

## **Executive Summary**

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## ES.1 Background

The Secretary of the Department of the Interior (Secretary), acting through the Bureau of Reclamation (Reclamation), proposes to adopt specific interim guidelines for Colorado River Lower Basin (Lower Basin) shortages and coordinated operations for Lake Powell and Lake Mead, particularly under drought and low reservoir conditions.

Reclamation, as the agency that is designated to act on the Secretary's behalf with respect to operation of Glen Canyon Dam and Hoover Dam and managing the mainstream waters of the lower Colorado River pursuant to federal law, is the lead federal agency for the purposes of compliance pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended, for the development and implementation of the proposed interim guidelines. Five federal agencies are cooperating for purposes of assisting with environmental analysis and preparation of this Environmental Impact Statement (EIS). The cooperating agencies are the Bureau of Indian Affairs (BIA), United States Fish and Wildlife Service (FWS), National Park Service (NPS), Western Area Power Administration (Western), and the United States Section of the International Boundary and Water Commission (USIBWC).

Volume I of the Final EIS includes six chapters as outlined below:

- ◆ Chapter 1: Purpose and Need;
- ◆ Chapter 2: Description of Alternatives;
- ◆ Chapter 3: Affected Environment;
- ◆ Chapter 4: Environmental Consequences;
- ◆ Chapter 5: Other Considerations and Cumulative Impacts; and
- ◆ Chapter 6: Consultation and Coordination.

In addition to the above, Volumes II and III contain appendices which are comprised of documents and other supporting materials concerning the proposed federal action. Volume IV contains reproductions of letters received from the public review of the Draft EIS, and Reclamation's responses to comments received.

### ES.1.1 Purpose and Need for Action

The eight-year period from 2000 through 2007 was the driest eight-year period in the 100-year historical record of the Colorado River. This drought in the Colorado River Basin has reduced Colorado River system storage, while demands for Colorado River water supplies have continued to increase. From October 1, 1999 through September 30, 2007, storage in Colorado River reservoirs decreased from 55.8 maf (approximately 94 percent of capacity) to 32.1 maf (approximately 54 percent of capacity), and was as low as 29.7 maf (approximately 52 percent of capacity) in 2004. Currently, the Department of the Interior (Department) does

not have specific operational guidelines in place to address the operations of Lake Powell and Lake Mead during drought and low reservoir conditions.

The purpose of the proposed federal action is to: 1) improve Reclamation's management of the Colorado River by considering trade-offs between the frequency and magnitude of reductions of water deliveries, and considering the effects on water storage in Lake Powell and Lake Mead, and on water supply, power production, recreation, and other environmental resources; 2) provide mainstream United States users of Colorado River water, particularly those in the Lower Division states, a greater degree of predictability with respect to the amount of annual water deliveries in future years, particularly under drought and low reservoir conditions; and 3) provide additional mechanisms for the storage and delivery of water supplies in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions.

### **ES.1.2 Proposed Federal Action**

The proposed federal action includes the adoption of specific interim guidelines for Lower Basin shortages and coordinated operations for Lake Powell and Lake Mead. These interim guidelines would remain in effect for determinations to be made through 2025 regarding water supply and reservoir operating decisions through 2026 and would provide guidance each year in development of the Annual Operating Plan for Colorado River Reservoirs (AOP). This proposed federal action considers four operational elements that collectively are designed to address the purpose and need for the proposed federal action.

The interim guidelines would be used by the Secretary to:

- ◆ determine those circumstances under which the Secretary would reduce the annual amount of water available for consumptive use from Lake Mead to the Colorado River Lower Division states (Arizona, California, and Nevada) below 7.5 million acre-feet (maf) (a "Shortage") pursuant to Article II(B)(3) of the United States Supreme Court Decree in the case of *Arizona v. California*, 547 U.S. 150 (2006) (Consolidated Decree);
- ◆ define the coordinated operation of Lake Powell and Lake Mead to provide improved operation of these two reservoirs, particularly under low reservoir conditions;
- ◆ allow for the storage and delivery, pursuant to applicable federal law, of conserved Colorado River system and non-system water in Lake Mead to increase the flexibility of meeting water use needs from Lake Mead, particularly under drought and low reservoir conditions; and
- ◆ determine those conditions under which the Secretary may declare the availability of surplus water for use within the Lower Division states. The proposed federal action would modify the substance of the existing Interim Surplus Guidelines (ISG), published in the Federal Register on January 25, 2001 (66 Fed. Reg. 7772), and the term of the ISG from 2016 to 2026.

### ES.1.3 Geographic Scope

The geographic region that could potentially be affected by the proposed federal action begins with Lake Powell and extends downstream along the Colorado River floodplain to the Southerly International Boundary (SIB) with Mexico. In addition to the potential impacts that may occur within the river corridor, the alternatives may also affect the water supply that is available to specific Colorado River water users in the Lower Basin. The following water agency service areas are also included in the appropriate affected environment discussions:

- ◆ Arizona water users, particularly the lower priority water users located in the Central Arizona Project service area;
- ◆ the Southern Nevada Water Authority (SNWA) service area; and
- ◆ the Metropolitan Water District of Southern California (MWD) service area.

Figure ES-1 shows the geographic scope for the Final EIS.

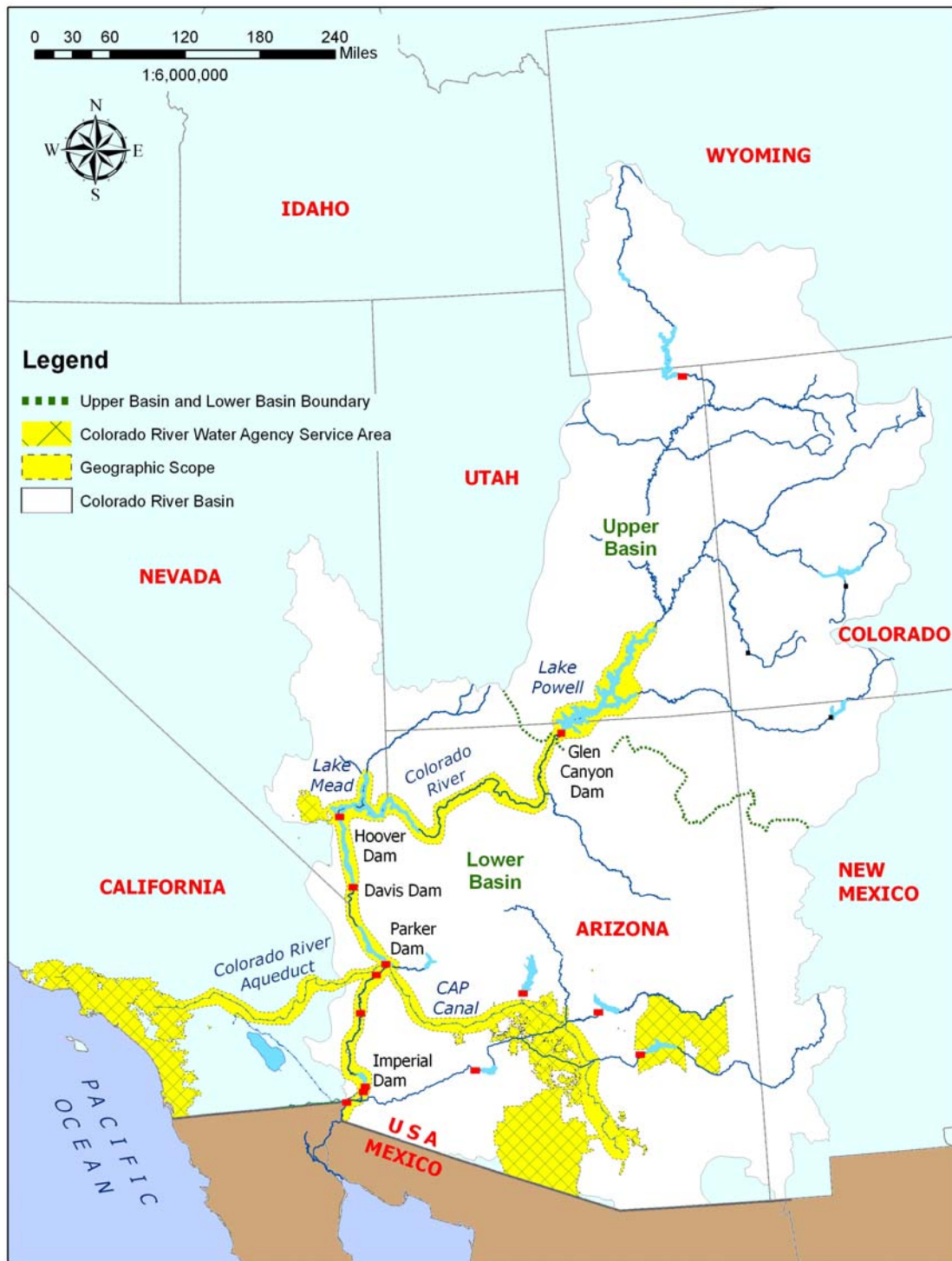
### ES.1.4 Alternatives

Six alternatives are considered and analyzed in this Final EIS. The alternatives consist of a No Action Alternative and five action alternatives. The five action alternatives are: Basin States Alternative, Conservation Before Shortage Alternative, Water Supply Alternative, Reservoir Storage Alternative, and the Preferred Alternative. The action alternatives reflect input from Reclamation staff, the cooperating agencies, stakeholders, and other interested parties.

