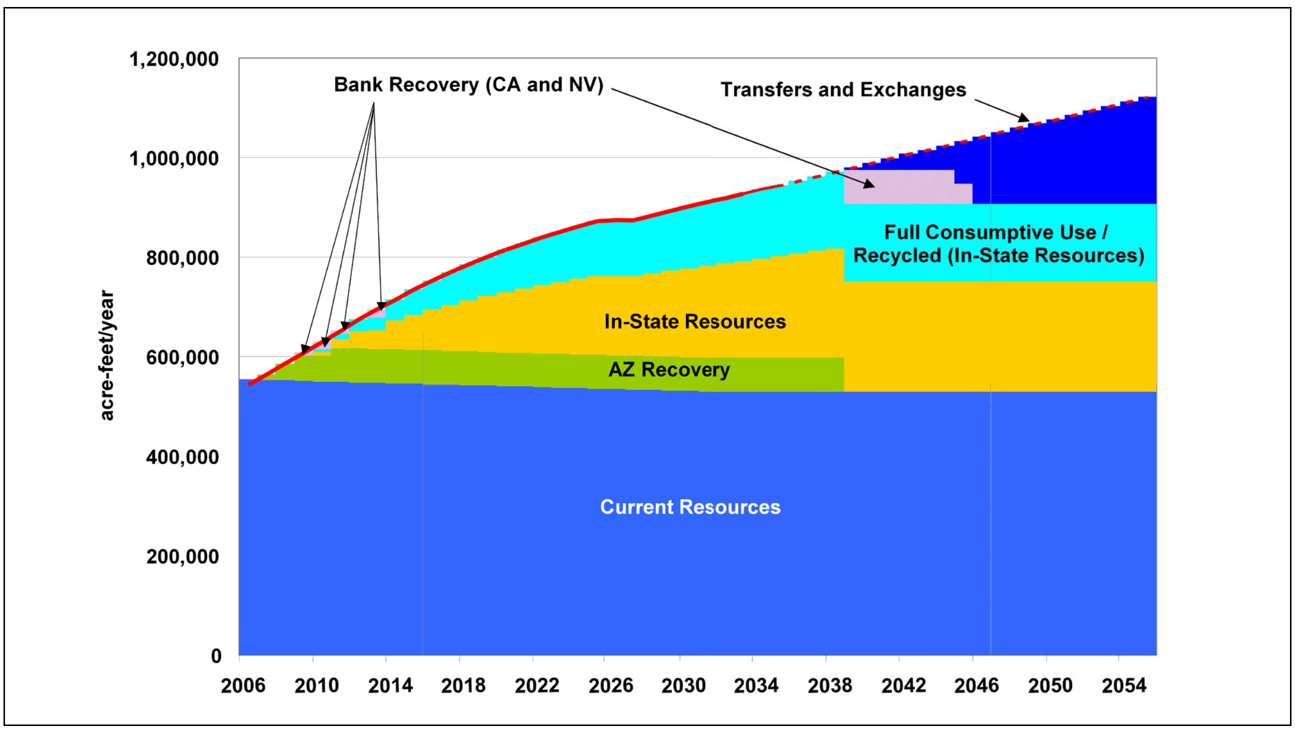
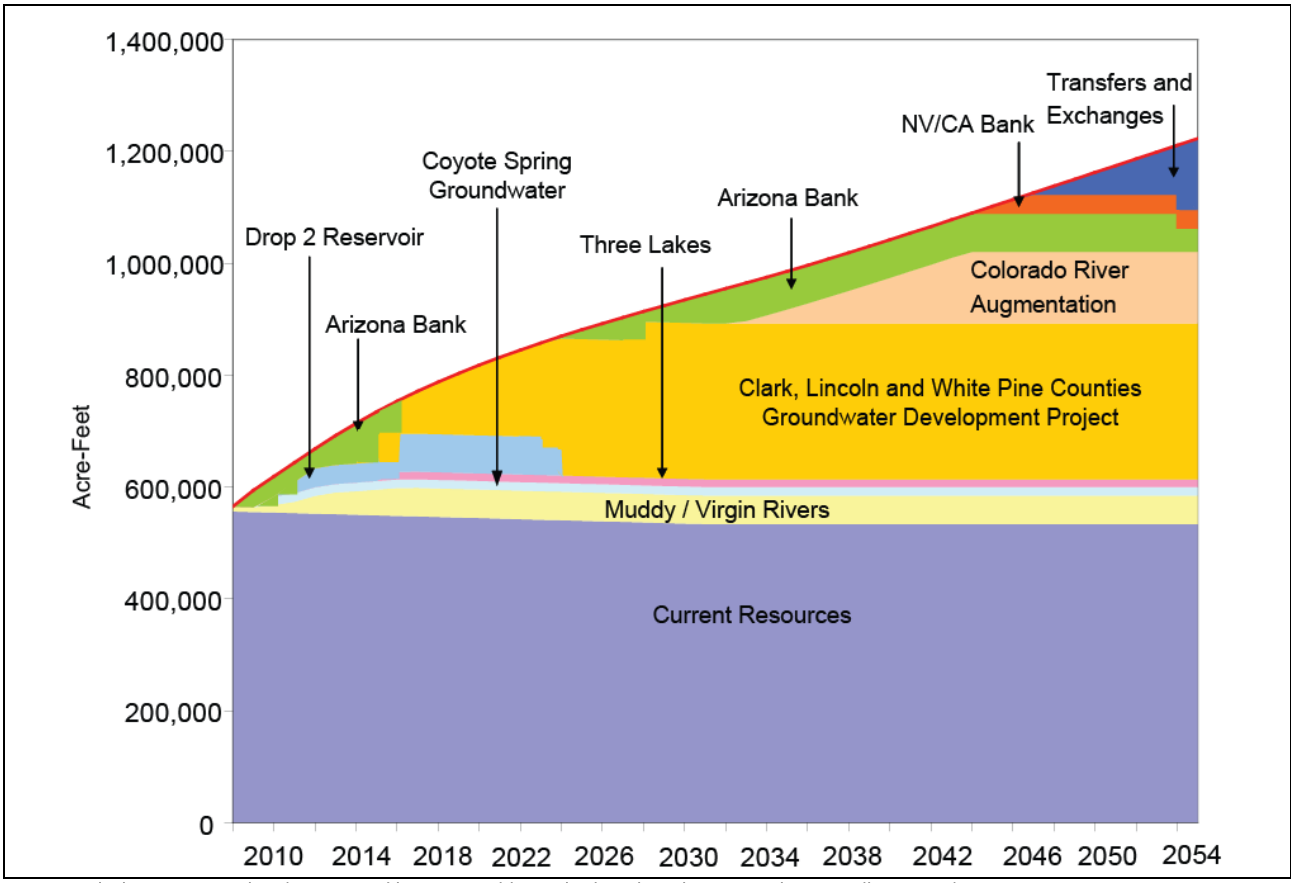


Figure 4-7
Meeting Demands 2006 Water Resource Plan

4.8 2008 Water Resource Plan (SNWA, 2008)

The finalization of the Interim Guidelines in 2007 was a milestone in Colorado River Basin history. The Interim Guidelines established shortage criteria for Nevada and Arizona that were tied to Lake Mead water levels. Nevada shortages are 13,000 af at Lake Mead elevations 1,050-1,075 ft amsl; 17,000 af at Lake Mead elevations 1,025-1,050 ft amsl; and 20,000 af below Lake Mead elevation 1,025 ft amsl. At 1,025 ft amsl, the Basin States will consult with the Secretary of the Interior and additional shortages will be imposed. Shortages as a result of this consultation will no doubt be much larger, which could significantly reduce Nevada's supply of Colorado River water.

In addition, the Interim Guidelines allowed Nevada to develop additional water supplies including ICS, which include Coyote Spring Valley Groundwater Imported ICS, Muddy/Virgin Rivers Tributary Conservation ICS and Brock Reservoir System Efficiency ICS. It is important to recognize that the approval of Muddy/Virgin Rivers Tributary Conservation ICS was a milestone; however, the combined volume of these rights is anticipated to equal about 30,000 afy of consumptive use. The 1994 Virgin River surface water rights that the SNWA agreed to not pursue until at least 2014 equaled an average of 113,000 afy. Demands had increased to require the Project to be on line by 2014. The 2008 Water Resource Plan (SNWA, 2008) was the first plan to address shortages. Water demands were projected to be 818,000 af in 2020 and 934,000 af in 2030 (Figure 4-8).



Note: Includes conservation (100,000 af by 2035, with gradual savings increases in preceding years)

Figure 4-8
Meeting Demands 2008 Water Resource Plan

4.9 2009 Water Resource Plan (SNWA, 2009a)

Two significant factors reduced the demand projections in the 2009 Water Resource Plan (SNWA, 2009a). These were a decrease in the population projections in comparison to the previous year and the establishment of a new conservation goal of 199 gpcd by 2035. Because of the success of the SNWA's conservation programs, and in keeping with the IWPAC's recommendation to further assess reductions in gallons per capita per day, this new conservation goal was established in 2009 (Figure 4-9).

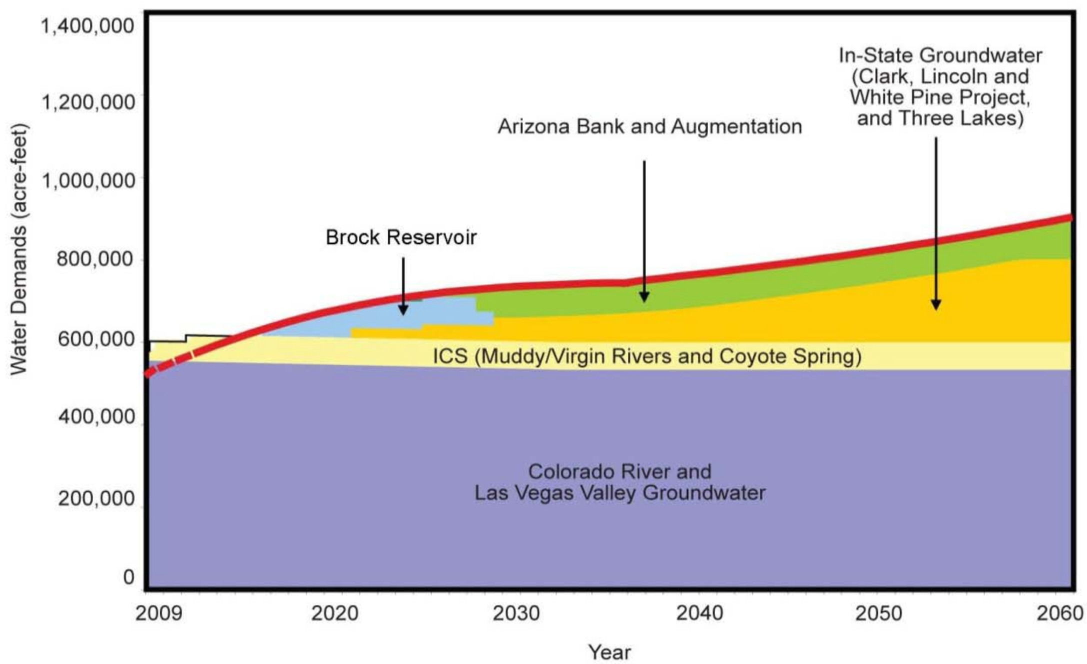


Figure 4-9
Meeting Demands 2009 Water Resource Plan

This was the first year since the Water Resource Plan's inception that the rate of growth in population projections actually decline, reflecting the economic downturn in southern Nevada. In addition, the drought continued resulting in Lake Mead levels dropping below 1,100 ft amsl and approaching the first shortage trigger level of 1,075 ft amsl. The 2009 plan is discussed in detail in Section 6.0 of this report.

In summary, year after year, resource plan after resource plan, the Project has been the supply to meet future demands and replace temporary resources. The Project became even more important with the agreement to postpone the use of the 1994 Virgin River surface rights and, more recently, as a critical replacement supply for potential shortages of Colorado River water.

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5.0 DEMAND PLANNING

In 1996, the SNWA adopted its first Water Resource Plan (SNWA, 1996). Since then, the plan has been reviewed annually and updated as needed, as summarized above. The plan is a dynamic document, intended to reflect changing developments in southern Nevada's water resource picture. Since the plan's inception, those developments have come principally from increased water demands, as well as landmark changes in rules, agreements or other factors affecting the use of Colorado River water. The 2009 Water Resource Plan (SNWA, 2009a) is the most current overview of existing and future water demands, including projected water resource development to meet those demands, over a 50-year planning horizon.

The SNWA's long-term forecast of demand considers population forecasts prepared by the University of Nevada, Las Vegas - Center for Business and Economic Research (CBER). CBER has monitored the Clark County economy for more than 25 years, and it has prepared population forecasts annually beginning in the 1990s. CBER forecasts incorporate the institution's experience and the best available local economic data and information into a nationally recognized economic model. Local economic conditions exceeded expectations beginning in the early 1990s due to expansion of the gaming industry and unprecedented growth that occurred. In the mid-2000s, the outlook for the gaming and resort industries was promising, as industry leaders spawned, yet again, unforeseen development plans. This expansion, combined with robust growth in the national economy and rapid development in the housing industry, lead to strong local economic conditions and increases in CBER's population forecasts. In late 2007, national and local economic conditions declined dramatically as we entered what is commonly referred to as the "great recession." CBER's recent forecasts have sought to capture the evolving economic conditions through recent local economic data and information. The resulting population forecasts show slower short-term economic growth; however, the long-term outlook continues to show significant growth, although the forecast rate of growth is well below the rates of the boom years of the 1990s and early 2000s.

In November 2010, the SNWA's Board of Directors reviewed the 2009 Water Resource Plan (SNWA, 2009a) and adopted it for another year. The 2009 Water Resource Plan (SNWA, 2009a) is based on both population projections and expected conservation, and forecasts demand through 2060. Water demand in the 2009 Water Resource Plan (SNWA, 2009a) is a function of both population and individual water use.

The measure of individual water use is gallons per capita per day, which is equal to the total community water use, divided by community population, divided by 365 days per year. While gallons per capita per day is not particularly useful for comparison between different communities because of inconsistent water use accounting practices, varying climate conditions, different demographic factors and other aspects, it is a good tool for an individual community to measure and compare its water use over time. Another component of determining projected water demand is factoring in current and future water conservation efforts that can slow the rate of increase or reduce overall water demand. Since 1991, the SNWA has reduced community water use from 344 to 240 gpcd in 2009 through implementation of water conservation efforts. To promote water efficiency and extend the availability of limited resources, the SNWA adopted a new, more aggressive conservation goal in 2009 to reduce water use to 199 gpcd by 2035. The SNWA anticipates this additional conservation will save the community approximately 276,000 afy by the year 2035 (SNWA, 2009b).

However, even with the incorporation of the SNWA's new conservation goal, the region's long-term water demands are projected to increase beyond existing, available water resources. Based on the June 2008 Clark County Population Forecast prepared by CBER, Clark County's population is expected to grow to approximately 3.65 million in 2035.

The SNWA relies on population projections to forecast water demands, but also takes into consideration current economic conditions, as they have an effect on water use. The current economic downturn affecting local, national and even global economies has presented unique challenges to water planners as to when the economy will recover. As a result, the SNWA has made short-term adjustments to CBER's population forecast. To reflect population trends for the year 2009, no new growth or additional water demands were assumed; however, annual growth is assumed in future years, as this has been the trend for southern Nevada. It is important to note that while subsequent 2009 and 2010 forecasts have been developed and published since the 2008 CBER forecast, significant long-term population changes are not evident in these more recent forecasts. As a result, the 2009 Water Resource Plan (SNWA, 2009a) remains an effective tool for water planners to forecast anticipated demands over the 50-year planning horizon.