Reclamation received two written proposals for alternatives that met the purpose and need of the proposed federal action, one from the seven Colorado River Basin States (Basin States) and another from a consortium of environmental non-governmental organizations (NGO). These proposals were used by Reclamation to formulate two of the alternatives considered and analyzed in the Final EIS (Basin States Alternative and Conservation Before Shortage Alternative). A third alternative (Water Supply Alternative) was developed by Reclamation, and a fourth alternative (Reservoir Storage Alternative) was developed by Reclamation in coordination with the NPS and Western. The No Action Alternative and the action alternatives analyzed in the Draft EIS were posted on Reclamation's website (<http://www.usbr.gov/lc/region/programs/strategies.html>) on June 30, 2006.

A fifth alternative, the Preferred Alternative, was developed after consideration of the comments received on the Draft EIS and further analysis. The Preferred Alternative was posted on Reclamation's website (same website address as above) on June 15, 2007 and is composed of operational elements from the action alternatives identified and analyzed in the Draft EIS.

Figure ES-1  
Geographic Scope



The Preferred Alternative is the most reasonable and feasible alternative; all environmental effects of this alternative, as well as the No Action Alternative and the remaining four action alternatives have been fully analyzed in this Final EIS. The identified environmental effects of the Preferred Alternative are well within the range of anticipated effects of the alternatives presented in the Draft EIS and do not affect the environment in a manner not already considered in the Draft EIS.

Reclamation selected from among the four key operational elements disclosed in the Draft EIS to formulate the Preferred Alternative. Reclamation has determined that the four operational elements selected under this alternative best meet all aspects of the purpose and need of the proposed federal action. Additionally, Reclamation has developed draft operational guidelines describing how the Preferred Alternative could be implemented during the interim period.

Summary descriptions of the No Action Alternative and the five action alternatives considered and evaluated in the Final EIS are provided below and in Table ES-1.

#### **ES.1.4.1 No Action Alternative**

The No Action Alternative provides a baseline for comparison of each of the action alternatives. The No Action Alternative represents a projection of future conditions that could occur during the life of the proposed federal action without an action alternative being implemented.

Pursuant to the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of September 30, 1968, or Long-Range Operating Criteria (LROC), the Secretary makes a number of determinations at the beginning of each operating year through the development and execution of the AOP, including the water supply available to users in the Lower Basin and the annual release from Lake Powell. However, the LROC currently does not include specific guidelines for such determinations. Furthermore, there is no actual operating experience under low reservoir conditions, i.e., there has never been a shortage determination in the Lower Basin. Therefore, in the absence of specific guidelines, the outcome of the annual determination in any particular year in the future cannot be precisely known. However, a reasonable representation of future conditions under the No Action Alternative is needed for comparison to each action alternative. The modeling assumptions used for this representation are consistent with the assumptions used in previous environmental compliance documents for the ISG, the Colorado River Water Delivery Agreement, and the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). However, the assumptions used in the No Action Alternative are not intended to limit or predetermine these decisions in any future AOP determination.

Table ES-1  
Matrix of Alternatives

Alternatives	Shortage Guidelines to Reduce Deliveries from Lake Mead (elevation in feet ms)	Coordinated Reservoir Operations (Lake Mead & Lake Powell) (elevation in feet ms)	Lake Mead Storage and Delivery of Conserved System and Non-system Water	Interim Surplus Guidelines (ISG) for Deliveries/Releases from Lake Mead
No Action	<ul style="list-style-type: none"> <li>Determination made through the AOP process, absent shortage guidelines</li> <li>Reasonably represented by a two-level shortage strategy - probabilistic protection of Lake Mead elevation 1,050 and absolute protection of Lake Mead elevation 1,000</li> </ul>	<ul style="list-style-type: none"> <li>Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required</li> <li>Operation at low reservoir levels reasonably represented by a 8.23 maf release from Lake Powell down to Lake Powell dead pool</li> </ul>	<ul style="list-style-type: none"> <li>No water management mechanism for storage and delivery of conserved system and non-system water</li> </ul>	<ul style="list-style-type: none"> <li>No modification or extension of the ISG which end in 2016</li> <li>After 2016, determination made through the AOP process, absent surplus guidelines; reasonably represented by the spill avoidance (referred to as the 70R) strategy</li> </ul>
Basin States	<ul style="list-style-type: none"> <li>Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively<sup>1</sup></li> <li>Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes consultation with Basin States)</li> </ul>	<ul style="list-style-type: none"> <li>Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required</li> <li>Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead</li> </ul>	<ul style="list-style-type: none"> <li>Creation, accounting, and delivery of ICS</li> <li>Maximum total ICS of 2.1 maf</li> <li>System assessment of 5% when ICS is created</li> </ul>	<ul style="list-style-type: none"> <li>Modification of ISG to eliminate Partial Domestic Surplus condition</li> <li>Extension of the modified guidelines through 2026</li> </ul>
Conservation Before Shortage	<ul style="list-style-type: none"> <li>Shortages are implemented in any given year when necessary to keep Lake Mead above SNWA's lower intake at elevation of 1,000 (absolute protection of elevation 1,000)</li> </ul>	<ul style="list-style-type: none"> <li>Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required</li> <li>Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead</li> </ul>	<ul style="list-style-type: none"> <li>Prior to shortage, conservation of different volumes of water tied to Lake Mead elevation</li> <li>Creation, accounting, and delivery of ICS</li> <li>Water for environmental uses</li> <li>Maximum total ICS of up to 4.2 maf</li> <li>System assessment of 5% when ICS is created</li> </ul>	<ul style="list-style-type: none"> <li>Modification of ISG to eliminate Partial Domestic Surplus condition</li> <li>Extension of the modified guidelines through 2026</li> </ul>
Water Supply	<ul style="list-style-type: none"> <li>Release full annual entitlement amounts until Lake Mead is drawn down to dead pool (elevation 895)</li> </ul>	<ul style="list-style-type: none"> <li>Minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required</li> <li>Balancing if Lake Powell is below elevation 3,575 or Lake Mead is below elevation 1,075</li> </ul>	<ul style="list-style-type: none"> <li>No water management mechanism for storage and delivery of conserved system and non-system water</li> </ul>	<ul style="list-style-type: none"> <li>Extension of the existing ISG through 2026</li> </ul>
Reservoir Storage	<ul style="list-style-type: none"> <li>Shortages (i.e., reduced deliveries in the United States) of 500, 667, 833, and 1,000 kaf from Lake Mead at elevations 1,100, 1,075, 1,050, and 1,025 respectively<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Minimum objective release of 8.23 maf from Lake Powell if Lake Powell is above elevation 3,595 unless storage equalization releases are required</li> <li>7.8 maf release from Lake Powell between Lake Powell elevations of 3,560 and 3,595</li> <li>Balancing below Lake Powell elevation 3,560</li> </ul>	<ul style="list-style-type: none"> <li>Storage and delivery of conserved system and non-system water</li> <li>Maximum total storage of conserved system and non-system water of 3.05 maf</li> <li>System assessment of 10% of stored conserved system and non-system water</li> </ul>	<ul style="list-style-type: none"> <li>Provisions of existing ISG terminate after 2007, and during period from 2008-2026, surplus determinations are limited to 70R and Flood Control conditions</li> </ul>
Preferred Alternative	<ul style="list-style-type: none"> <li>Shortages (i.e., reduced deliveries in the United States) of 333, 417, and 500 kaf from Lake Mead at elevations 1,075, 1,050, and 1,025 respectively<sup>1</sup></li> <li>Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1,025 (Note: includes consultation)</li> </ul>	<ul style="list-style-type: none"> <li>Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required</li> <li>Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead</li> </ul>	<ul style="list-style-type: none"> <li>Creation, accounting, and delivery of ICS</li> <li>Maximum total ICS in Lake Mead of up to 4.2 maf</li> <li>System assessment of 5% when ICS is created</li> </ul>	<ul style="list-style-type: none"> <li>Modification of ISG to eliminate Partial Domestic Surplus condition</li> <li>Extension of the modified guidelines through 2026</li> </ul>

<sup>1</sup> These are amounts of shortage (i.e., reduced deliveries in the United States). As in the Draft EIS, the Final EIS includes modeling assumptions that identify water deliveries to Mexico pursuant to the 1944 Treaty.



**ES.1.4.2 Basin States Alternative**

The Basin States Alternative was developed by the Basin States and proposes a coordinated operation of Lake Powell and Lake Mead that would minimize shortages in the Lower Basin and avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes shortages to conserve reservoir storage; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions; a mechanism (i.e., Intentionally Created Surplus or ICS) for the creation, accounting, and delivery of conserved system and non-system water; and a modification and extension of the ISG through 2026.

**ES.1.4.3 Conservation Before Shortage Alternative**

The Conservation Before Shortage Alternative was developed by a consortium of environmental non-governmental organization (NGOs), and includes voluntary, compensated reductions (shortages) in water use to minimize involuntary shortages in the Lower Basin and to avoid risk of curtailments of Colorado River water use in the Upper Basin. This alternative includes voluntary shortages prior to involuntary shortages; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions; an expanded ICS mechanism for the creation, accounting, and delivery of conserved system and non-system water, including water for environmental uses; and modification and extension of the ISG through 2026.

**ES.1.4.4 Water Supply Alternative**

The Water Supply Alternative maximizes water deliveries at the expense of retaining water in storage in the reservoirs for future use. This alternative would reduce water deliveries only when insufficient water to meet entitlements is available in Lake Mead. When reservoir elevations are relatively low, Lake Powell and Lake Mead would share water (“balance contents”). This alternative does not include a mechanism for the creation, accounting, and delivery of conserved system and non-system water in Lake Mead. The existing ISG would be extended through 2026.

**ES.1.4.5 Reservoir Storage Alternative**

The Reservoir Storage Alternative was developed in coordination with the cooperating agencies and other stakeholders, primarily Western and the NPS. This alternative would keep more water in storage in Lake Powell and Lake Mead by reducing water deliveries and by increasing shortages to retain more water in storage and thereby, benefit power and recreational interests. This alternative includes larger, more frequent shortages that serve to conserve reservoir storage; coordinated operations of Lake Powell and Lake Mead determined by specified reservoir conditions (more water would be held in Lake Powell than under the Basin States Alternative); and an expanded mechanism for the creation, accounting, and delivery of conserved system and non-system water in Lake Mead. The existing ISG would be terminated after 2007.

**ES.1.4.6 Preferred Alternative**

The Preferred Alternative incorporates operational elements identified in the Basin States and Conservation Before Shortage alternatives. This alternative includes shortages to conserve reservoir storage; a coordinated operation of Lake Powell and Lake Mead determined by specified reservoir conditions that would minimize shortages in the Lower Basin and avoid risk of curtailments of use in the Upper Basin; and also adopts the ICS mechanism for promoting water conservation in the Lower Basin. It is anticipated that the maximum cumulative amount of ICS would be 2.1 maf; however, the potential effects of a maximum cumulative amount of ICS of up to 4.2 maf have been analyzed in the Final EIS. This alternative also includes modification and extension of the ISG through 2026.

**ES.2 Summary of Potential Environmental Effects****ES.2.1 Methodology**

Hydrologic modeling of the Colorado River system was conducted to determine the potential hydrologic effects of the alternatives. Modeling provides projections of potential future Colorado River system conditions (i.e., reservoir elevations, reservoir releases, river flows) for comparison of those conditions under the No Action Alternative to conditions under each action alternative. Due to the uncertainty with regard to future inflows into the system, multiple simulations were performed in order to quantify the uncertainties of future conditions and as such, the modeling results are typically expressed in probabilistic terms.

Hydrologic modeling also provides the basis for the analysis of the potential effects of each alternative on other environmental resources such as recreation, biology, and electrical power. The potential effects to specific resources are identified and analyzed for each action alternative and compared to the potential effects to that resource under the No Action Alternative. These comparisons are typically expressed in terms of the relative differences in probabilities between the No Action Alternative and the action alternatives.

**ES.2.2 Hydrologic Resources****ES.2.2.1 Reservoir Storage**

**Lake Powell.** Under the No Action Alternative and the action alternatives, the elevations of Lake Powell are projected to fluctuate between full and lower levels during the period of analysis (2008 through 2060). At the 90th percentile Lake Powell end-of-July elevation values, the action alternatives and the No Action Alternative are projected to be similar over the period of analysis.

Lake Powell elevations are generally lower under the Water Supply Alternative relative to the No Action Alternative. Conversely, Lake Powell elevations are generally higher under the Reservoir Storage Alternative relative to the No Action Alternative. Lake Powell elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar to each other because these alternatives assume the same operation at Lake Powell. At the 50<sup>th</sup> percentile, Lake Powell elevations under the Preferred Alternative are approximately ten feet lower than under the No Action Alternative in 2026; at the 10<sup>th</sup> percentile, Lake Powell elevations are nearly the same in 2026.

The probabilities of Lake Powell elevations less than 3,560 feet msl (the approximate minimum elevation for operation of several launch ramps) are higher under the Water Supply Alternative and lower under the Reservoir Storage Alternative relative to all other alternatives including the No Action Alternative. Probabilities under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are similar, with a probability of about five percent in 2016. The probability of Lake Powell elevations less than 3,490 feet msl (the approximate minimum elevation for operation of the Glen Canyon Dam Powerplant) is low (three percent or less) for the Preferred Alternative.

**Lake Mead.** Under the No Action Alternative and the action alternatives, the elevation of Lake Mead is projected to fluctuate between full pool and lower elevations during the period of analysis (2008 through 2060). At the 90<sup>th</sup> percentile Lake Mead end-of-December elevation values, the Basin States, Conservation Before Shortage, and Water Supply alternatives, the Preferred Alternative, and the No Action Alternative are projected to be similar over the period of analysis. The 90<sup>th</sup> percentile Lake Mead end-of-December elevation values under the Reservoir Storage Alternative are slightly higher than under the other alternatives.

At the 50<sup>th</sup> and 10<sup>th</sup> percentiles, Lake Mead elevations are generally higher under the Reservoir Storage Alternative relative to the No Action Alternative. Lake Mead 50<sup>th</sup> percentile elevations under the Water Supply Alternative are generally lower than those under the No Action Alternative. However, the Lake Mead 10<sup>th</sup> percentile elevations under the Water Supply Alternative vary and are sometimes higher and sometimes lower than those under the No Action Alternative. Lake Mead elevations under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to each other at the 50<sup>th</sup> and 10<sup>th</sup> percentiles. At the 50<sup>th</sup> percentile, Lake Mead elevations under the Preferred Alternative are approximately 16 feet lower relative to the No Action Alternative; however, at the 10<sup>th</sup> percentile, Lake Mead elevations are approximately 20 feet higher.

The probabilities of Lake Mead elevations less than 1,050 feet msl (the approximate minimum elevation for operation of the Hoover Dam Powerplant and the operation of SNWA's upper intake) are higher under the Water Supply Alternative and lower under the Reservoir Storage Alternative relative to all other action alternatives. Probabilities under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are similar, with a probability of approximately 15 to 17 percent in 2016.

The probability of Lake Mead elevations below 1,000 feet msl (the minimum elevation for operation of SNWA's lower intake) is low (between zero and two percent) for all alternatives except for the Water Supply Alternative (up to 12 percent).