CBER projections have provided effective support for water demand forecasting; however, forecasting population is not an exact science. Long-term projections have typically under-forecasted actual results; in part because of the unprecedented economic growth that has been experienced in southern Nevada. During the last century, southern Nevada experienced significant and often unanticipated population increases. As areas throughout the Southwest began to draw a large number of residents and businesses, the Las Vegas Valley grew from a population of just a few thousand in the early 1900s to nearly 2 million in 2010. During the past several decades, regional population increases have continually surpassed expectations—making Nevada one of the fastest growing states in the nation, and naming Las Vegas as the United States' fastest-growing city and metropolitan area from 1960 to 2000. According to Clark County Comprehensive Planning estimates, between 1990 and 2000, southern Nevada's population nearly doubled, from 797,142 to 1,428,690 residents. This extraordinary population increase was impractical to predict, in part because of the unprecedented expansion of the gaming and housing markets that occurred in that time.

Clark County's population forecast has typically not kept pace with actual population results. For example, a review of CBER projections from 1991 demonstrates a 2010 population forecast of nearly 1.4 million. The actual population for 2010 is approximately 2 million, revealing a population under-forecast of 600,000. CBER forecasts have commonly revealed significant inaccuracies as forecasts project further into the future. While the 1999 CBER forecast outlined in Table 5-1 reveals near-term projections consistent with actual results, at 10 years out the forecast under-projects by more than 200,000.

Table 5-1
Comparison of CBER 1999 Clark County
Population Forecast to Population Estimates

Year	CBER 1999 Population Forecast[a]	Clark County Comprehensive Planning, Population Estimate[b]
2000	1,383,335	1,428,690
2001	1,439,676	1,498,278
2002	1,492,042	1,578,332
2003	1,541,672	1,641,529
2004	1,588,948	1,747,025
2005	1,633,915	1,815,700
2006	1,676,664	1,912,654
2007	1,717,754	1,996,542
2008	1,758,073	1,986,145
2009	1,797,813	2,006,347
2010	1,836,859	2,036,358

Source:
[a]"Clark County, Nevada Population Forecast, 1999-2035", The Center for Business and Economic Research, University of Nevada, Las Vegas, December 29, 1999.
[b]Clark County Comprehensive Planning URL: http://www.clarkcountynv.gov/depts/comprehensive_planning/demographics/Pages/default.aspx, accessed June 21, 2011.

For water managers, under-forecasting population numbers presents a serious risk that if realized, could mean severe water resource shortfalls for southern Nevada. For this reason, the SNWA assumes a conservative approach when considering population projections in terms of water-demand forecasting. This approach has proven useful as past forecasts have under-estimated actual results, and is expected to continue to be employed as current population projections reveal significant uncertainty regarding southern Nevada's population potential. (Figure 5-1) compares recent CBER projections as well as the 2010 Nevada State Demographer (NSD, 2010) forecast of Clark County population to illustrate this uncertainty.

The Nevada State Demographer develops population projections for primarily state budget planning efforts. The forecast is based on the most current estimates and extends to a 20-year horizon. In 2010, the State Demographer provided population estimates for Clark County in high/low scenarios. These projections estimate population to increase anywhere between 1 and 57 percent over the next 20 years, a range of population increase between 27,000 and 1,114,800 people. If southern Nevada's population realizes a 57 percent increase as projected by the State Demographer, but the region has been preparing for an increase of only 1 percent, the community will be considerably short of water resources to meet demands. Furthermore, environmental permitting issues, construction periods and related costs require considerable lead time for construction of the facilities needed to meet resource shortfalls in time to meet demands. While additional water supplies are being developed to meet demands, the community could be subjected to severe and aggressive demand restrictions, likely resulting in economic downturn.

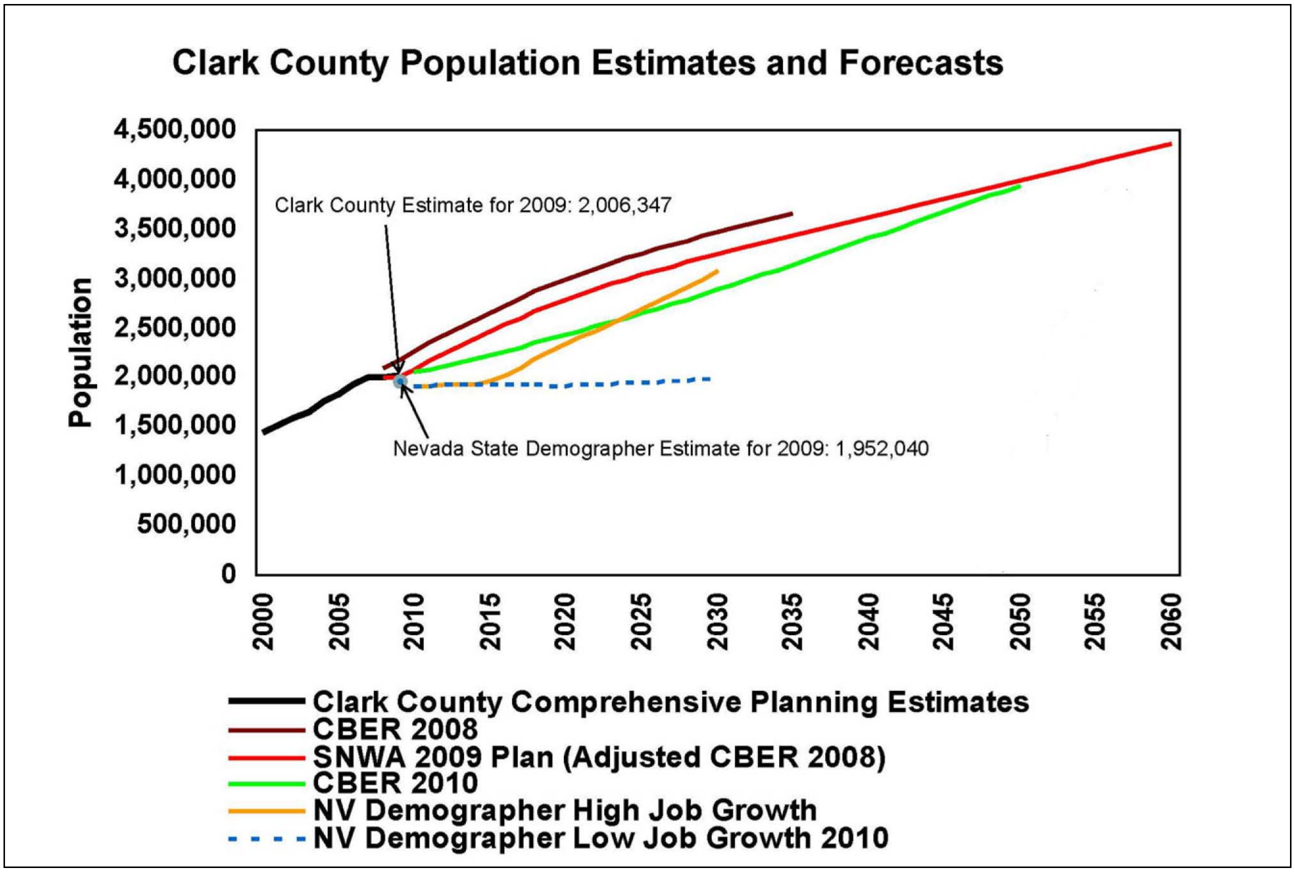

Figure 5-1
Clark County Population Projections (CBER and Nevada State Demographer)

Like the State Demographer's projections, CBER also develops population forecasts specific to Clark County. CBER recognizes that population forecasting is not an exact science, and notes that recent depressed economic activities are part of natural swings that should be fully expected over a forecasted range (2009 Executive Summary, CBER). Furthermore, CBER recognizes the risk associated with short-term population projections. Because forecasts rely on current knowledge of construction activity on the Las Vegas Strip, CBER warns population forecast users that these conditions could result in either overestimating or underestimating population growth in the short run. Despite the uncertainty in short-term forecasting, the natural swings will level out, especially over the long-term.

Southern Nevada's current economic conditions have certainly influenced local water demands. Stalled growth, home foreclosures, limited resort expansion, and higher than average unemployment have resulted in lower than expected water demands for the SNWA's water purveyors. While CBER's current growth rates do not predict the extreme population increases experienced during the last several decades, based on past populations realized and future expectations of Western population increases, long-term growth potential cannot be ignored.

According to the 2000 U.S. Census, the West was the fastest growing region between 1990 and 2000, realizing nearly a twenty percent population increase. In Nevada, state population growth for this decade reached a national high at 66 percent. Although Nevada's population increases have diminished in recent years (Atlas World Group, 2009) due to current economic conditions, the significant past trend toward regional growth is expected to recover due to natural population increases, migration within the country and immigration from outside of the United States. Statistics compiled by the Urban Land Institute (Spivak, 2010) show that between 2000 and 2008, Nevada had a 63 percent increase in foreign-born population, the sixth highest percentage increase of all metropolitan areas in the country. In addition, ULI's Patrick Phillips forecasts that an additional 150 million people are expected in the United States over the next 40 years. Southwestern states such as Arizona, Colorado, Nevada, New Mexico, and Utah are expected to continue to experience some of the fastest population growth and economic and demographic transitions anywhere in the country. Together, these five states are projected to grow by nearly 12.7 million residents by 2040, which would nearly double 2005 levels and require tremendous new construction in both residential and non-residential sectors of the community (Lang et al., 2008).

Forecasting is a critical component of any planning process. Due to the uncertainty regarding southern Nevada's population potential, the SNWA must consider a number of factors when assessing water demands, and have the flexibility to manage and use water resources as demands change. As a result, the SNWA has adopted a flexible portfolio of diverse water supplies that will be acquired and developed in a strategic manner to minimize impacts associated with heavy reliance on a single resource. As with any of the resources outlined within the SNWA's portfolio, the Project will be implemented and utilized as demand warrants. The 2009 Water Resource Plan (SNWA, 2009a) provides the flexibility to defer projects should the current economic slowdown continue, or advance water resource development in a timely manner should demand exceed projections or if drought conditions warrant accelerated water resource development. The 2009 Water Resource Plan (SNWA, 2009a) remains an effective planning tool that will be reviewed annually and adjusted as conditions change. While the current downturn affecting southern Nevada's economy presents challenges to water planners as it represents uncertainty as to what future growth rates will occur, it is expected that the potential for long-term future growth remains high and that water managers must prepare for these expectations.

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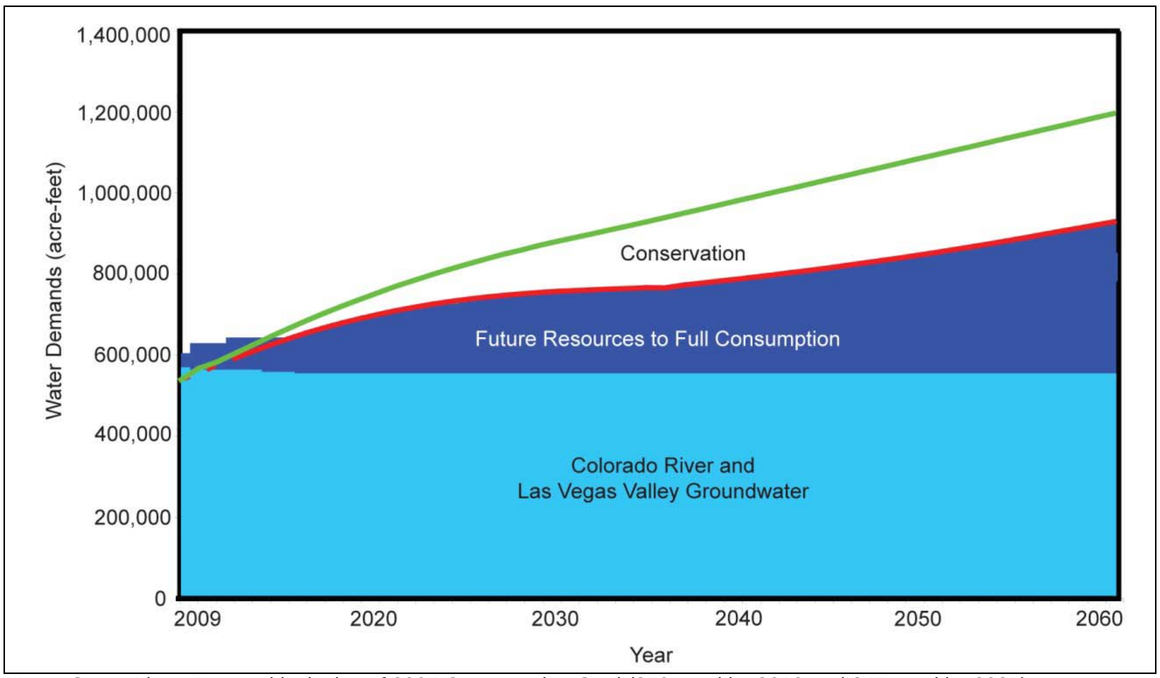
6.0 MEETING EXISTING AND FUTURE DEMANDS

The following is a detailed discussion of meeting demands as outlined in the 2009 Water Resource Plan (SNWA, 2009a). To meet current and future demands, the SNWA will use a combination of additional resources, including resources to be developed. Figure 6-1 demonstrates the amount of conservation projected to be achieved and the amount of additional resources needed to meet demands through 2060. Figure 6-1 also demonstrates how water conservation reduces the SNWA's water demands, thereby extending the availability of existing resources over time. Meeting southern Nevada's demands will require both the efficient use of existing and future supplies, and the development of additional water resources.



Note: Green Line - Demand inclusive of 2005 Conservation Goal (250 gpcd by 2010 and 245 gpcd by 2035)
Red Line - Demand inclusive of 2009 Conservation Goal (199 gpcd by 2035)

Figure 6-1
Summary of Projected Water Demands and Water Resources

Water demand projections, after reductions resulting from conservation programs, will be met, in part, with the resources currently available, which primarily include Colorado River water and Las Vegas Valley groundwater. SNWA's first priority resource for use is the portion of Nevada's basic Colorado River consumptive use apportionment that SNWA receives plus associated return-flow credits. As the largest renewable resource in the SNWA's portfolio, Nevada's basic Colorado River allocation and return-flow credits will be used throughout the planning horizon. Southern Nevada also will use a total of 46,340 af of permanent groundwater rights in the Las Vegas

Valley each year, which are not only a renewable resource, but also a tool to manage peak summer demands for municipal purveyors in the Las Vegas area.

Figure 6-2 identifies the specific resources that the SNWA's Board of Directors has identified to use to meet current and future demands. Beyond continued conservation, Nevada's basic apportionment and Las Vegas Valley groundwater rights, the highest priority resource to meet water demands will be development of the Project. When necessary, banked reserves and other resources will be used to meet demands, as described below.

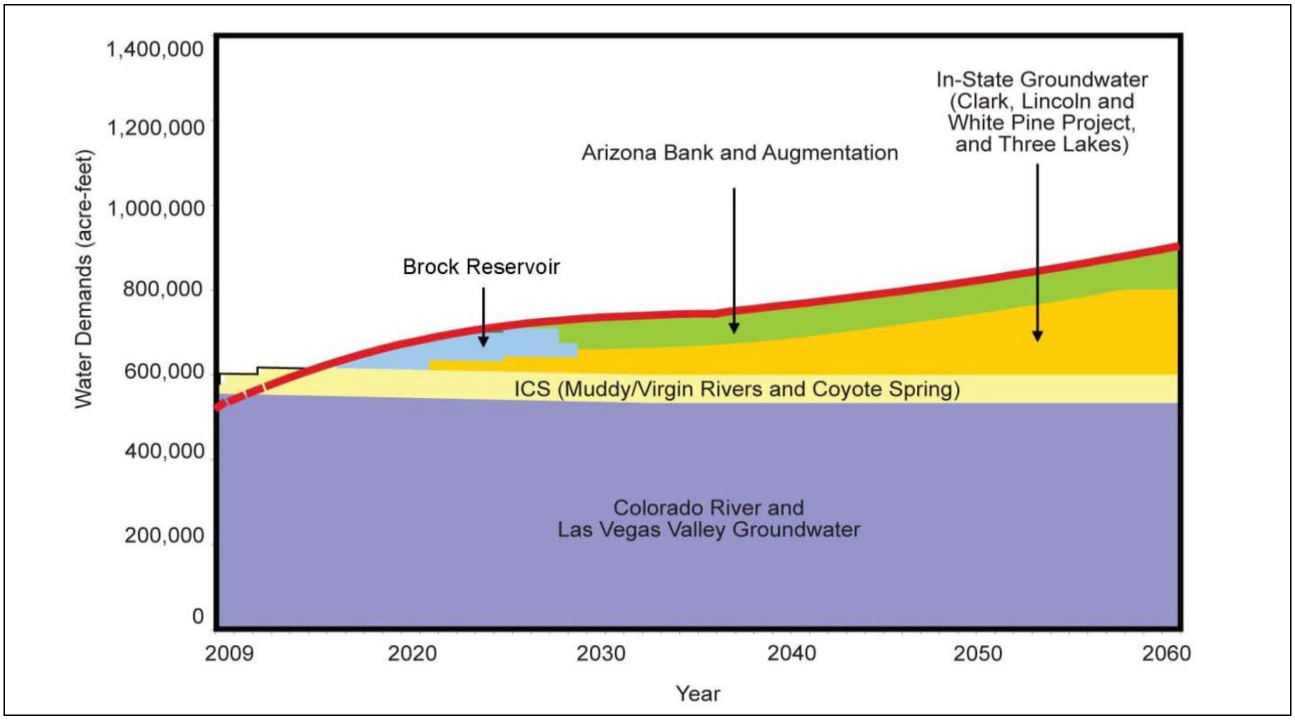


Figure 6-2
Projected Water Demand and Future Resources
(Under Normal Colorado River Conditions)

6.1 Intentionally Created Surplus

Muddy/Virgin River Tributary Conservation ICS will be utilized to their full consumptive use volume. For planning purposes, it is anticipated that 30,000 afy of these water rights will be acquired and used to create ICS. Coyote Spring Valley Groundwater Imported ICS includes 9,000 afy, which will be utilized to their full consumptive use volume. The SNWA also anticipates using 400,000 af of water generated by the Brock Reservoir System Efficiency ICS Project, which is available at a maximum of 40,000 afy during normal operating conditions (The SNWA is limited to a cumulative use of 100,000 af from 2011 to 2015).

6.2 In-State Groundwater

These resources are comprised of groundwater rights and applications in Three Lakes Valleys (North and South), Tikaboo Valley South, and applications associated with the Project. It is anticipated that 8,018 afy will be developed in association with permitted rights in Three Lakes Valley and Tikaboo Valley South. The SNWA anticipates developing up to 184,655 afy of the SNWA's water rights applications in Spring, Delamar, Dry Lake, Cave, and Snake valleys.

6.3 Banked Resources

Under normal Colorado River operating conditions, the SNWA does not anticipate using banked reserves in the near-term planning horizon (2010-2024), as these resources provide a critical tool for the SNWA to meet demands during shortage. The SNWA projects using up to 40,000 afy of banked water resources in Arizona beginning in 2025, until other permanent water resources are fully developed.

6.4 Colorado River Augmentation

Colorado River augmentation projects are being evaluated in exchange for deferring development of the SNWA's 1994 Virgin River rights. The SNWA anticipates using the consumptive use of up to 75,000 afy, which will replace banked water resources once exhausted.

6.5 Flood Control Surplus and Domestic Surplus

Drought conditions have affected storage on the Colorado River and the availability of flood control and domestic surplus water. While the SNWA does not anticipate the use of this resource in the near-term and does not include it as a resource available to meet future demands, this water will be used to the fullest extent possible if it becomes available (through 2026 under the Interim Guidelines).

Figure 6-2, from the 2009 Water Resource Plan (SNWA, 2009a), demonstrates how demands are to be met under normal Colorado River conditions. The 2009 Water Resource Plan (SNWA, 2009a) also discusses designated shortages: 13,000 af at Lake Mead elevations 1,075-1,050 ft amsl; 17,000 af at Lake Mead elevation 1,050-1,025 ft amsl; and 20,000 af at below Lake Mead elevation 1,025 ft amsl. At Lake Mead elevation 1,025 ft amsl, consultation with the Secretary of the Interior will occur to determine additional measures necessary to minimize further Lake Mead declines and preserve Lower Basin access to Colorado River water.

The Project represents a significant portion of planned water resources needed to meet future demands, as well as to protect the community from current and potential extended drought conditions throughout the Colorado River Basin. Even with a broad range of conservation programs, demand is expected to increase throughout the planning horizon, as demonstrated in Table 6-1.

Table 6-1
SNWA Projected Water Demand
(Diversion Quantities)

Year	SNWA Water Demand (acre-feet)
2020	684,442
2030	732,365
2040	764,681
2050	822,807
2060	897,087

Note: SNWA water demands are based on the 2009 Water Resource Plan (SNWA, 2009a)

Figure 6-3 illustrates the water demands in the 2009 Water Resource Plan (SNWA, 2009a) and how those water demands cannot be met without the Project. It also assumes that augmentation supplies would not be available.

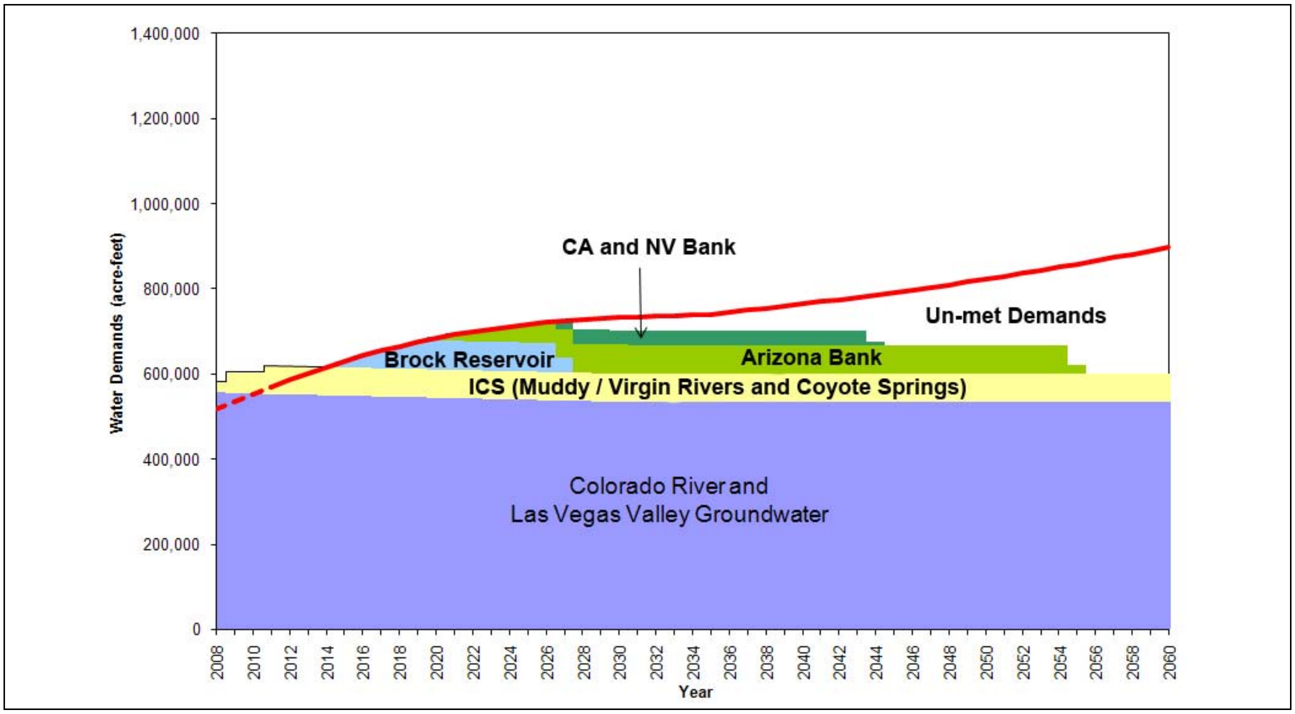


Figure 6-3
2009 Water Resource Plan without In-State Groundwater and Augmentation

As discussed above, Nevada could receive up to 75,000 afy from the first project completed to augment the Colorado River. Currently the BOR (BOR, in press), in cooperation with the Basin States, is preparing a Colorado River Basin Water Supply and Demand Study. This is the first step in evaluating future augmentation projects. At this time, defining potential projects are a long way off, much less finding and constructing such a project. Because of the uncertainty and the fact that this 75,000 afy is designated to help replace the Arizona Water Bank, it was not included in Figure 6-3.

The figure illustrates that in 2028, under normal operating conditions, without the Project or augmentation supplies, demands would not be met. This figure also illustrates using the water banks. Figure 6-2 did not show utilization of the California and Nevada water banks because banked resources are treated like a savings account, they are exhaustible and are set aside and preserved for use when other permanent supplies are not available. Figures 6-2 and 6-3 illustrate normal Colorado River conditions.

Figure 6-4 illustrates water resource deficits at various years under designated shortage conditions. Brock Reservoir is only available through 2036 under normal conditions and is not available during shortage conditions, therefore is not shown. For example, by 2040 under normal conditions, 96,500 afy diversion amount is needed from the Project and under Level 2 Shortage, 118,600 afy diversion amount is needed.

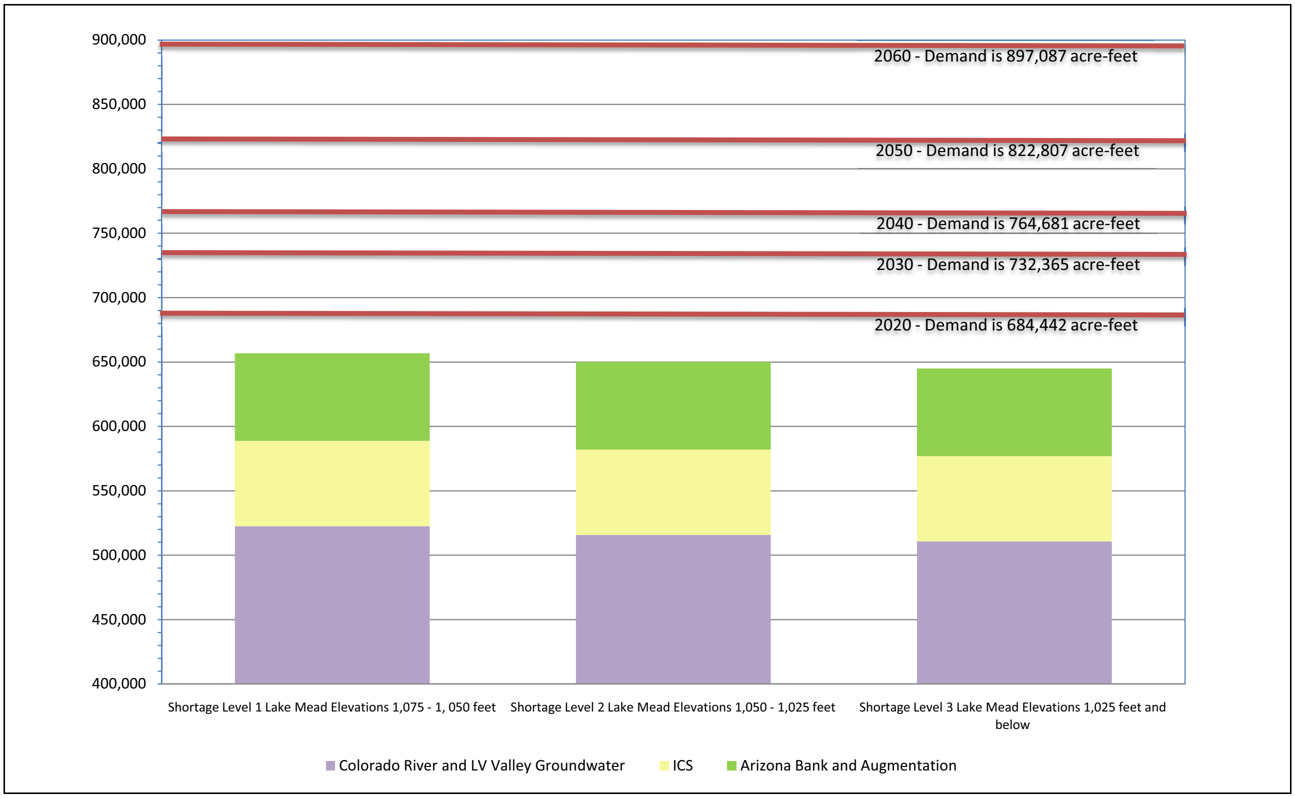


Figure 6-4
Water Resource Deficits at Various Years
(Designated Shortage Colorado River Conditions)

The SNWA must develop additional long-term water resources for southern Nevada to meet future demands and replace temporary supplies. Developing resources independent of the Colorado River will provide significant protection should demands meet long-term projections and/or existing resources diminish as a result of supply limitations and drought conditions. The 2009 Water Resource Plan addresses a maximum shortage of 20,000 af.

As discussed above, Nevada's shortages when Lake Mead is below 1,025 ft amsl will no doubt be much greater than 20,000 af. Shortages are discussed in detail in a later section of this report. As these shortages are realized, the need for the Project is critical. The 2009 Water Resource Plan states that when a Level One shortage is declared (Lake Mead reaches elevation 1,075 ft amsl), the SNWA will begin construction of the Project.

7.0 SUPPLY LIMITATIONS

7.1 Temporary Supplies

While critical components to the SNWA's water resource portfolio, temporary supplies largely rely on Colorado River water and are limited to a specific amount of water. These bridge resources include banked resources in Arizona and California, and the Brock Reservoir. While these resources are critically important to the SNWA in meeting short-term demands, at some time permanent supplies must be developed to replace these supplies. The Project is critical to replace these supplies as well as provide resources for future growth. All of the above mentioned supplies—California and Arizona's water banks, and Southern Nevada's System Efficiency ICS resource—still require intake facilities at Lake Mead. Continued drought and potential shortage declarations can affect the availability of this infrastructure, further demonstrating the need for southern Nevada to develop resources that are separate from the Colorado River.

7.2 Drought

For more than a decade, southern Nevada, as well as communities throughout the Southwest, has confronted unprecedented challenges as a result of extreme drought. While the Colorado River Basin has benefited in recent years from historic management agreements and the system's significant amount of storage to help weather drought conditions, there remain a number of management challenges that will continue to impact Colorado River users—especially as stored resources diminish and shortages are declared.

For southern Nevada—a community that depends on the Colorado River for ninety percent of its water supply—the need for supply diversification is paramount. In 1999, the Colorado River Basin began to experience drought conditions that became the worst five-year drought in the recorded history of the Basin. These conditions were aggravated by several years of extremely dry soil conditions, which further reduced total runoff. As a result, water levels in the two primary storage reservoirs on the Colorado River, Lake Mead and Lake Powell, declined to levels not observed since Lake Powell began filling in the early 1960s. Except for 2005 and 2008, when the Colorado River Basin received slightly above-normal runoff, drought conditions in the Basin persisted. At the end of 2010, the combined storage of Lake Mead and Lake Powell was about 55 percent of capacity, and Lake Mead's water level was about 130 ft amsl lower than experienced in the late 1990s.

For the SNWA, continued declines in Lake Mead water levels could result in reduction of available Colorado River water supplies and operating challenges associated with water intake facilities in Lake Mead. The SNWA will face a reduction in supply if the elevation of Lake Mead declines to 1,075 ft amsl, and will lose upper Intake No. 1 when Lake Mead reaches elevation 1,050 ft amsl. The SNWA will incur staged shortages when Lake Mead water levels fall below elevations 1,075, 1,050 and 1,025 ft amsl, shortages will be 13,000 af, 17,000 af, and 20,000 af, respectively. At elevation 1,025 ft amsl the Basin States will consult with the Secretary of the Interior as to additional shortages. These additional shortages could be a significant portion of the SNWA's Colorado River allocation. During discussions with the Basin States, Arizona's position was that Nevada should bear between two to three times as much shortage as what was finally agreed on at the designated levels. It is unknown what amount of shortage Nevada might have to take below elevation 1,025 ft amsl, but it most likely will be significantly higher than 20,000 af.