**Lake Mohave and Lake Havasu.** Lake Mohave and Lake Havasu are operated on rule curves and have target end-of-month elevations. This manner of operation for the two reservoirs will continue in the future and would apply to operations under the No Action Alternative and the action alternatives. Therefore, future Lake Mohave and Lake Havasu elevations would not be affected by the proposed federal action.

#### **ES.2.2.2 Reservoir Releases**

During the interim period (2008 through 2026), Glen Canyon Dam releases less than the annual minimum objective release of 8.23 maf occurred less than one percent of the time under the No Action Alternative, approximately ten percent of the time under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, and approximately 17 percent of the time under the Reservoir Storage Alternative. During the interim period, releases greater than the annual minimum objective release of 8.23 maf occurred approximately 42 percent of the time under the No Action Alternative, approximately 62 percent of the time under the Basin States and Conservation Before Shortage alternatives, 69 percent of the time under the Water Supply Alternative, 44 percent of the time under the Reservoir Storage Alternative, and 59 percent of the time under the Preferred Alternative.

During the interim period (2008 through 2060), the observed minimum and maximum Hoover Dam annual releases under the No Action Alternative are 7.46 maf and 17.13 maf, respectively. By comparison, the minimum annual release under the action alternatives is 7.3 maf and occurs under the Conservation Before Shortage Alternative. The maximum annual release of 17.16 maf occurs under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. In general, the observed annual release volumes under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative are similar to those observed under the No Action Alternative. The Hoover Dam annual releases observed under the Water Supply Alternative are generally higher than those observed under the No Action Alternative. The Hoover Dam annual releases observed under the Reservoir Storage Alternative are generally lower than those observed under the No Action Alternative.

Releases from Davis Dam and Parker Dam generally reflect the same pattern of releases under the different action alternatives as those from Hoover Dam. The differences in the release volumes are mostly attributed to the depletions that occur upstream of each respective dam.

#### **ES.2.2.3 Groundwater**

Differences in Colorado River flows downstream of Hoover Dam are similar between the action alternatives and the No Action Alternative and these differences are relatively minor. Corresponding effects of the action alternatives relative to the No Action Alternative on groundwater will also be relatively minor.

### ES.2.3 Water Deliveries

All of the action alternatives increase the probability that Normal Condition deliveries will be met over the interim period relative to the No Action Alternative. The differences between the action alternatives and the No Action Alternative, in terms of the probability of occurrence for water supply deliveries under a Normal Condition, range from about 15 to 40 percent over the interim period.

The Water Supply Alternative exhibits the same probability of Surplus Condition deliveries as the No Action Alternative (between about 30 to 40 percent) between 2008 and 2016 due to identical assumptions regarding surplus during this period. The ISG provisions terminate under the No Action Alternative in 2016. However, these provisions are retained in the Water Supply Alternative through 2026 and therefore this alternative consistently exhibits the highest probability of surplus deliveries during the interim period. The Reservoir Storage Alternative exhibits the lowest probabilities (between about ten to 20 percent) during the interim period because surplus determinations are limited to Quantified and Flood Control Surplus Conditions beginning in 2008. The surplus provisions under the Basin States and the Conservation Before Shortage alternatives, and under the Preferred Alternative, are similar and the probability of a Surplus Condition from 2010 through 2016 is slightly less than under the No Action Alternative due to the absence of the Partial Domestic Surplus provision in these three alternatives. After the end of the interim period in 2026, the probability for all alternatives converges to between ten and 20 percent.

The storage and delivery mechanism and related storage and delivery of conserved system and non-system water were modeled under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. This mechanism has the effect of increasing the probability of occurrence of a Surplus Condition since more water is retained in Lake Mead relative to the No Action Alternative. The maximum increase in the probability of occurrence of a Surplus Condition is seven percent, occurring in two years under the Preferred Alternative.

During most of the interim period, the probability of an involuntary and voluntary shortage is less under all of the action alternatives than under the No Action Alternative; however, after 2026, the Water Supply Alternative has the highest probability of shortage due to the relatively depleted storage conditions and the assumption that the operations revert back to the assumptions used in the modeling of the No Action Alternative after 2026. The probability of occurrence of shortages under the Reservoir Storage Alternative is slightly higher than under the No Action Alternative between 2008 and 2013; however, after 2013 shortages under the Reservoir Storage Alternative occur less frequently as compared to the No Action Alternative. The probability of occurrence of shortages under the Basin States and Conservation Before Shortage alternatives and the Preferred Alternative are lower relative to the No Action Alternative throughout the interim period, ranging from 15 to 20 percent lower.

In terms of magnitude, the average shortage volumes during the interim period are lowest under the Water Supply Alternative (between zero and 240 kafy) and highest under the Reservoir Storage Alternative (between 600 and 750 kafy). The average shortage volumes

for the Preferred Alternative (between 400 and 530 kafy) are less than the average shortage volumes for the No Action Alternative (between 500 and 610 kafy) during the interim period.

Multi-year shortages with annual shortage volumes equal to or greater than 400 kaf are likely for all alternatives with the exception of the Water Supply Alternative, with the Conservation Before Shortage Alternative and the Preferred Alternative exhibiting probabilities of between ten and 30 percent over the interim period for durations of two or more years. Multi-year shortages with annual shortage volumes equal to or greater than 500 kafy are more likely to occur under the Reservoir Storage Alternative with probabilities of approximately 35 percent for durations of two or more years and 26 percent for durations of five or more years. Multi-year shortages with annual shortage volumes equal to or greater than 600 kafy are likely only for the Reservoir Storage Alternative. No alternatives exhibited shortages of greater than or equal to 1.0 mafy for any duration.

The storage and delivery mechanism and related storage and delivery of conserved system and non-system water were modeled under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives and the Preferred Alternative. This mechanism has the effect of decreasing the occurrence of shortages. Due to the assumptions of increased participation in the storage and delivery mechanism, the greatest differences (up to a ten percent reduction in shortage probability during the interim period) were observed under the Reservoir Storage Alternative and under the Preferred Alternative.

#### **ES.2.4 Water Quality**

The future average annual salinity levels under the different action alternatives are not expected to exceed the numeric criteria for salinity at Hoover Dam, Parker Dam and Imperial Dam, established by the Colorado River Basin Salinity Control Forum. The difference between all alternative is less than three percent relative to the No Action Alternative. The ability for the United States to continue to meet the salinity differential at the Northerly International Boundary with Mexico pursuant to Minute 242 will not be affected.

The temperature range for Glen Canyon Dam releases under the Water Supply Alternative could potentially be warmer due to lower Lake Powell reservoir elevations. The Reservoir Storage Alternative generally results in cooler temperatures for Glen Canyon Dam releases since this alternative generally results in higher Lake Powell elevations. The temperature of Glen Canyon Dam releases under the Basin States and Conservation Before Shortage Alternatives, and the Preferred Alternative, are similar to those under the No Action Alternative.

Hydrologic and water quality modeling for Lake Mead for the Boulder Islands North Alternative, the preferred alternative published in the System Conveyance and Operations Program Final EIS (Clean Water Coalition 2006), shows that drawing down Lake Mead elevation to 1,000 feet msl would not have a significant effect on water quality in Lake Mead. The probability that Lake Mead will be drawn down to elevations below 1,000 feet msl over the interim period is low for all alternatives, except the Water Supply Alternative. Therefore, potential effects of the alternatives on Lake Mead water temperatures are considered to be negligible.

### ES.2.5 Air Quality

As reservoir elevation decreases and shoreline is exposed, the potential for increased fugitive dust increases. The projected exposed shoreline acreage under the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative, are similar (i.e., from zero to five percent for the year 2025) to that projected under the No Action Alternative at Lake Powell. In general, the greatest increase in exposed shoreline acreage (i.e., about 30 percent for the year 2025) compared to the No Action Alternative at Lake Powell is projected under the Water Supply Alternative; the greatest reduction (i.e., about 15 percent for the year 2025) is projected under the Reservoir Storage Alternative.