In the event of shortage, southern Nevada's ability to utilize the full portion of certain water resource options becomes limited. These resources include Muddy River, Virgin River and Coyote Spring Valley ICS, and its water banking arrangements in Arizona and California. No portion of the Brock Reservoir System Efficiency ICS is available for use during shortage. Additionally, if Lake Mead water levels continue to drop, the SNWA may be unable to withdraw water from its upper intake as early as 2012. However, should the elevation of Lake Mead fall below 1,000 ft amsl—the operational limit of the SNWA's pumping facilities—it is likely the SNWA will be unable to withdraw its Colorado River apportionment, as well as other resources including return-flow credits, ICS resources and banked resources. According to BOR modeling, Lake Mead will have either no capacity or limited capacity to serve southern Nevada if current conditions persist for another four years. The Project is critical to meeting demands doing future shortages and capacity limitations (Appendix A, Figure A-2).

In the Colorado River Basin, climate change and drought could have implications for millions of water users that depend on the Colorado River. The primary impact of climate change on water supplies is precipitation changes. Current estimates suggest a 5-20 percent reduction in annual Colorado River runoff by 2050 due primarily to climatic changes (Hoerling et al., 2009). The 2011 BOR Climate Change Report also predicts changes in the timing and amount of runoff due to dust deposit (BOR, 2011, p. 24). Even not considering future climatic changes, based on the BOR's probability of future shortages (which are based on past flow records) there is a forty percent probability by 2020 and a fifty percent probability by 2025, that in any given year the Lower Basin will be in shortage resulting in reduced supplies for Nevada (Appendix A, Figure A-2).

Additionally, the severity and longevity of the existing drought remains unknown. In the past 11 years, the Colorado River has experienced supply reductions totaling approximately 41 maf, as annual unregulated inflows to Lake Powell over this period were only 69 percent of the 1971 to 2000 average. Due to varying hydrologic conditions, future reductions related to drought conditions are difficult to estimate. However, a 2006 study that reconstructed more than five centuries of Colorado River stream flow confirms that droughts more severe than any in the last 100 years have previously occurred (Woodhouse et al., 2006). These studies of precipitation indicate that Colorado River flow, absent of climate change, could be on average 3 million af less than allocated due to Colorado River apportionment occurring during one of the wettest periods in the Colorado River Basin. The reconstructions, as demonstrated in Figure 7-1, confirm the Colorado River's highly variable flows, which are expected to additionally stress the over-allocated river. It is also important to note that the Upper Basin States (Colorado, Utah, Wyoming, and New Mexico) have yet to develop their full apportionment under the Colorado River Compact. Although shortages have not been imposed in the Lower Basin, it should be recognized that with additional development in the Upper Basin and persistent drought conditions, the Lower Basin States (Arizona, Nevada, and California) may be required to suffer considerable water delivery shortages.

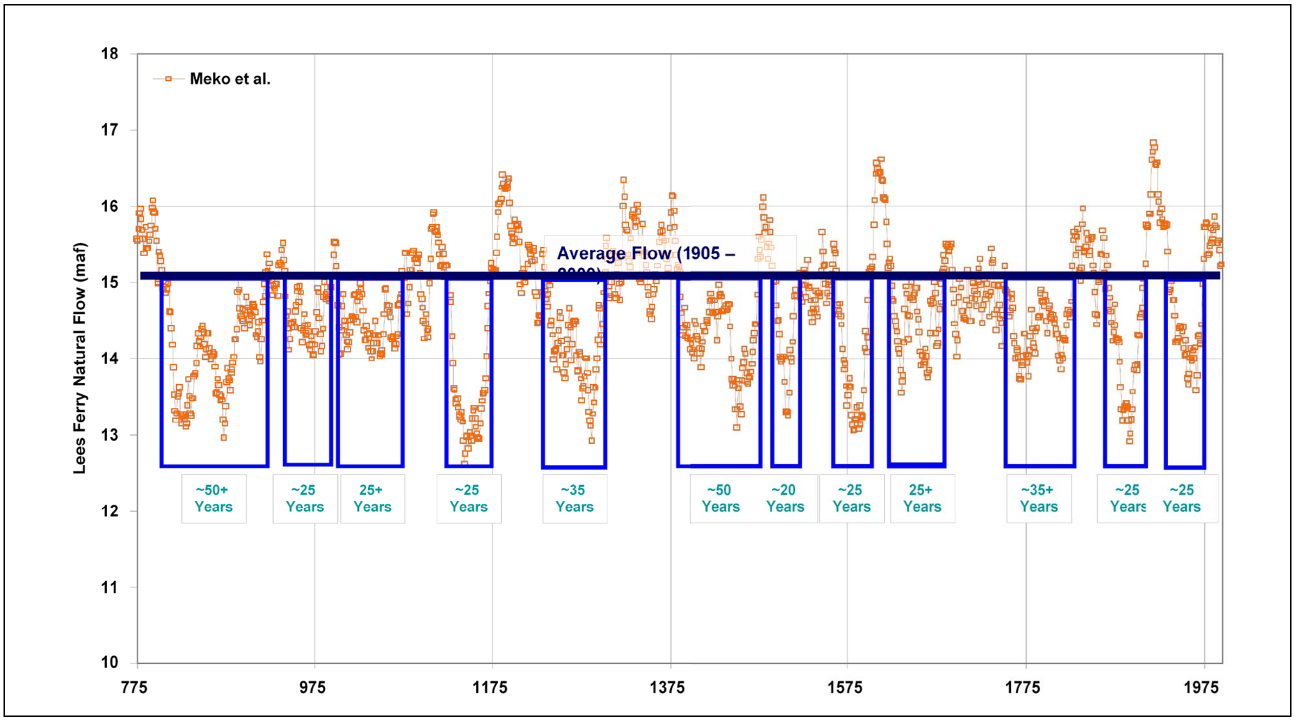


Figure 7-1
Colorado River Stream Flow Reconstruction

Drought conditions, together with the numerous supply limitations facing southern Nevada, demonstrate a need for the SNWA to secure a water supply resource independent of the Colorado River. A diversified water resource portfolio is the only sound defense against long-term, unknown impacts that are expected to strain currently available water resources. For a community that currently receives almost all of its water supply from a single resource, southern Nevada has no reasonable alternative than to develop water resources outside the Colorado River Basin. The Project will provide southern Nevada with future supplies and a level of surety should drought conditions persist, or shortages are declared.

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8.0 SHORTAGE SCENARIOS

While the 2009 Water Resource Plan (SNWA, 2009a) addresses reductions of the SNWA's Colorado River supplies up to 20,000 af, additional shortages to Nevada are very likely if Lake Mead reaches an elevation of 1,025 ft amsl. The Interim Guidelines require the Basin States to consult with the Secretary of the Interior regarding additional shortages when Lake Mead reaches this level.

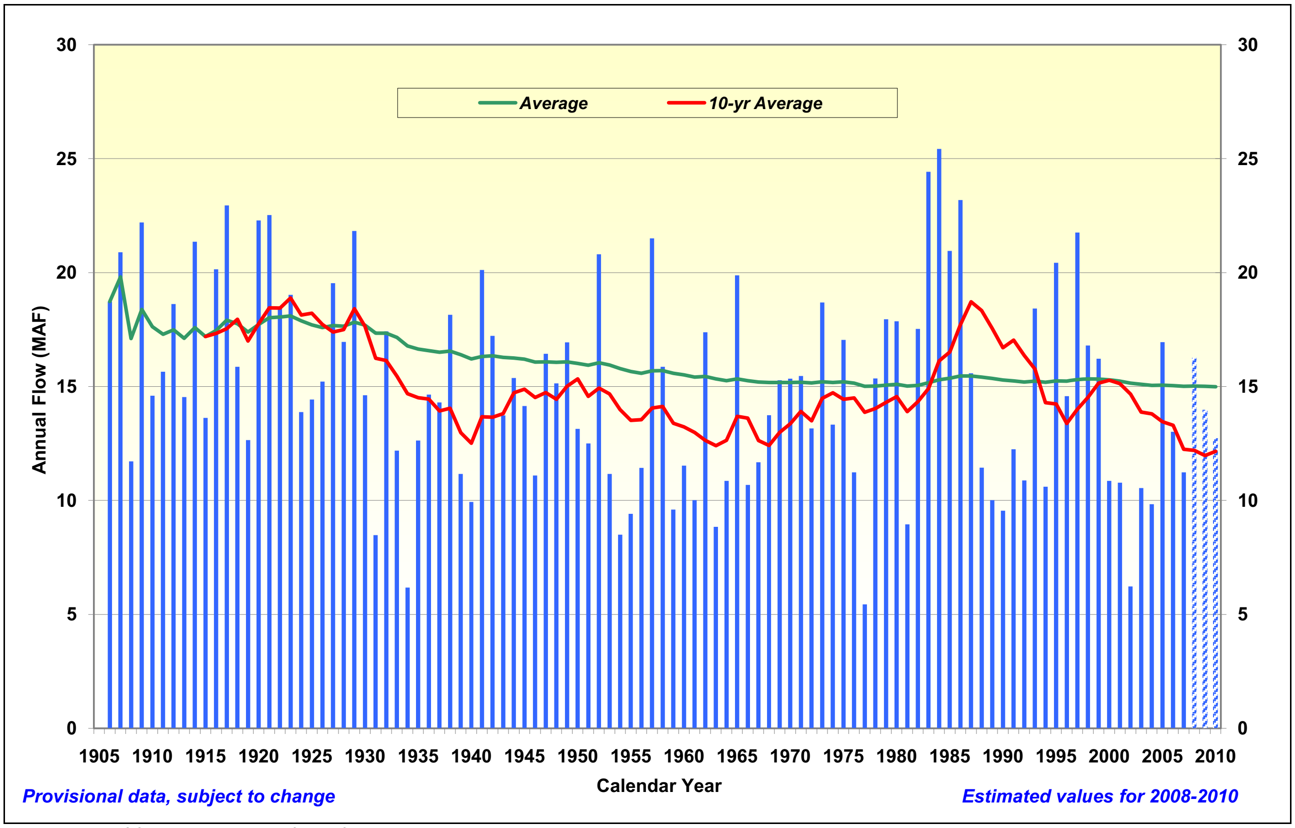
To evaluate the long-term potential for shortages to be imposed, an analysis was conducted utilizing historical Colorado River flows (flow records have been kept since 1906) with the BOR's Colorado River Simulation System (CRSS) computer model to predict future Lake Mead levels under dry, average and wet conditions. The BOR utilized CRSS to model numerous scenarios as part of the development of the Interim Guidelines. The amount of Colorado River water available to the SNWA in these various scenarios was then compared to demands contained in the 2009 Water Resource Plan, (SNWA, 2009a) and then demands were met with available water resources, and any unmet demands are met with water from the Project. The detailed analysis is attached in Appendix A.

The following summarizes the potential for shortages under dry, average and wet conditions. Appendix A contains more detail regarding the methodology and contains the analysis that compares demands and resources from the 2009 Water Resource Plan (SNWA, 2009a) in detail with the projected shortages.

Although several methods are available for ascertaining the range of possible future inflows, the BOR utilizes the existing historical record of natural flows to create several distinct hydrologic sequences that are then used in a series of simulations. Future hydrologic sequences are generated from the historical natural flow record by "cycling" through the record. Using the historical natural flow data from 1906 through 2007, results in a set of 102 separate simulations referred to as "traces" or "hydrological sequences." This enables an evaluation of proposed operating policies over a broad range of possible future hydrologic conditions. Evaluations typically include all 102 traces using statistical techniques. Natural flow data is shown in Figure 8-1.

Three modeling scenarios or traces were chosen to represent dry, average and wet Colorado River conditions. From the 102 CRSS traces the following were chosen.

- The 10th Percentile was chosen to represent a dry hydrological sequence in comparison to other modeled hydrological sequences because the total inflow to Lake Powell for this hydrological sequence represents a case where only ten percent of the hydrological sequences are at or below this inflow. This scenario will be referred to as "Future Conditions on the Colorado River–Dry." From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 14.2 maf.



Source: Prairie, pers. comm. (2010)

Figure 8-1
Colorado River at Lees Ferry, Arizona–Natural Flow

- The Average represents a hydrological sequence that has the same approximate total inflow to Lake Powell as the average of all of the hydrological sequences and will be referred to as "Future Conditions on the Colorado River–Average." From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 15.0 maf.

- The 90th Percentile was chosen to represent a wet hydrological sequence in comparison to the other modeled hydrological sequences because the total inflow to Lake Powell for this hydrological sequence represents a case where only ten percent of the hydrological sequences are greater than this inflow. This scenario will be referred to as "Future Conditions on the Colorado River–Wet." From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 15.8 maf.

Lake Mead elevations and corresponding reservoir conditions for each of these hydrological sequences is plotted in Figures 8-2 through 8-4.

Looking at Lake Mead elevations in Figures 8-2 through 8-4, it is apparent that even under average and wet hydrology on the Colorado River, Nevada will still experience Extended Shortages. It is also important to note that, in a shortage, water managers have little indication of whether the shortage will last 2 years, or 50 years, so water managers must prepare for lengthy shortages. In the Future Conditions on the Colorado River–Wet scenario, there is a 10-year period when shortages will be

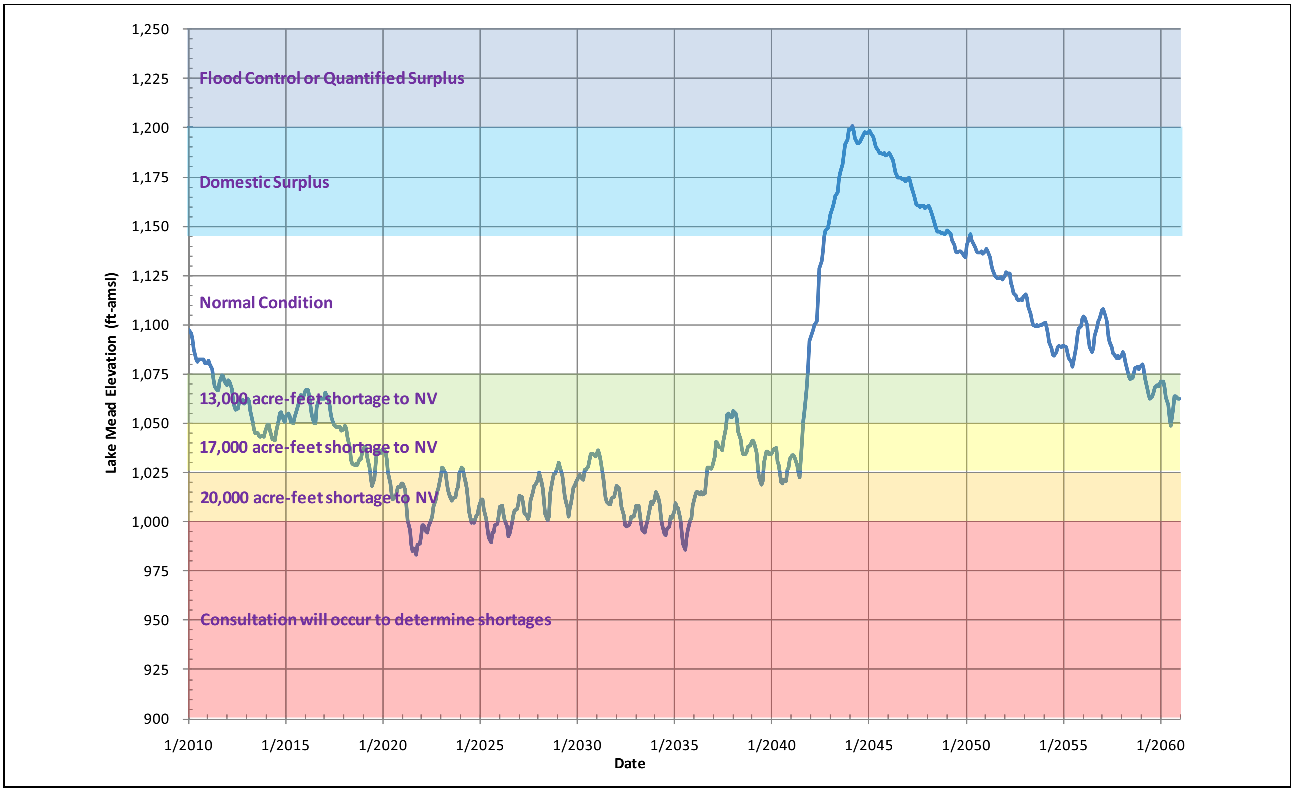


Figure 8-2
Future Conditions on the Colorado River–Dry

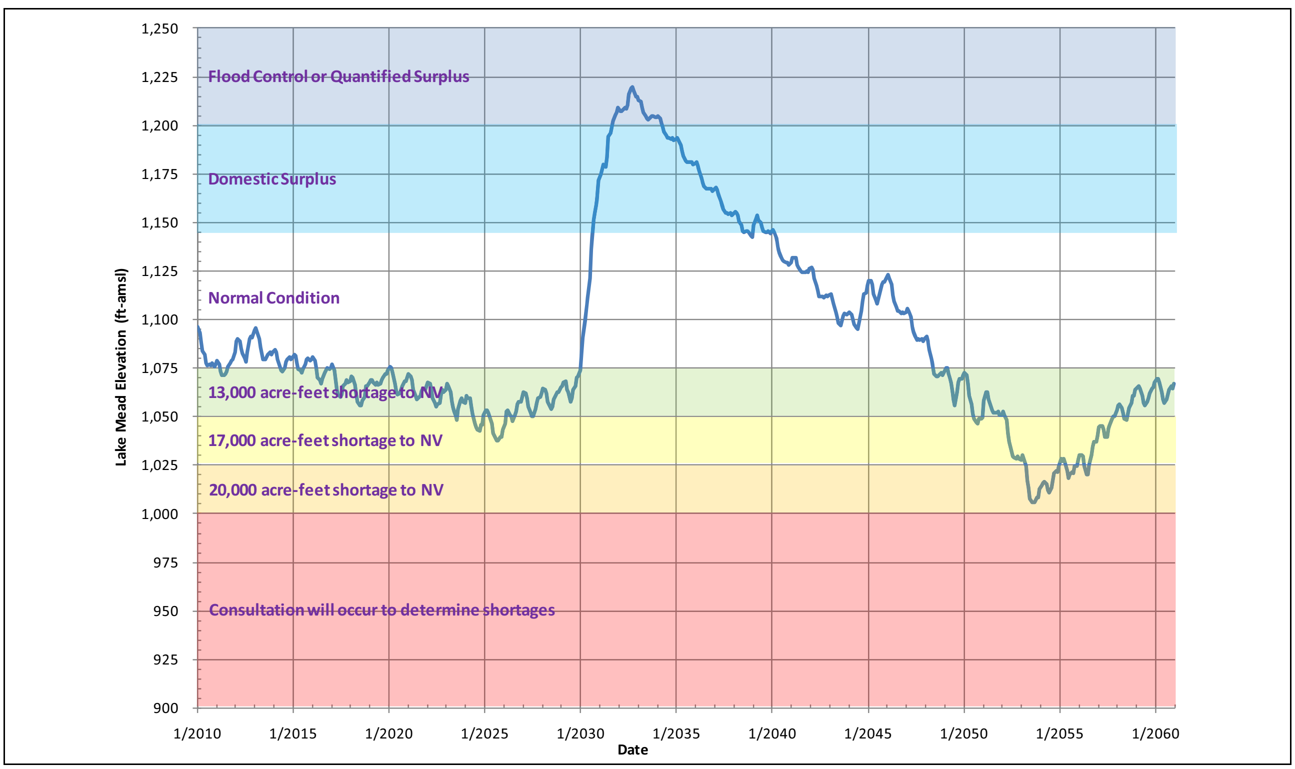


Figure 8-3
Future Conditions on the Colorado River–Average

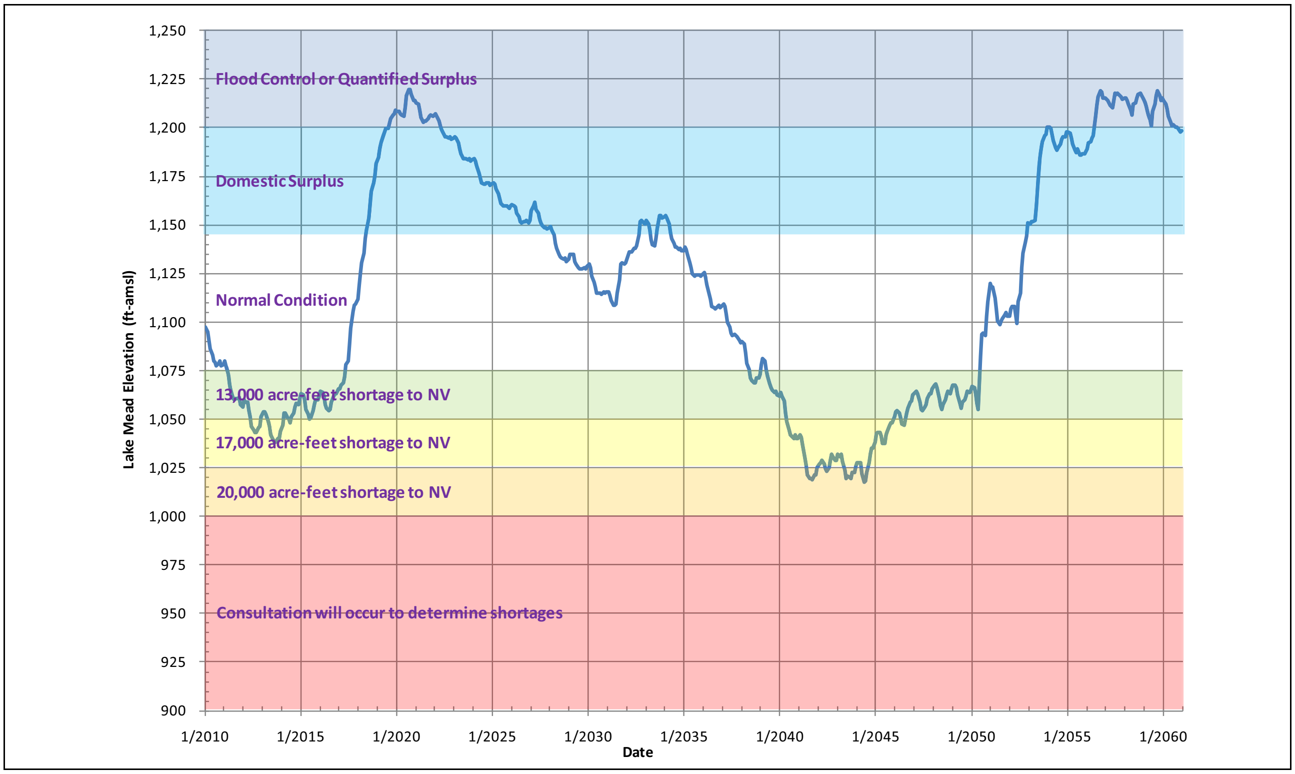


Figure 8-4
Future Conditions on the Colorado River–Wet

declared and Nevada will not be able to take its full Colorado River apportionment. However, even in the Future Conditions of the Colorado River–Dry scenario, there will be periods of surplus on the Colorado River.

Figure 8-5 illustrates resource deficits at various years under designated and Extended Shortage conditions. Extended Shortage is defined in Appendix A as the third consecutive year of a Shortage Level 3 and assumes Nevada's basic Colorado River apportionment would be cut by 40,000 afy of consumptive use during the third consecutive year of shortage and that water available from the Arizona Bank would not be available. In 2040, demands are 765,000 afy and the deficit under Extended Shortage is 232,000 afy.

In addition to the above summary, the analysis found in Appendix A further illustrates how demands could be met using the SNWA's water resource portfolio and the Project. A graph and a table is provided for each of the three traces showing the amount of water utilized from the Project to illustrate how the SNWA might manage its water resource portfolio. There are three periods of time in this sequence when Lake Mead drops below elevation 1,000 ft amsl. At this low elevation, the SNWA would be taking emergency measures to deliver some water from Lake Mead, the viability of those measures is not known so this analysis assumes no water would be available.

In these years, the Project makes up approximately 65 percent of the supplies available to the SNWA. Even with the Project, there is still a significant portion of demands that cannot be met when Lake Mead drops below elevation 1,000 ft amsl; however, the Project provides essential water for health and human safety during these times.

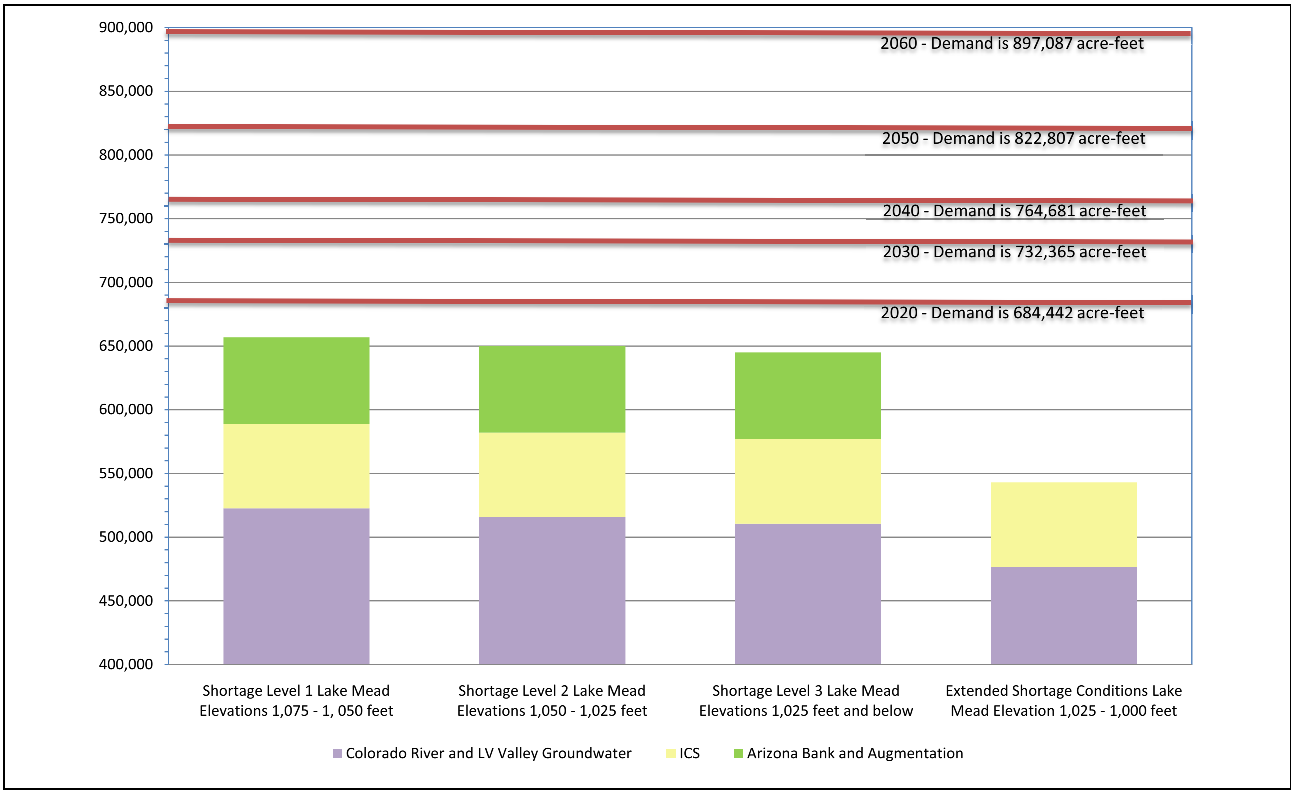


Figure 8-5
Water Resources Deficits at Various Years
(Designated and Extended Shortage)

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9.0 CONCLUSIONS

Since October 1989, with the filing of 146 applications to appropriate unused groundwater in eastern and central Nevada, southern Nevada water managers have planned to develop permanent groundwater supplies to meet future demands. The SNWA was formed in 1991 to address regional water resource and infrastructure needs of southern Nevada. As a result of an integrated resource planning process, the SNWA began preparing an annual Water Resource Plan and developing temporary finite resources (i.e., the Arizona Groundwater Bank) to bridge future demands, allowing more time to develop permanent resources.

While the timing of the development of permanent groundwater resources has varied over the water resource planning process, the development of permanent groundwater supplies to meet future demands and replace temporary resources has been a foundation of each Water Resource Plan since the first plan was developed in 1996 (SNWA, 1996). The ongoing drought in the Colorado River Basin has made the development of permanent groundwater supplies the highest priority. Analysis of the historical records of Colorado River flows indicates it is highly probable that future shortages will result in reductions in southern Nevada's Colorado River supplies in wet cycles, as well as drought cycles.

The SNWA's Water Resource Plans demonstrate the dynamic and uncertain nature of resource planning and acquisition. This, coupled with the uncertainty caused by drought and climate change, justifies the need for a permanent resource independent from the Colorado River. The Project is necessary to:

- Meet Water demands that are projected to increase in future years – Although current economic conditions have reduced near-term demands and conservation has reduced future demands, long-term growth is anticipated to continue, which will require additional resources.

- Replace temporary supplies such as groundwater banks – While the SNWA has finite temporary supplies available to meet near-term demands, these supplies will expire and are not renewable, and all demands must instead be met with permanent water resources.

- Replace supplies reduced due to drought conditions – The longevity of the existing drought and possible future sustained drought conditions are unknown. Reductions in water resources throughout the Colorado River Basin are expected to continue due to drought and climate change.

It is the SNWA's responsibility to ensure sufficient water is available, treated, and distributed to the residents of southern Nevada. Reliance on one source of supply, such as the Colorado River with the current drought and future climate change, threatens the SNWA's ability to meet this responsibility as well as have sufficient supplies to meet future growth. The Project is necessary to ensure the SNWA meets its responsibility to the residents of southern Nevada.

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Appendix A

Colorado River Extended Shortage Analysis

A.1.0 PURPOSE

The following analysis demonstrates that water resources from the Project can be managed conjunctively with the SNWA Colorado River allocation and other current resources available to the SNWA to meet future demands and respond to the current and future droughts. This analysis illustrates the importance and necessity of the Project during shortages on the Colorado River; demonstrates how the SNWA could conjunctively manage the Project during times of surplus on the Colorado River or during times when other resources are available to the SNWA; and demonstrates that even during periods of high flows, the Colorado River will still experience periodic drought.