Except for the Reservoir Storage Alternative, all of the action alternatives are projected to have similar or decreased shoreline exposure (i.e., from a less than one percent increase to a nine percent decrease) compared to the No Action Alternative for Lake Mead, and for Glen Canyon Dam to Lake Mead reach (Lake Mead delta). There is a greater potential for reduction in shoreline acreage exposure (i.e., 18 percent for the year 2025) under the Reservoir Storage Alternative and this potential is generally consistent for all years.

As reservoir elevation decreases and more shoreline is exposed, the potential for increased fugitive dust emission increases. However, an increase in fugitive emissions as a result of increased exposed shoreline would be limited at Lake Powell because the increased exposure of acreage would be comprised largely of sandstone.

### ES.2.6 Visual Resources

The probability of exposing Cathedral in the Desert ranged from three to 17 percent under the alternatives. The Water Supply Alternative would offer the greatest chance of exposure, while the Reservoir Storage Alternative offers the least chance. There would be no visual effects on attraction features at Lake Mead.

At Lake Powell, the maximum height of calcium carbonate rings ranged from 192 feet under the Water Supply Alternative to 148 feet under the Basin States and Conservation Before Shortage alternatives, the Preferred Alternative, and the No Action Alternative, and to 128 feet under the Reservoir Storage Alternative. At Lake Mead, the maximum height of calcium carbonate rings ranged from 170 feet under the Reservoir Storage Alternative to 221 feet under the Water Supply Alternative, similar to the 218 foot height under the No Action Alternative. The calcium carbonate ring height under the Basin States and Conservation Before Storage alternatives, and the Preferred Alternative was approximately 197 feet. For both reservoirs, the presence of the calcium carbonate ring produces an effect regardless of its height. Therefore, while there are numeric differences in the projected height of the rings, the overall difference in visual impact among the alternatives is not considered significant.

At the inflow areas to both Lake Powell and Lake Mead, sediment deltas will continue to build up over time and be visible under all alternatives. Their relative exposure and visibility are directly related to reservoir elevations. The differences among all alternatives are negligible for both Lake Powell and Lake Mead.

## ES.2.7 Biological Resources

### ES.2.7.1 *Vegetation and Wildlife*

**Lake Powell and Lake Mead.** Under the Water Supply Alternative, there may be a minor negative impact on obligate phreatophytes, and marsh and the wildlife that use such habitats because lake elevations tend to be lower than under the No Action Alternative. Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there may be a minor positive impact on obligate phreatophytes, and marsh and associated wildlife because lake elevations tend to be higher than under the No Action Alternative.

**Glen Canyon Dam to Lake Mead.** All five action alternatives tend to have lower 10<sup>th</sup> percentile releases from Glen Canyon Dam than the No Action Alternative. These lowered releases may negatively impact obligate phreatophytes, and marsh and associated wildlife downstream of Lake Powell. The impacts are expected to be minor because though lower, they are within the range of historical flows.

**Hoover Dam to Davis Dam and Lake Havasu and Parker Dam.** There would be no impacts to vegetation or wildlife in these river reaches under all five action alternatives because there may be only small differences in Lake Mead releases and these reaches are dominated by Lake Mohave and its backwater, and Lake Havasu. Vegetated habitats potentially affected by flow changes between Hoover Dam and Lake Mohave are limited. Lake Mohave and Lake Havasu are operated on monthly rule curves so vegetation and wildlife effects at the lakes under the action alternatives are identical to those under the No Action Alternative.

**Davis Dam to Parker Dam.** There may be higher 10<sup>th</sup> and 50<sup>th</sup> percentile monthly releases and a higher annual median release from Davis Dam under the Water Supply Alternative and this may cause a minor positive impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. Under the Reservoir Storage Alternative, there may be lower 10<sup>th</sup> and 50<sup>th</sup> percentile monthly releases and a lower annual median release from Davis Dam; this may cause a minor negative impact to obligate phreatophytes, and marsh and associated wildlife as compared to the No Action Alternative. These differences remain within the range of historical flows. The other action alternatives, including the Preferred Alternative would have little to no effect compared to the No Action Alternative.

**Parker Dam to Imperial Dam.** Under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, there are lower 10<sup>th</sup> and 50<sup>th</sup> percentile monthly releases and a lower annual median release from Parker Dam; these lower releases may have a minor negative impact on obligate phreatophytes, and marsh and associated wildlife. Under the Water Supply Alternative there is a higher annual median release from Parker Dam, which may provide a minor benefit to obligate phreatophytes, and marsh and associated wildlife.



**Imperial Dam to NIB.** There are no impacts to vegetation or wildlife under any of the action alternatives in this reach.

**NIB to SIB.** Mexico diverts its water at Morelos Diversion Dam (at the NIB) and flows downstream of this dam are rare. There is a higher probability of excess flows passing Morelos Diversion Dam under the Conservation Before Shortage and Reservoir Storage alternatives than under the No Action Alternative, which is expected to cause a moderate positive benefit to river flows, obligate phreatophytes, and marsh and associated wildlife downstream of Morelos Diversion Dam<sup>1</sup>. The other action alternatives, including the Preferred Alternative, would provide similar flows as the No Action Alternative.

### **ES.2.7.2 Special Status Species**

In addition to the assessment of effects on general vegetation and wildlife, the analysis also considered potential effects on special status fish, bird, and plant species. These effects were evaluated for species occurring at Lake Powell and Lake Mead, the reaches of the Colorado River between Glen Canyon Dam and Lake Mead, and downstream of Lake Mead.

**Lake Powell.** Lower Lake Powell elevations under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, at the 10<sup>th</sup> and 50<sup>th</sup> percentile of reservoir elevations may increase the amount of riverine habitat available at the inflow areas to Lake Powell. This may provide a minor positive impact to razorback sucker, bonytail, Colorado pikeminnow, and flannelmouth sucker found in the riverine areas at the inflows. The higher lake elevations under the Reservoir Storage Alternative may decrease the amount of riverine habitat at the inflow areas, which may result in a minor negative impact.

Clark's grebe that may inhabit Lake Powell could be impacted by elevation changes in Lake Powell that affect marsh habitat at the inflow areas. Under the Reservoir Storage and Water Supply alternatives, there may be higher and lower lake elevations, respectively, which would mean a minor positive and a minor negative impact, respectively, to Clark's grebe.

**Glen Canyon Dam to Lake Mead.** The action alternatives, except for the Reservoir Storage Alternative, may result in higher river temperatures downstream of Glen Canyon Dam at the 10<sup>th</sup> percentile elevations and higher to lower temperatures at the 50<sup>th</sup> percentile elevations relative to the No Action Alternative. The Reservoir Storage Alternative may result in higher to lower river temperatures at the 10<sup>th</sup> and 50<sup>th</sup> percentiles elevations, respectively. Higher temperatures may provide a minor positive impact to humpback

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<sup>1</sup> These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage alternatives. These modeling assumptions were utilized in the Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current management of the Colorado River.

chub, bluehead sucker and flannelmouth sucker spawning and growth. However, these warmer temperatures also benefit non-native fish species which compete with native fish, and parasites that affect native fish, resulting in a minor negative impact. The lower average temperatures in the summer and winter at the 10<sup>th</sup> percentile of elevations under the Reservoir Storage Alternative could reduce the growing season for humpback chub, bluehead sucker, and flannelmouth sucker but would not affect spawning, resulting in a minor negative impact. The short duration of warmer average temperatures in the spring followed by cooler temperatures are unlikely to provide any benefit to non-native fish and native fish parasites. Lower annual releases in some years could reduce sediment loss from the Colorado River while higher releases in some years could increase sediment losses. How these changes in sediment transport could affect native fish habitat is unknown. The range in hourly flows could be reduced during lower annual releases and increased during higher annual releases. Lower temperatures may provide a minor negative impact to these native fish species. Under the Reservoir Storage Alternative, average water temperatures above 15°C (59°F) may occur one month later than under the No Action Alternative and may have a minor negative impact on leopard frogs due to increased potential for thermal shock in July. Under the other action alternatives impacts to the leopard frog are not expected relative to the No Action Alternative.

Higher 90<sup>th</sup> percentile releases under the Reservoir Storage Alternative have a potential for increased impact to beach habitat in the lower Grand Canyon, which could adversely impact vegetation and Grand Canyon evening primrose on those beaches. Under the five action alternatives, flows may exceed those under the No Action Alternative and 17,000 cfs in some months, which may cause additional impact to Kanab ambersnail habitat at Vasey's Paradise. Under the Reservoir Storage Alternative, flows in June could exceed those under the No Action Alternative and exceed 20,000 cfs, thus causing greater impact to Niobrara ambersnail habitat. Under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative at the 90<sup>th</sup> percentile there may be flows that when above 20,000 cfs are equal to or less than those under No Action Alternative, which would provide a minor positive benefit to the Niobrara ambersnail. Under the five action alternatives there may be a minor negative impact on the southwestern willow flycatcher because of the 10<sup>th</sup> percentile release flows trend lower than those under the No Action Alternative. These lower potential flows could adversely impact southwestern willow flycatcher habitat in the Grand Canyon.

**Lake Mead.** The lower and higher Lake Mead elevations that may occur under the Water Supply and Reservoir Storage alternatives, respectively, could cause minor negative and minor positive impacts, respectively, to special status bird species. Impacts on bird species may be caused by increased or decreased potential for dewatering of riparian habitats and headcutting at the Lake Mead inflow areas. Higher lake elevations under the Reservoir Storage Alternative may inundate additional shoreline habitat for the sticky buckwheat, Geyer's milkvetch and Las Vegas Bearpoppy and be a minor negative impact. Lower Lake Mead elevations under the Water Supply Alternative may expose additional shoreline habitat for these plants and be a minor positive impact. These impacts were deemed minor because all habitats below the full pool elevation of Lake Mead are subject to periodic inundation and exposure as the lake elevation fluctuates in

the future. Under the Preferred Alternative, there could be minor positive impacts to special status fish when elevations are above the current razorback spawning areas at the 50<sup>th</sup> percentile of elevations and when lower elevations would extend riverine habitat in the inflow area for special status fish. Elevations higher than under the No Action Alternative at the 10<sup>th</sup> percentile would have no impacts on razorback sucker spawning. Lake elevations under both the Basin States and Conservation Before Shortage alternatives could be both above and below those under the No Action Alternative and would have no impact to razorback suckers. The increased amount of riverine habitat at the 10<sup>th</sup> percentile of elevations could provide a minor positive impact to special status fish in the Colorado River inflow. Under the Water Supply Alternative there may be both minor positive and negative impacts to special status fish species due to providing more riverine habitat and lower elevations relative to razorback spawning areas, respectively, at the 50<sup>th</sup> percentile. Under the Reservoir Storage Alternative, elevations could be above current razorback sucker spawning areas over 50 percent of the time in about half the modeled years, a moderate positive impact. Higher reservoir elevations would provide less riverine habitat for special status fish in the Colorado River inflow at the 10<sup>th</sup> and 50<sup>th</sup> percentile elevations for a minor negative impact.

**Hoover Dam to Davis Dam and Lake Havasu to Parker Dam.** There is no substantial difference between the No Action Alternative and any of the action alternatives in this reach.

**Davis Dam to Lake Havasu.** Lower monthly and annual median releases from Davis Dam under the Reservoir Storage Alternative may have a minor negative impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado River cotton rat. Impacts to these species may occur through adverse effects to their habitats from reduced dam releases. Razorback sucker, flannelmouth sucker, and bonytail may experience a minor negative impact because lower potential releases could have adverse impacts to riverine spawning habitat and backwater rearing habitats that these species utilize. Higher monthly and annual median releases from Davis Dam under the Water Supply Alternative may have a minor positive impact on obligate phreatophytes, and marsh and associated special status bird species, and Colorado river cotton rat. Razorback sucker, flannelmouth sucker, and bonytail may also benefit from these higher flows because they could maintain more of the spawning and rearing habitats present in this reach.

**Parker Dam to Imperial Dam.** Lower monthly and annual median flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative, may have minor negative impacts to the habitats of the special status bird species and Colorado River cotton rat. Obligate phreatophytes, and marsh and associated special status species would be negatively impacted by lower releases. Razorback sucker and bonytail chub may be negatively impacted by lower flows under the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives, and the Preferred Alternative. Lower flows may negatively impact spawning and rearing habitats for these species. Higher annual median flows under the Water Supply Alternative would benefit the habitats of special status birds, mammals and fish and may have a minor positive impact.

**Imperial Dam to NIB.** Under the No Action Alternative and the action alternatives there would be no impact to special status species in this reach.

**NIB to SIB.** Flows past Morelos Diversion Dam<sup>2</sup> are more probable under the Reservoir Storage and Conservation Before Shortage alternatives. The increased probability of flows may have a moderate positive impact on the special status bird species through positive impacts to riparian and marsh habitats these species utilize. These higher probabilities of flows may also positively impact the special status bat species listed in this section, Yuma hispid cotton rat, and Colorado river cotton rat through positive impacts to their riparian and marsh habitats. Though these flows are an overall benefit to the riparian corridor downstream of the NIB, the increased probability of high flows could increase the likelihood of scouring *Atriplex* vegetation in this reach, which would be a minor negative impact to MacNeill's sooty-winged skipper.

### ES.2.8 Cultural Resources

For Lake Powell, under the Water Supply Alternative at the 10th percentile, there are at least 227 unexcavated sites subject to effect, as compared to about 193 sites under the other alternatives. Consultation is underway regarding eligibility and effect.

For the reach from Glen Canyon to Lake Mead, the alternatives pose no additional threat to cultural resources because of the programs already underway.

For Lake Mead, there are at least 32 cultural resources located below elevation 1,080 feet msl. The probability of exposing sites below this elevation vary by alternative, with the Reservoir Storage Alternative having the lowest probability (up to 13 percent lower compared to the No Action Alternative) and the Water Supply Alternative having the highest probability (up to nine percent higher compared to the No Action Alternative). The Basin States and Conservation Before Shortage alternatives and the Preferred Alternative have probabilities similar to those of the No Action Alternative.

For reaches downstream of Lake Mead, no adverse effects are anticipated from any of the alternatives. However, consultation regarding eligibility and effect is under way.

For Indian sacred sites and other issues of Tribal concern (not including ITAs), none of the alternatives are expected to restrict access or result in loss of physical integrity to sacred sites. Consultations with Indian tribes are ongoing with respect to these issues and other issues and concerns.

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<sup>2</sup> These flows were modeled as part of the storage and delivery mechanism under the Conservation Before Shortage and Reservoir Storage Alternatives. These modeling assumptions were utilized in the Final EIS in order to analyze the potential impacts to environmental resources of the storage and delivery mechanism, particularly with regard to reservoir elevations and river flow impacts. The use of these modeling assumptions does not represent any determination by Reclamation as to whether, or how, these releases could be made under current administration of the Colorado River.

**ES.2.9 Indian Trust Assets**

After analyzing each resource, it is concluded that Tribal trust assets identified in the study area would not be adversely affected by any of the anticipated environmental impacts stemming from the proposed federal action.

**ES.2.10 Electrical Power Resources**

The Basin States, Conservation Before Shortage, and Water Supply alternatives could potentially have minor impacts in generation, capacity, and economic value of electrical power at Glen Canyon and Hoover Powerplants due to slightly lower average reservoir elevations that could occur under these alternatives. The Water Supply Alternative could potentially have the highest effect on electrical power production and value because this alternative provides the lowest average reservoir elevations of the action alternatives. The Preferred Alternative and the Reservoir Storage Alternative could potentially provide a benefit to electrical power production and value at Glen Canyon and Hoover Powerplants because these alternatives would provide higher average reservoir elevations than the No Action Alternative. However, most of these changes are less than one percent and as such, these impacts are considered minor.

For the Parker-Davis Project and Headgate Rock powerplants, the Preferred Alternative and the Basin States, Conservation Before Shortage, and Reservoir Storage alternatives could potentially decrease electrical power production at these facilities as compared to the No Action Alternative because of the lower release volumes from the associated dams/powerplants. The Reservoir Storage Alternative generally provides lower water releases compared to the No Action Alternative and other action alternatives and therefore this alternative could have the greatest effect on power production at these facilities. The Water Supply Alternative results in greater release volumes downstream and therefore slight increases in electrical power production and value as compared to the No Action Alternative. Again, these changes are relatively minor (most less than one percent) compared to overall electrical power production at these facilities.