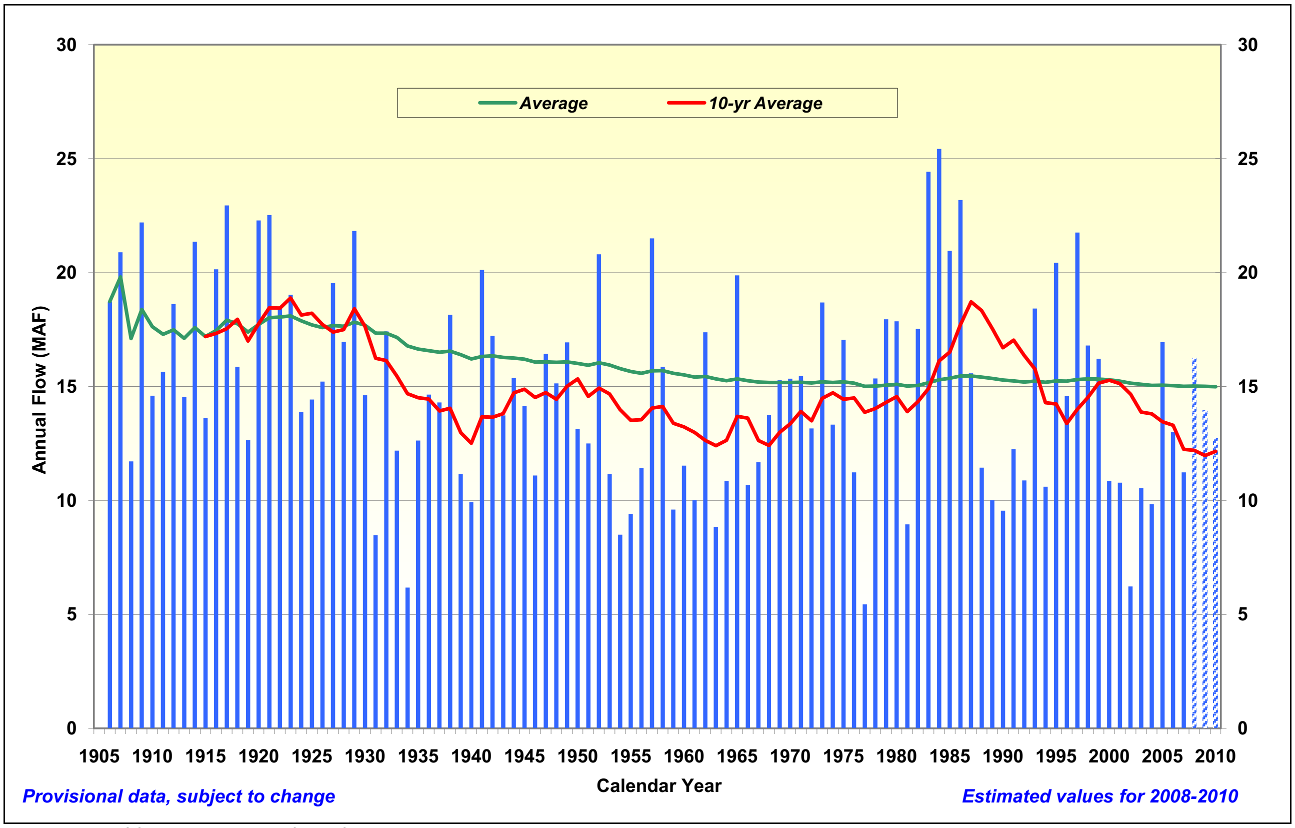
A.2.0 METHODOLOGY

A.2.1 Colorado River Simulation System (CRSS)

CRSS is the BOR's computer model used to evaluate long-term policy and address long-term planning for the Colorado River System. The CRSS data used for this analysis was obtained from the BOR (Jerla, pers. comm., 2010). The first model was created in the 1980's and has evolved through several different modeling platforms. Since 1996, the CRSS model has been implemented in RiverWare. The model used for this analysis was also used in the development of the Interim Guidelines. Detailed modeling documentation can be found in the Final Environmental Impact Statement (FEIS) for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (BOR, 2007).

CRSS is used to simulate the future conditions of the Colorado River system on a monthly time step from 2010 through 2060. Output data include reservoir storage, releases from dams, hydroelectric generation, etc. Input data for the model includes monthly natural flow at 29 nodes throughout the Colorado River system. Input data also includes physical parameters (e.g., individual reservoir storage capacity, evaporation rates, and reservoir release capabilities), initial reservoir conditions, and the diversion and depletion schedules for entities in the seven Colorado River Basin States (Basin States) and Mexico. Operating rules for current or proposed operating policies are considered input.

Although several methods are available for ascertaining the range of possible future inflows, the BOR utilizes the existing historical record of natural flows to create several distinct hydrologic sequences that are then used in a series of simulations. For this process, the BOR used a particular technique for sampling from the historical record known as the Indexed Sequential Method, or ISM (BOR, 1985; Ouarda et al., 1997). Each future hydrologic sequence is generated from the historical natural flow record by "cycling" through the record. This method produces the "n" possible flow sequences, where "n" corresponds to the number of years in the flow data set. Using the historical natural flow data from 1906 through 2007, with ISM results in a set of 102 separate simulations referred to as "traces" or "hydrological sequences." This enables an evaluation of proposed operating policies over a broad range of possible future hydrologic conditions. Evaluations typically include all 102 traces using statistical techniques. Natural flow data is shown in Figure A-1.



Source: Prairie, pers. comm. (2010)

Figure A-1
Colorado River at Lees Ferry, Arizona–Natural Flow

Using ISM, CRSS generates a wide range of hydrologic possibilities which include periods of extreme drought and periods of above average flow, allowing evaluation of future conditions under a wide range of future flows. Model output is sensitive to input diversion and depletion schedules. Actual future depletion schedules, especially when simulating system conditions far into the future (beyond 20 years from the present) may differ. Moreover, it is possible that future flows may include periods of wet or dry conditions that are outside of all the possible sequences seen in the historical record.

Since the FEIS (BOR, 2007) on the Interim Guidelines, the following modeling parameters and assumptions have been changed by the BOR, some of which are specific to the modeling for this analysis:

1. Upper Basin demands – The Upper Basin demand schedules are periodically updated as new information is compiled. The Upper Basin demands have been updated since the FEIS (BOR, 2007).

2. Lower Basin Intentionally Created Surplus Schedules – The Lower Basin Intentionally Created Surplus Schedules used in the FEIS (BOR, 2007) were designed to evaluate the impacts associated with adopting such a program. Since then, the model schedules have been updated.

3. Starting conditions for reservoirs are actual end of calendar year 2009 conditions. The FEIS (BOR, 2007) was run with a forecast for end of calendar year 2007 conditions. The model is updated twice a year to reflect the then-current reservoir starting conditions.

4. Guidelines extended beyond 2026 (specific to modeling for this analysis) – Interim Guidelines are in place until 2026. At such a time the operating guidelines, including the volumes of shortages, may be revisited or extended. During the development of the Interim Guidelines other states felt the SNWA should take a large share in shortages and in 2026 the volume of shortages to Nevada could be increased. After 2026, the model is set to either revert back to the operating conditions in place prior to the adoption of the Interim Guidelines or to use operating criteria and shortage volumes in the Interim Guidelines beyond 2026 to provide a uniform set of policy for the entire modeling period. All of the Basin States and the BOR realize it is highly unlikely the previous operating guidelines will be used. In addition, it is unknown what future shortage amounts will be beyond 2026. Therefore, in this analysis the operating criteria and shortage volumes in the Interim Guidelines were extended beyond 2026 to provide a uniform set of policy for the entire modeling period.

A.2.2 Analysis

This analysis was conducted by the SNWA and used to show how demand would be met in any year based on a specific trace of hydrology from the CRSS model. The water demands used were from the 2009 Water Resource Plan (SNWA, 2009). The following resource assumptions were made:

- When Lake Mead goes below 1,000 ft amsl:

  - The Project at 184,655 afy delivery (consumptive use, which for the purpose of this report means 184,655 afy will be delivered from the project to customers and this resource will be expanded by approximately seventy percent because of the return flow credits it will generate. When viewing numerical volumes later in the report of Project Demands, this volume includes the additional fraction gained by the generation of return flow credits. When Lake Mead drops below elevation 1,000 ft amsl, no return flow credits are generated and the volume represented is simply the amount of water conveyed from the project to the Las Vegas Valley.)

  - No Colorado River resources available (consumptive use or return flows) because current and planned infrastructure does not allow for deliveries at this elevation. The SNWA would be taking many different extraordinary emergency response measures to ensure water deliveries from Lake Mead. The viability of these future measures are not known; therefore, a conservative approach, assuming no water being available, was used for this analysis.

- Groundwater Las Vegas Valley – No change to current operations which consist of 46,340 afy of consumptive use.

- Unused Nevada Colorado River Apportionment (non-SNWA) – As reflected in the 2009 Water Resource Plan.

- Intentionally Created Surplus:

  - Available throughout planning horizon, unless Lake Mead is below 1,000 ft amsl
  - Virgin and Muddy Rivers: 30,000 afy consumptive use
  - Coyote Spring Valley groundwater: 9,000 afy consumptive use

- Brock Reservoir – 400,000 af of water that is available from 2011 to 2036, but only during normal and surplus conditions on the Colorado River. The maximum annual delivery is 40,000 af and no more than 100,000 af can be delivered between 2011 and 2015.

- Temporary Banked water resources – Banked water resources are treated like a savings account; they are exhaustible and are set aside and preserved for use when other permanent supplies are unavailable. For this analysis, some preservation of the banked water resources was assumed to mimic real operational decisions that would likely be made to keep some water in savings as a cushion for future uncertainty. California and Arizona Banks are not available when Lake Mead is below 1,000 ft amsl. The dates for use represent assumptions specific to this analysis.

  - Southern Nevada (Las Vegas Valley Groundwater): It is unclear the maximum annual withdrawal that could be made without adverse impacts. For this analysis 333,000 af is available with a maximum annual recovery of 20,000 afy of consumptive use.

  - Arizona Bank: 1,250,000 af is available with a maximum annual recovery of 40,000 afy of consumptive use beginning in 2018 and available through 2060. The SNWA's ability to recover water may be reduced in the event certain municipal entities in Arizona are experiencing shortages.

  - California Bank: 70,000 af is available with a maximum annual recovery of 30,000 afy consumptive use beginning in 2022 and available through 2060.

- The Project:

  - Will be available in 2020
  - Volume: 9,000 afy minimum (base-flow) to 184,655 afy maximum pumping/delivery

- Colorado River consumptive use (and return flow credits) based on reservoir conditions specified in the Interim Guidelines:

  - Flood Control Surplus: unlimited Colorado River consumptive use available

- Domestic Surplus: additional 100,000 afy Colorado River consumptive use available

- Normal: quantity available to the SNWA varies over time consistent with the 2009 Water Resource Plan (a total of 300,000 afy is available to Nevada)

- Shortage Level 1 (Lake Mead less than elevation 1,075 ft amsl): Nevada basic apportionment reduced by 13,000 afy of consumptive use

- Shortage Level 2 (Lake Mead less than elevation 1,050 ft amsl): Nevada basic apportionment reduced by 17,000 afy of consumptive use

- Shortage Level 3 (Lake Mead less than elevation 1,025 ft amsl): Nevada basic apportionment reduced by 20,000 afy of consumptive use

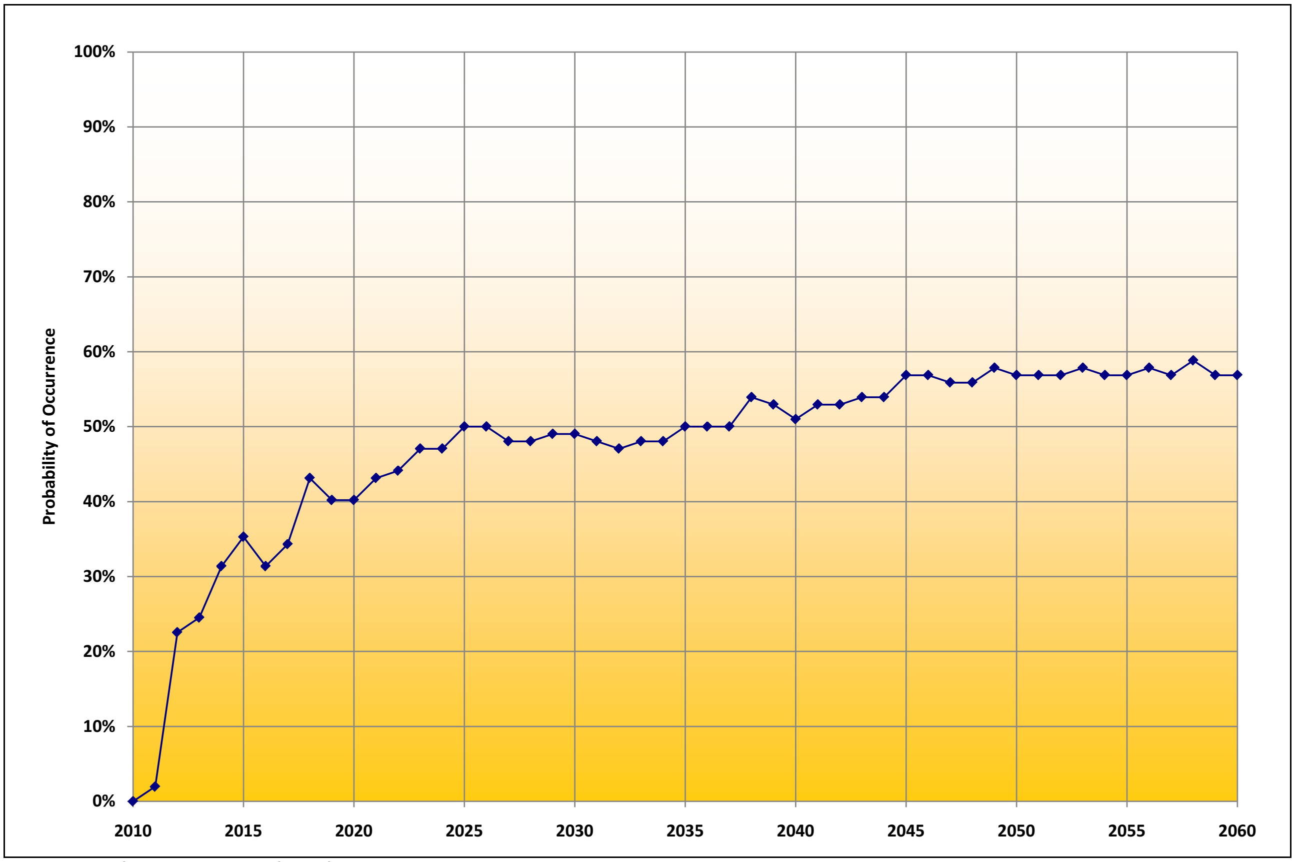
- Additional Assumptions for this analysis:
  Shortage Level 3 is currently the last shortage level defined for the Lower Basin. However, Section 7.B.4 of the Interim Guidelines state that if Lake Mead is below elevation 1,025 ft amsl and likely to drop below elevation 1,000 ft amsl, "the Secretary shall consult with the Basin States to discuss further measures that may be undertaken." The outcome of this consultation is unknown; however, it is likely to result in larger shortages. In order to more accurately represent this provision of the Interim Guidelines, this analysis assumed Nevada's basic apportionment will be reduced by 40,000 afy of consumptive use during the third consecutive year of a Shortage Level 3 and the Arizona Bank would not be available. This condition is referred to as an Extended Shortage.

A.3.0 RESULTS

The following section shows the probability of shortages and specific Lake Mead elevations based on CRSS. The analysis demonstrates that water resources from the Project can be managed conjunctively with water from the Colorado River and other current resources available to the SNWA to meet future demands and respond to the current and future droughts. Shortages on the Colorado River combined with increasing demands justify a significant need for the project under a wide range of scenarios on the Colorado River.

As evidenced by Figure A-2, there is a forty percent probability by 2020, and a fifty percent probability by 2025, that in any given year the Lower Basin will be in shortage, which would result in reduced Colorado River water deliveries to Nevada. This means that for a given year, for instance 2035, half of the hydrological sequences modeled result in Lake Mead being in a declared shortage condition, where Lake Mead is at or below elevation 1,075 ft amsl on January 1 of that year.

CRSS was also used to demonstrate statistically, the frequency and duration of shortages. This data is presented in Table A-1. A shortage sequence for this analysis is defined as a period of time when one or more consecutive years of shortage occur. For example, if a trace showed Lake Mead being in shortage from 2015 to 2024 and again from 2030 to 2035, this trace would be said to have two shortage sequences; one lasting 10 years, and one lasting 6 years. In all 102 traces, every single trace



Source: Jerla, pers. comm. (2010)

Figure A-2
Probability of Shortage

Table A-1
Frequency and Duration of Shortages

	Average	Minimum	Maximum	Median
Number of Shortage Sequences	1.90	1.00	4.00	2.00
Average Duration of Shortage Sequence (years)	15.52	2.67	49.00	11.58

identifies at least one shortage sequence to the Lower Basin users of the Colorado River between now and 2060 and these shortages last over 15 consecutive years on average.

As stated in the Section A.1.0, three modeling scenarios or traces were chosen to illustrate that the Project is needed to meet demands when Colorado River flows are dry, average, and wet. From the 102 CRSS traces that were modeled, the following are representations of possible future conditions based on the total amount of inflow into Lake Powell for the modeling period.

- The 10th Percentile represents a dry hydrological sequence in comparison to other modeled hydrological sequences because the total inflow to Lake Powell for this hydrological sequence represents a case where only ten percent of the hydrological sequences are at or below this inflow. In this analysis this dry hydrological sequence will be referred to as "Future Conditions on the Colorado River–Dry." Although we call this a dry scenario it mimics a hydrological sequence that has occurred in the past and has both wet years and dry years which when combined results in lower average inflows to Lake Powell. From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 14.2 maf.