All of the action alternatives, with the exception of the Reservoir Storage Alternative, could potentially increase pumping costs for entities that pump water from Lake Powell due to the lower reservoir elevations, as compared to the No Action Alternative. At Lake Mead, all of the action alternatives, with the exception of the Water Supply Alternative, provide higher reservoir elevations as compared to the No Action Alternative and therefore could potentially result in lower pumping costs for the entities that pump water from Lake Mead.

Reductions in power revenues could reduce the amount of money available to meet the intended uses of the basin power funds, possibly leading to reductions in allocations to power contractors or power rate adjustments. The action alternatives generally have a minor impact on the economic value of electrical power generation at the Glen Canyon and Hoover Powerplants. However, total loss of electrical power generation capabilities would have a substantial effect on the basin power funds. At the Glen Canyon Powerplant, the probability of this type of loss in electrical power generation capability is very small (less than five percent) except under the Water Supply Alternative, which would result in as much as a nine percent probability. At Hoover Powerplant, the probability of total loss of generation is

higher, increasing from zero in 2008 to about 30 percent in 2026. However, the Reservoir Storage Alternative is the exception to this, while the remaining alternatives are very similar to the No Action Alternative.

### **ES.2.11 Recreation**

#### ***ES.2.11.1 Shoreline Facilities***

The Reservoir Storage Alternative would result in higher reservoir elevations and a lower probability of closure of shoreline facilities than the other action alternatives and the No Action Alternative. Conversely, the Water Supply Alternative would result in the highest probability of such closures. The Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative are similar to the No Action Alternative.

At Lake Mead, all of the alternatives have similar probabilities of facility closures except for the Reservoir Storage Alternative, which has a slightly to moderately lower probability. At Lake Mead, under all of the alternatives there is a 74 to 78 percent probability that the Pearce Bay launch ramp would be closed to boaters, except under the Reservoir Storage Alternative this probability is 66 percent. Similarly, there is a 21 to 30 percent probability of closure of the Echo Bay public launch ramp (in the north end of the reservoir) under all of the alternatives, except under the Reservoir Storage Alternative this probability is nine percent.

#### ***ES.2.11.2 Boating and Navigation***

For safe boating at Lake Powell, probabilities range from 24 to 28 percent that NPS would have to prohibit boating around Castle Rock and Gregory Butte under the No Action Alternative and the Reservoir Storage Alternative. Under the Basin States Alternative there is a 36 percent probability and under the Conservation Before Shortage Alternative there is a 35 percent probability that boating prohibitions would need to be put in place. Under the Water Supply Alternative, the probability of this occurrence is 52 percent. Under the Preferred Alternative there is a 32 percent probability that prohibitions would be put in place.

For Lake Mead, all the alternatives except the Reservoir Storage Alternative in July 2026 provide a 72 to 76 percent probability that boaters may encounter navigational hazards at the upstream end of Lake Mead due to reservoir elevations being drawn down to below 1,170 feet msl. Under the Reservoir Storage Alternative there is a 69 percent probability of a similar recreational impacts. Similar effects would occur in the Overton Arm of Lake Mead.

For whitewater boating through Grand Canyon, the Glen Canyon Dam ROD flows will be maintained. Even in a 7.0 maf Glen Canyon Dam release year, the minimum daily flow will remain at or above 5,000 cfs, a safe boating threshold.

#### ***ES.2.11.3 Sport Fish Populations***

Sport fish populations would not be adversely affected at Lake Powell under any of the alternatives. Although surface water temperatures may approach lethal levels in the upper 10 feet of the reservoir under any alternative, lethal levels for striped bass and threadfin

shad are not expected to be exceeded by any alternative. Moreover, cooler temperatures below the lake surface would serve as a refuge for the fish. The situation for striped bass and threadfin shad in Lake Mead is similar to Lake Powell. Higher water temperatures could impair the Lake Mead Fish Hatchery, particularly under the Water Supply Alternative.

Under the No Action Alternative, 10<sup>th</sup> percentile temperatures are suitable for growth, spawning and incubation in most months. Higher water temperatures under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, could affect various life history stages of rainbow trout downstream of Glen Canyon Dam. Under the action alternatives, 10<sup>th</sup> percentile modeling results indicate that there could be minor impacts to rainbow trout due to warmer temperatures. The Water Supply Alternative shows the most warming and potential to negatively impact trout. The Reservoir Storage Alternative shows the least warming and will often result in colder temperatures than the No Action Alternative. Conditions for trout under the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative, will be similar to slightly worse than under the No Action Alternative.

### **ES.2.12 Transportation**

For the Lake Powell ferry, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative would have minor effects on ferry service; the Water Supply Alternative could result in potential moderate adverse effects; and the Reservoir Storage Alternative could have beneficial effects. The probability varies from year to year, but there is up to a 17 percent probability that the Lake Powell ferry may become inoperable under the Water Supply Alternative for some period of time. Conversely, the ferry would remain operable with the highest probabilities and greatest durations of time under the Reservoir Storage Alternative.

For the Colorado River ferry service downstream of Davis Dam, only under the Reservoir Storage Alternative are there any measurable effects and these potential effects would be minor. The other action alternatives show no difference from the No Action Alternative.

The Lake Havasu ferry service would be unaffected under all of the action alternatives.

### **ES.2.13 Socioeconomics**

#### ***ES.2.13.1 Employment, Income, and Tax Revenue***

Although a loss in employment and income could potentially occur under any of the action alternatives, the probability of any shortage occurring would be greater under the No Action Alternative. This suggests that the potential loss in employment, income, and tax revenues estimated for the No Action Alternative would be reduced under each of the action alternatives. The probabilities of any shortage amount occurring would be similar under all the action alternatives during the interim period with the exception of the Water Supply Alternative. When compared to the other action alternatives, the probabilities of any shortage amount occurring would be lower under the Water Supply Alternative. This indicates that, with the exception of the Water Supply Alternative, the potential losses in

employment, income, and tax revenues would be similar among the action alternatives during the interim period. However, none of the changes in employment and income are considered substantial when compared to total employment and income generated within the study area.

For the period 2027 through 2060, the change in employment and income would be similar between the No Action Alternative and the action alternatives. The greatest difference would be in 2027 in which the probabilities would be slightly higher when compared to those under the No Action Alternative. However, by 2040, the probabilities of shortages occurring under all of the alternatives are very similar.

#### **ES.2.13.2      *Municipal and Industrial Water Uses***

Adverse effects on employment and income in Arizona and Nevada during shortages would be minimized as a result of drought plans being in place. No adverse effects are expected in California because of priority of apportionment and the availability of alternative water supplies.

#### **ES.2.13.3      *Recreation Economics***

Recreation opportunities and associated economic activity at Lake Powell are not expected to be substantially different under the No Action Alternative, the Basin States and Conservation Before Shortage alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially be adversely affected under the Water Supply Alternative due to the potentially lower Lake Powell elevations that may occur under this alternative. Conversely, recreation opportunities and associated economic activity would benefit under the Reservoir Storage Alternative as a result of potentially higher Lake Powell elevations under this alternative.

Recreation opportunities and associated economic activity at Lake Mead are not expected to be substantially different under the No Action Alternative, the Basin States, Conservation Before Shortage, and Water Supply alternatives, and the Preferred Alternative. Recreation opportunities and associated economic activity could potentially benefit under the Reservoir Storage Alternative due to the potentially higher Lake Mead elevations that may occur under this alternative.

Because daily and hourly flows in the Lake Powell to Lake Mead reach and in the Colorado River reaches downstream of Lake Mead would likely remain within ranges suitable for boating, there would be no change in river-related economic activity.

#### **ES.2.14      *Environmental Justice***

After evaluating each resource, it is concluded that the environmental justice communities identified in the study area would not be disproportionately affected by any of the anticipated environmental impacts stemming from the proposed federal action. Nor would the proposed federal action result in adverse disproportionate impacts on human health within these environmental justice communities.



**ES.2.15 Indirect Effects of ICS Mechanism**

SNWA proposes three ICS projects which were specifically formulated to utilize the ICS mechanism: Virgin River and Muddy River Tributary Conservation, Coyote Spring Well and Moapa Transmission System Project, and lower Colorado River Drop 2 Storage Reservoir Project. It is anticipated that creation of ICS and subsequent delivery of water from Lake Mead for the proposed SNWA projects will be approved as part of the ROD for the proposed federal action. While the proposed SNWA water conservation projects are not federal projects, they will rely on Reclamation's approval for creation and delivery of ICS from Lake Mead. The effects of these projects within the geographic scope of the proposed federal action have been included in the modeling assumptions and are therefore included in the various resource analyses in this Final EIS. The localized impacts of these water conservation projects (outside the geographic scope of the proposed federal action) are described as indirect effects of Reclamation's establishment of the ICS mechanism.