- The Average represents a hydrological sequence that has the same approximate total inflow to Lake Powell as the average of all of the hydrological sequences. In this analysis this average hydrological sequence will be referred to as "Future Conditions on the Colorado River–Average." From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 15.0 maf.

- The 90th Percentile represents a wet hydrological sequence in comparison to the other modeled hydrological sequences because the total inflow to Lake Powell for this hydrological sequence represents a case where only ten percent of the hydrological sequences are greater than this inflow. In this analysis this wet hydrological sequence will be referred to as "Future Conditions on the Colorado River–Wet." Although we call this a wet scenario it mimics a hydrological sequence that has occurred in the past and has both wet years and dry years, which when combined results in higher average inflows to Lake Powell. From 2010 to 2060 this scenario models an average annual inflow to Lake Powell of 15.8 maf.

The Lake Mead elevations and corresponding reservoir conditions for each of these hydrological sequences is plotted in Figures A-3 through A-5.

Based on Lake Mead Elevations in the above traces, it is apparent that even under average and wet hydrology on the Colorado River, Nevada will still experience Extended Shortages of Colorado River deliveries. Even under higher flow conditions, there is still a period of over ten years where the Lower Basin is consistently experiencing shortage. It is also important to note that going into a shortage, planners have little indication of whether the shortage will last 2 years, or 50 years, so planning must consider lengthy shortages. In the Future Conditions on the Colorado River–Wet hydrological sequence, there is a ten year period when shortages will be declared and Nevada will not be able to take its full Colorado River apportionment. However, even in the Future Conditions of the Colorado River–Dry hydrological sequence, there will be periods of surplus on the Colorado River.

The analysis illustrates how demands could be met using the SNWA's water resource portfolio and the Project. A graph and a table is provided for each of the three traces showing the amount of water utilized from the Project to illustrate how the SNWA might manage its water resource portfolio. The data is presented in Tables A-2 through A-4 and the values are in acre-feet. The values for the Project and return flows where appropriate under the Colorado River Operative conditions. The demand for the Project is also presented graphically in Figures A-6 through A-8.

Table A-2 and Figure A-6 show how resources might be managed under dry conditions on the Colorado River. There are thirty consecutive years of shortages on the Colorado River and there are three periods of time in this scenario when Lake Mead drops below elevation 1,000 ft amsl, and we are assuming no water would be available from the Colorado River or related resources. In these

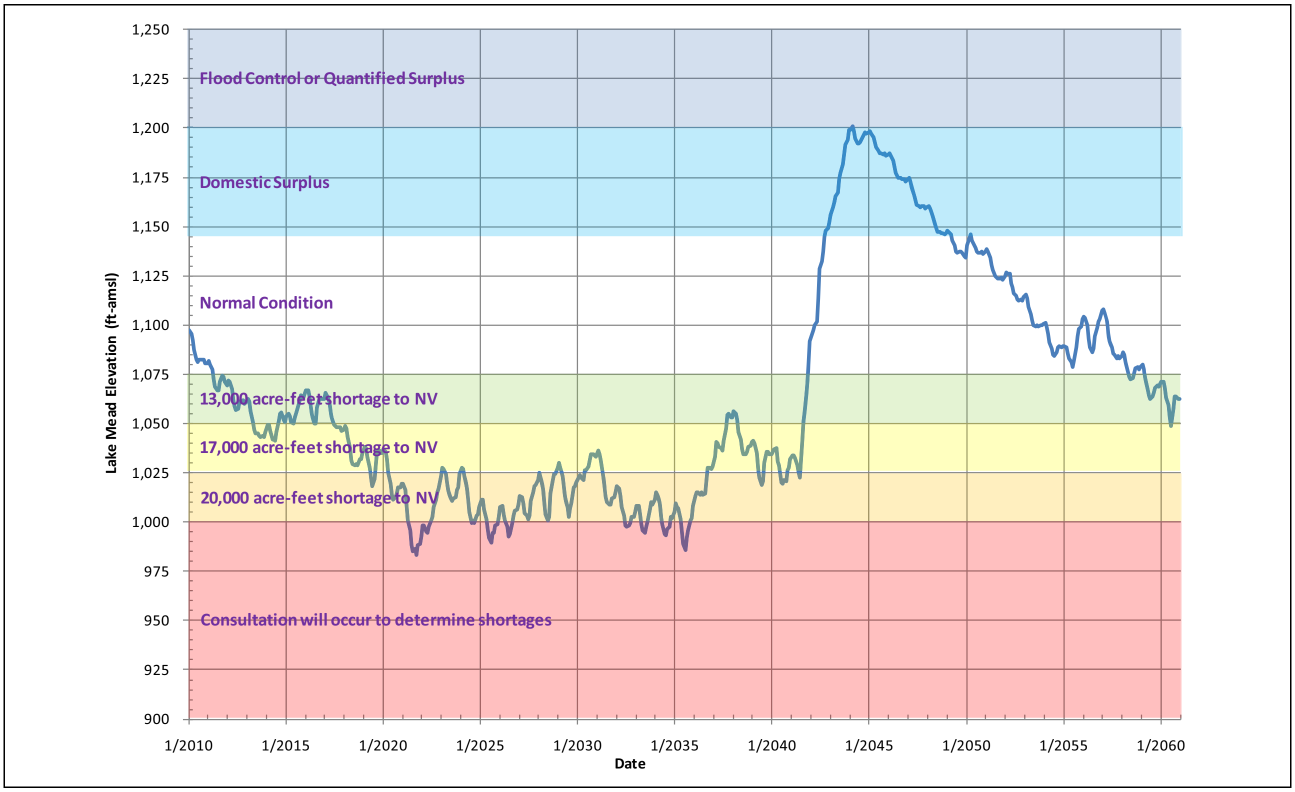


Figure A-3
Future Conditions on the Colorado River–Dry

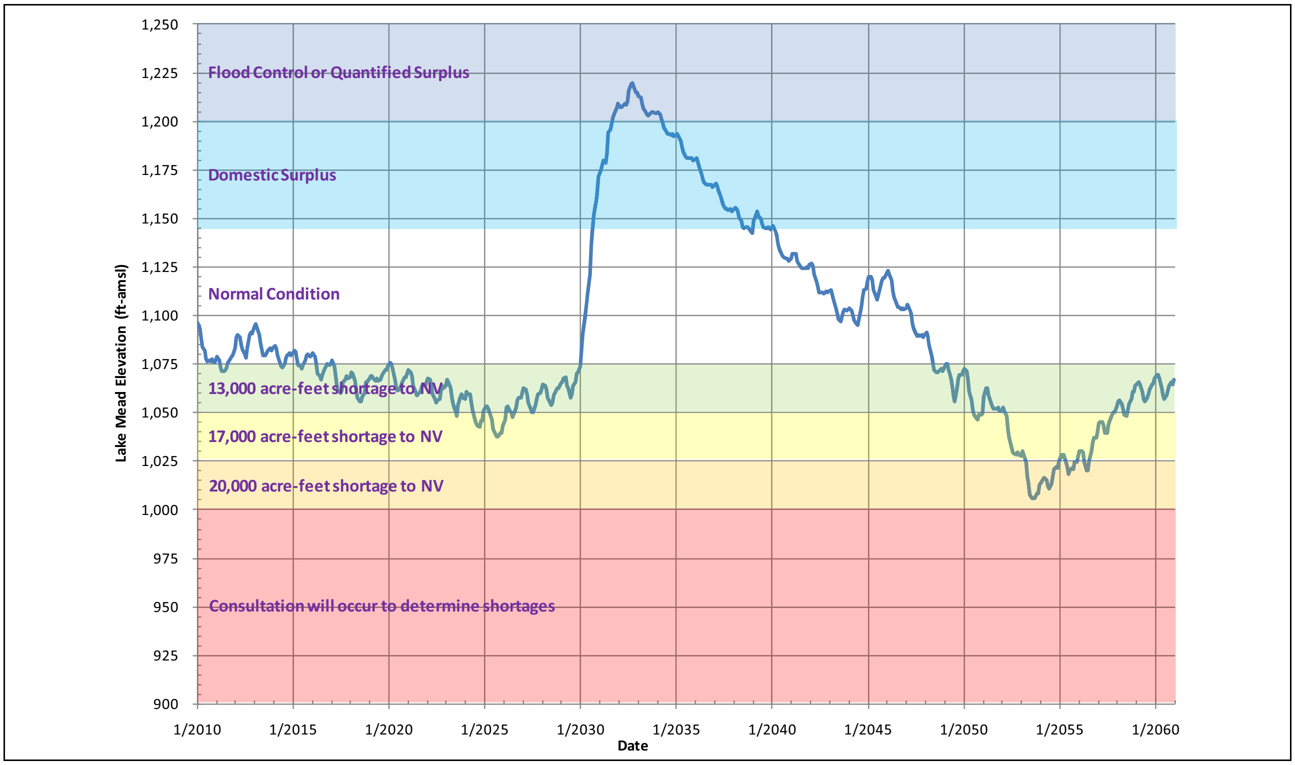


Figure A-4
Future Conditions on the Colorado River–Average

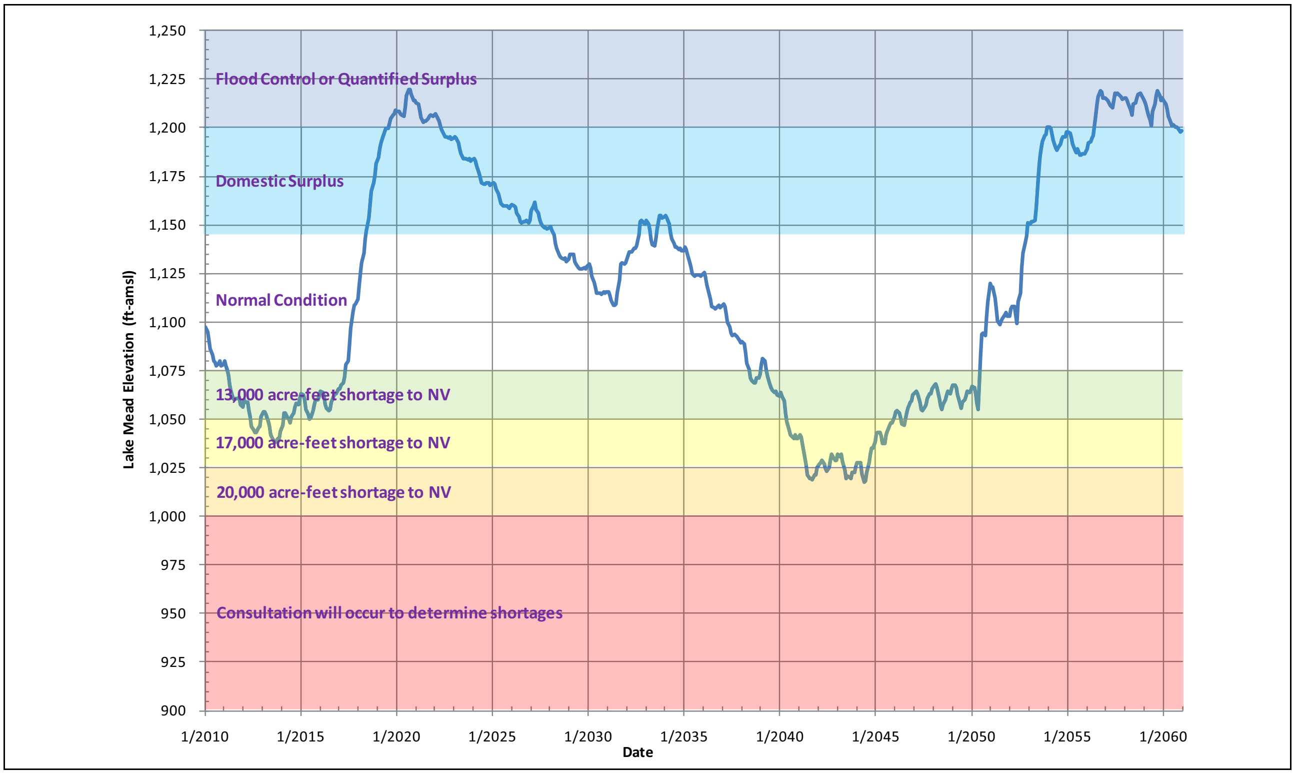


Figure A-5
Future Conditions on the Colorado River–Wet

years, the Project makes up approximately 67 percent of the supplies available to the SNWA. Even with the Project, there is still a significant portion of demands that cannot be met when Lake Mead drops below elevation 1,000 ft amsl; however, the Project provides essential water for health and human safety during these times.

Table A-3 and Figure A-7 show how resources might be managed under average conditions on the Colorado River. Use of the Project gradually ramps up as demands increase. During the 13 consecutive years of shortage that occur in the early part of this trace, the Project provides water to meet demands when other resources are limited. This is again seen in the second shortage sequence when the Project demands increase to help meet demands during shortage conditions on the Colorado River.

Table A-4 and Figure A-8 show how resources might be managed under wet conditions on the Colorado River. Under these wet conditions, the first use of the project begins in 2038 and slowly ramps up. The Project is still necessary to provide water during the shortage period on the Colorado River that occurs from 2039 to 2050.

Table A-2
Future Conditions on the Colorado River–Dry

Year	2009 Resource Plan Demands	Colorado River Condition	Permanent Supplies	Temporary Supplies	Groundwater Project
2010	552,500	Normal	641,329	0	0
2011	569,755	Normal	639,368	0	0
2012	586,281	Step1	615,307	0	0
2013	601,989	Step1	613,346	0	0
2014	616,794	Step2	604,586	12,208	0
2015	630,612	Step1	609,425	21,187	0
2016	643,366	Step1	607,464	35,902	0
2017	654,980	Step1	605,503	49,477	0
2018	665,386	Step2	596,742	68,644	0
2019	675,210	Step2	594,781	80,429	0
2020	684,422	Step2	592,821	91,602	0
2021	692,288	Step3	72,140	20,000	184,655
2022	699,472	Step3	583,799	0	115,673
2023	705,952	Step3	547,838	0	158,114
2024	711,707	Step3	72,140	20,000	184,655
2025	716,718	Step3	72,140	20,000	184,655
2026	720,969	Step3	72,140	20,000	184,655
2027	724,445	Step3	539,995	68,000	116,451
2028	727,880	Step3	538,034	68,000	121,846
2029	730,523	Step2	575,173	68,000	87,350
2030	732,365	Step3	568,112	68,000	96,253
2031	734,151	Step2	571,252	68,000	94,900
2032	735,880	Step3	72,140	20,000	184,655
2033	737,550	Step3	72,140	20,000	184,655
2034	739,159	Step3	72,140	20,000	184,655
2035	738,818	Step3	72,140	20,000	184,655
2036	745,284	Step3	532,152	68,000	145,133
2037	749,965	Step2	571,252	68,000	110,713
2038	754,754	Step1	578,052	68,000	108,702
2039	759,657	Step2	571,252	68,000	120,406
2040	764,681	Step2	571,252	68,000	125,429
2041	769,830	Step2	571,252	68,000	130,579
2042	775,111	Normal	600,152	68,000	106,960
2043	780,530	Domestic	765,230	0	15,300
2044	786,092	Domestic	770,152	641	15,300
2045	791,804	Domestic	770,152	6,352	15,300
2046	797,670	Domestic	770,152	12,218	15,300
2047	803,697	Domestic	770,152	18,246	15,300
2048	809,891	Domestic	770,152	24,440	15,300
2049	816,257	Domestic	770,152	30,806	15,300
2050	822,802	Normal	600,152	68,000	154,651
2051	829,531	Normal	600,152	68,000	161,379
2052	836,450	Normal	600,152	68,000	168,298
2053	843,564	Normal	600,152	68,000	175,413
2054	850,880	Normal	600,152	68,000	182,729
2055	858,404	Normal	600,152	68,000	190,252
2056	866,140	Normal	600,152	68,000	197,989
2057	873,877	Normal	600,152	68,000	205,725
2058	881,614	Normal	600,152	68,000	213,462
2059	889,350	Normal	600,152	68,000	221,199
2060	897,087	Step1	578,052	68,000	251,035

Color	Colorado River Condition
	Flood Control Surplus
	Domestic Surplus
	Normal
	Step 1 Shortage
	Step 2 Shortage
	Step 3 Shortage
	Step 3 Shortage for 3rd consecutive year (Extended Shortage)
	Step 3 Shortage when Lake Mead drops below elevation 1,000 ft amsl

Table A-3
Future Conditions on the Colorado River–Average

Year	2009 Resource Plan Demands	Colorado River Condition	Permanent Supplies	Temporary Supplies	Groundwater Project
2010	552,500	Normal	641,329	0	0
2011	569,755	Normal	639,368	0	0
2012	586,281	Normal	637,407	0	0
2013	601,989	Normal	635,446	0	0
2014	616,794	Normal	633,486	0	0
2015	630,612	Normal	631,525	14,774	0
2016	643,366	Normal	629,564	28,508	0
2017	654,980	Normal	627,603	41,102	0
2018	665,386	Step1	603,542	61,844	0
2019	675,210	Step1	601,581	73,629	0
2020	684,422	Step1	599,621	84,802	0
2021	692,288	Step1	597,660	94,628	0
2022	699,472	Step1	595,699	103,773	0
2023	705,952	Step1	593,738	112,214	0
2024	711,707	Step1	591,777	119,930	0
2025	716,718	Step1	589,816	126,902	0
2026	720,969	Step2	581,056	134,337	5,577
2027	724,445	Step1	585,895	102,000	36,551
2028	727,880	Step1	583,934	102,000	41,946
2029	730,523	Step1	581,973	102,000	46,550
2030	732,365	Step1	580,012	102,000	50,353
2031	734,151	Domestic	718,851	0	15,300
2032	735,880	Flood	720,580	0	15,300
2033	737,550	Flood	722,250	0	15,300
2034	739,159	Domestic	723,859	0	15,300
2035	738,818	Domestic	723,518	0	15,300
2036	745,284	Domestic	729,984	0	15,300
2037	749,965	Domestic	734,665	0	15,300
2038	754,754	Domestic	739,454	0	15,300
2039	759,657	Normal	600,152	68,000	91,506
2040	764,681	Domestic	749,381	0	15,300
2041	769,830	Normal	600,152	68,000	101,679
2042	775,111	Normal	600,152	68,000	106,960
2043	780,530	Normal	600,152	68,000	112,378
2044	786,092	Normal	600,152	68,000	117,941
2045	791,804	Normal	600,152	68,000	123,652
2046	797,670	Normal	600,152	68,000	129,518
2047	803,697	Normal	600,152	68,000	135,546
2048	809,891	Normal	600,152	68,000	141,740
2049	816,257	Step1	578,052	68,000	170,206
2050	822,802	Step1	578,052	68,000	176,751
2051	829,531	Step2	571,252	68,000	190,279
2052	836,450	Step1	578,052	68,000	190,398
2053	843,564	Step2	571,252	68,000	204,313
2054	850,880	Step3	566,152	68,000	216,729
2055	858,404	Step3	566,152	68,000	224,252
2056	866,140	Step2	571,252	68,000	226,889
2057	873,877	Step2	571,252	68,000	234,625
2058	881,614	Step1	578,052	67,431	236,131
2059	889,350	Step1	578,052	0	311,299
2060	897,087	Step1	578,052	5,122	313,914

Color	Colorado River Condition
	Flood Control Surplus
	Domestic Surplus
	Normal
	Step 1 Shortage
	Step 2 Shortage
	Step 3 Shortage
	Step 3 Shortage for 3rd consecutive year (Extended Shortage)
	Step 3 Shortage when Lake Mead drops below elevation 1,000 ft amsl

Table A-4
Future Conditions on the Colorado River–Wet

Year	2009 Resource Plan Demands	Colorado River Condition	Permanent Supplies	Temporary Supplies	Groundwater Project
2010	552,500	Normal	641,329	0	0
2011	569,755	Normal	593,028	0	0
2012	586,281	Step1	586,281	0	0
2013	601,989	Step1	601,989	0	0
2014	616,794	Step2	604,586	12,208	0
2015	630,612	Step1	609,425	21,187	0
2016	643,366	Step1	607,464	35,902	0
2017	654,980	Step1	605,503	49,477	0
2018	665,386	Normal	625,642	39,744	0
2019	675,210	Flood	675,210	0	-
2020	684,422	Flood	684,422	0	-
2021	692,288	Flood	692,288	0	-
2022	699,472	Domestic	741,459	0	0
2023	705,952	Domestic	739,498	0	0
2024	711,707	Domestic	737,537	0	0
2025	716,718	Domestic	735,576	0	0
2026	720,969	Domestic	733,616	0	0
2027	724,445	Domestic	731,655	0	0
2028	727,880	Domestic	729,694	0	0
2029	730,523	Normal	604,073	126,450	0
2030	732,365	Normal	602,112	130,253	0
2031	734,151	Normal	600,152	134,000	0
2032	735,880	Normal	600,153	135,728	0
2033	737,550	Domestic	723,812	13,738	0
2034	739,159	Domestic	723,812	15,348	0
2035	738,818	Normal	600,152	138,666	0
2036	745,284	Normal	600,152	145,133	0
2037	749,965	Normal	600,152	149,813	0
2038	754,754	Normal	600,152	68,000	86,602
2039	759,657	Step1	578,052	68,000	113,606
2040	764,681	Step1	578,052	68,000	118,629
2041	769,830	Step2	571,252	68,000	130,579
2042	775,111	Step2	571,252	68,000	135,860
2043	780,530	Step2	571,252	68,000	141,278
2044	786,092	Step2	571,252	68,000	146,841
2045	791,804	Step2	571,252	68,000	152,552
2046	797,670	Step1	578,052	68,000	151,618
2047	803,697	Step1	578,052	68,000	157,646
2048	809,891	Step1	578,052	68,000	163,840
2049	816,257	Step1	578,052	68,000	170,206
2050	822,802	Step1	578,052	68,000	176,751
2051	829,531	Normal	600,152	68,000	161,379
2052	836,450	Normal	600,152	68,000	168,298
2053	843,564	Domestic	760,264	68,000	15,300
2054	850,880	Domestic	767,580	68,000	15,300
2055	858,404	Domestic	770,152	68,000	20,252
2056	866,140	Flood	850,840	0	15,300
2057	873,877	Flood	858,577	0	15,300
2058	881,614	Flood	866,314	0	15,300
2059	889,350	Flood	874,050	0	15,300
2060	897,087	Flood	881,787	0	15,300

Color	Colorado River Condition
	Flood Control Surplus
	Domestic Surplus
	Normal
	Step 1 Shortage
	Step 2 Shortage
	Step 3 Shortage
	Step 3 Shortage for 3rd consecutive year (Extended Shortage)
	Step 3 Shortage when Lake Mead drops below elevation 1,000 ft amsl

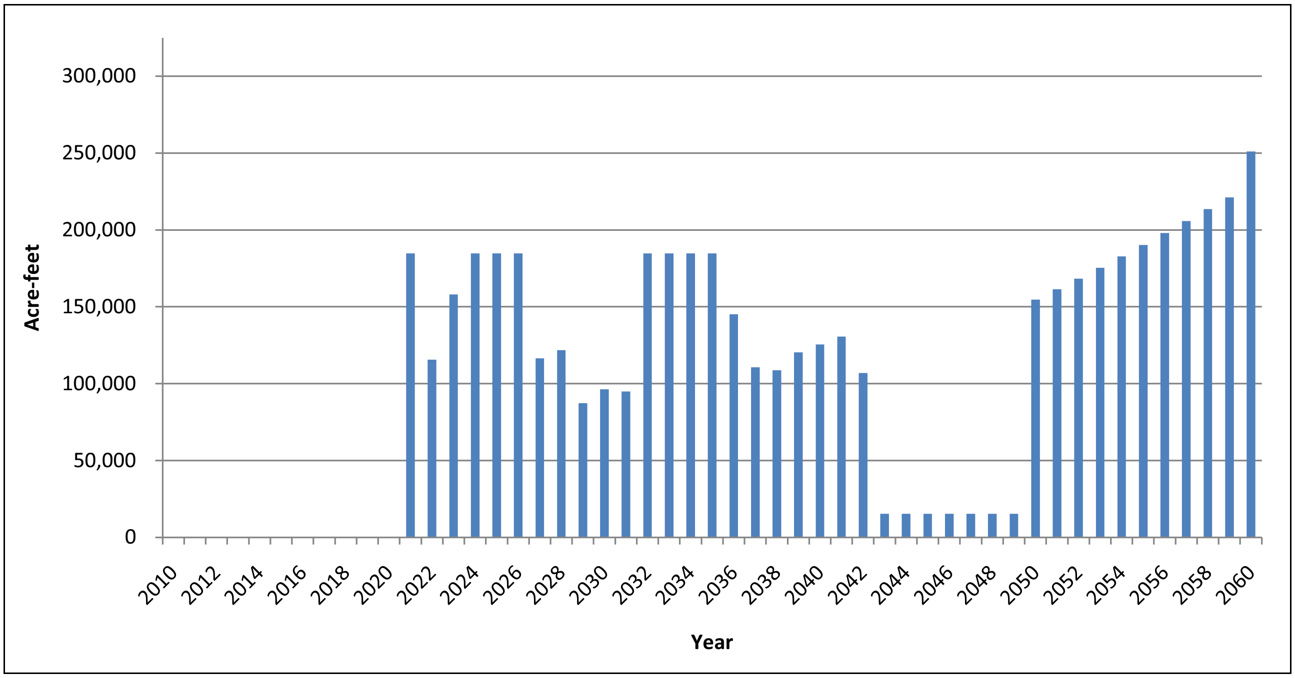


Figure A-6
Project Demands (including return flow credit contribution) under Future Conditions on the Colorado River–Dry

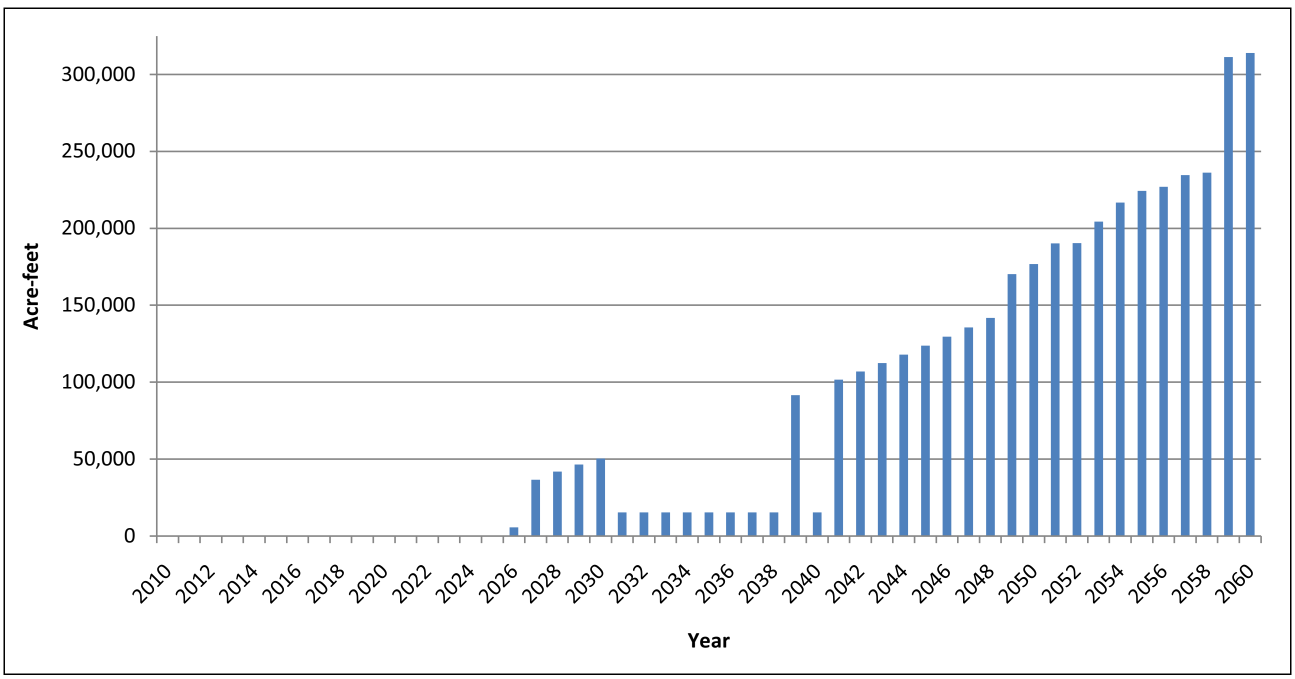


Figure A-7
Project Demands (including return flow credit contribution) under Future Conditions on the Colorado River–Average

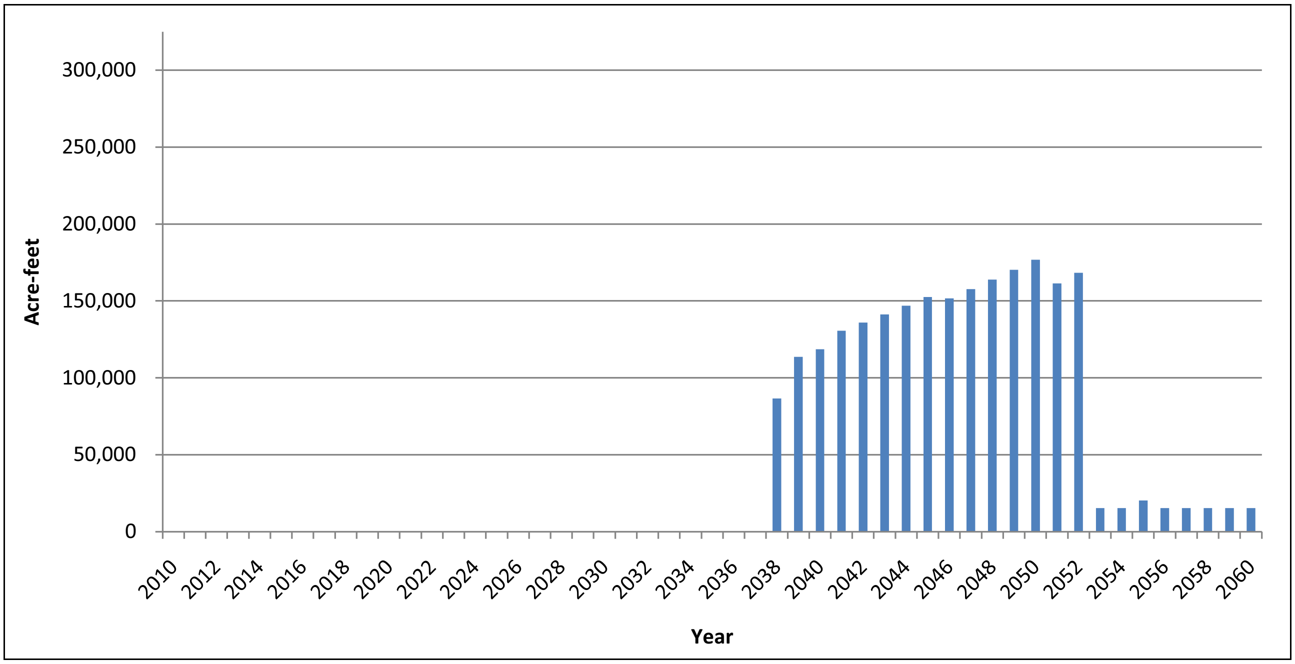


Figure A-8
Project Demands (including return flow credit contribution) under Future Conditions on the Colorado River–Wet

A.4.0 CONCLUSIONS

When considering dry, average, and wet Colorado River flows, the Project is critical for the SNWA to meet future demands. These three traces demonstrate the range of variable flows that might occur on the Colorado River and the need for the Project in each hydrological sequence. This analysis illustrates the need for water resource management and adaptability. However, a water supply independent of the Colorado River is essential.

The above analysis demonstrates how water resources from the Project can be managed conjunctively with Colorado River and other current resources available to the SNWA to meet future demands and respond to current and future droughts. The analysis illustrates the importance of the Project during shortages on the Colorado River and the importance of conjunctive management which will allow for periods of rest and recovery for the Project during times of surplus on the Colorado River.

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