The Coyote Spring Well and Moapa Transmission System Project would increase flow in the Muddy River, although the effect on flows would be minor and may provide minor positive impacts.

The Drop 2 Storage Reservoir Project would result in a reduction in non-storable flows that are delivered to Mexico. The Environmental Assessment for the Drop 2 Storage Reservoir Project included a specific analysis of the hydrologic impacts of the project on smaller (non-flood release) flows in the limitrophe division of the Colorado River and concluded decreases in surface water flows passing Morelos Diversion Dam would not conflict with 1944 Treaty delivery obligations, or substantially alter the existing drainage pattern or flows of the limitrophe reach. The Final EA did not identify significant impacts from the project.

No significant impacts on water quality, visual resources, cultural resources, ITAs, electrical power, recreation, transportation, or environmental justice are anticipated from the SNWA Tributary Conservation projects. The changes in river flow would be minimal and may provide minor positive impacts.

**ES.2.16 Climate Change Considerations**

Based on the current inability to precisely project future impacts of climate change to runoff throughout the Colorado River Basin at the spatial scale needed for CRSS, Reclamation based its hydrologic analysis for this EIS primarily on the resampled historical record. However, in order to understand the potential effects of future inflow sequences outside the range of historical flows (i.e., future sequences with increased variability including the severity, frequency, and duration of droughts), particularly during the 19-year period of the application of the proposed federal action, Reclamation analyzed the sensitivity of the hydrologic resources (including reservoir storage, reservoir releases, and river flows) to hydrologic scenarios derived from alternative methodologies (including stochastic hydrology methods and paleo-reconstruction methods) in the Draft EIS. An additional analysis has been added to Appendix N in the Final EIS that incorporates a newly published tree-ring reconstruction of hydrologic inflows at Lees Ferry (Meko et al. 2007) that extends the estimate of annual flow at Lees Ferry back to the year 762, a record length of 1,244 years.

Although precise estimates of the future impacts of climate change to runoff throughout the Colorado River Basin at appropriate spatial scales are not currently available, these impacts may include decreased mean annual flow and increased variability, including more frequent and more severe droughts. Furthermore, even without precise knowledge of the effects on runoff, increasing temperatures alone would likely increase losses (e.g., evapotranspiration and sublimation), resulting in reduced runoff.

Acknowledging the potential for impacts due to climate change and increased hydrologic variability, the Secretary proposes that these guidelines be interim in duration and extend through 2026, providing the opportunity to gain valuable operating experience for the management of Lake Powell and Lake Mead, particularly for low reservoir conditions, and improve the basis for making additional future operational decisions, whether during the interim period or thereafter. In addition, the Preferred Alternative has been crafted to include operational elements that would respond if potential impacts of climate change and increased hydrologic variability are realized. In particular, the Preferred Alternative includes a coordinated operation element that allows for the adjustment of Lake Powell's release to respond to low reservoir storage conditions in Lake Powell or Lake Mead as described in Section 2.7 and Section 2.3. In addition, the Preferred Alternative will enhance conservation opportunities in the Lower Basin and the retention of water in Lake Mead through adoption of the ICS mechanism. Finally, the Preferred Alternative includes a shortage strategy at Lake Mead that would result in additional shortages being considered, after appropriate consultation, if Lake Mead elevations drop below 1,025 feet msl.

### **ES.3 Summary**

A summary of potential effects of the No Action Alternative and the action alternatives is provided in Table ES-2.

### **ES.4 Cumulative Impacts**

The proposed federal action would not result in any significant cumulative impacts.

Summary of Potential Effects of the Alternatives		Alternatives						
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage	Preferred Alternative	
4.3	Environmental Consequences by Resource, Year and Value							
	Hydrologic Resources							
	Probability of Glen Canyon annual release volumes ≥ 7.5 maf, 2009 to 2060	99.96%	96.66%	96.66%	97.9%	100%	96.39%	
	Probability of Glen Canyon annual release volumes ≥ 8.23 maf, 2009 to 2060	99%	96.32%	96.38%	96.33%	93.79%	96.64%	
	Lake Powell March elevation, probability of water levels ≤ 3,490 feet msl 2026	1.0%	0%	0%	9.0%	0%	0%	
	Lake Mead July elevation, probability of water levels ≤ 1,050 feet msl 2026	30%	23%	23%	29%	9%	21%	
4.4	Hoover Dam annual release, 2026 50 <sup>th</sup> percentile values	9.04 maf	9.17 maf	9.11 maf	9.39 maf	8.68 maf	9.16 maf	
	Water Deliveries							
	Probability of involuntary shortage, 2026	49%	35%	7%	12%	37%	41%	
	Probability of voluntary and involuntary shortage, 2026	49%	35%	36%	12%	37%	41%	
	Probability of normal deliveries, 2026	34%	26%	25%	47%	45%	19%	
	Probability of surplus, 2026	17%	39%	39%	41%	18%	40%	
4.5	Water Quality							
	Temperature at Little Colorado River, July 2026, 50 <sup>th</sup> percentile	12 °C	12 °C	12 °C	13 °C	12 °C	12 °C	
	Salinity downstream of Parker Dam, 2026,	621 mg/L	625 mg/L	625 mg/L	633 mg/L	615 mg/L	625 mg/L	
	Salinity at Imperial Dam, 2026	740 mg/L	747 mg/L	751 mg/L	760 mg/L	735 mg/L	747 mg/L	
4.6	Air Quality							
	Lake Powell 2025, 10 <sup>th</sup> percentile exposed shoreline	17,000 acres	17,000 acres	17,000 acres	22,000 acres	14,000 acres	17,000 acres	
	Lake Mead 2025, 10 <sup>th</sup> percentile exposed shoreline	89,000 acres	82,000 acres	83,000 acres	90,000 acres	73,000 acres	82,000 acres	

Table ES-2  
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives							Preferred Alternative
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage			
4.7	Visual Resources								
	Lake Powell maximum height of calcium carbonate ring, 10 <sup>th</sup> percentile, 2025	148 feet	148 feet	148 feet	192 feet	128 feet		148 feet	
	Lake Mead maximum height of calcium carbonate ring, 10 <sup>th</sup> percentile, 2025	218 feet	197 feet	199 feet	221 feet	170 feet		195 feet	
4.8	Biological Resources <sup>1</sup>								
	Effects on Vegetation and Wildlife								
	Lake Powell and Lake Mead	--	None to minor positive	None to minor positive	Minor negative	Minor positive		Minor positive	
	Glen Canyon Dam to Lake Mead	--	Minor negative	Minor negative	Minor negative	Minor negative		Minor negative	
	Hoover Dam to NIB	-	None to minor negative	None to minor negative	None to minor positive	None to minor negative		None to minor negative	
	NIB to SIB	--	None	Moderate positive	None	Moderate positive		None	
	Effects on Special Status Species								
4.9	Glen Canyon Dam to Lake Mead humpback chub	--	Minor positive to minor negative	Minor positive to minor negative	Minor positive to minor negative	Minor negative		Minor positive to minor negative	
	Parker Dam to Imperial Dam Yuma clapper rail	--	Minor negative	Minor negative	Minor positive	Minor negative		Minor negative	
	NIB to SIB	--	None	Moderate positive	None	Moderate positive		None	
	Southwestern willow flycatcher								
4.10	Cultural Resources								
	Number of Lake Powell sites potentially exposed, 10 <sup>th</sup> percentile	194 sites	190 sites	190 sites	227 sites	193 sites		190 sites	
	Probability of exposing 32 Lake Mead sites ≤ elevation 1,080 feet msl, 2026	45%	45%	46%	48%	23%		47%	
4.10	Indian Trust Assets <sup>1</sup>								
	Water rights affected	-	None	None	None	None		None	
	Trust land affected	-	None	None	None	None		None	

Table ES-2  
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives						Preferred Alternative
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage		
4.11	Electrical Power Resources							
	Glen Canyon Powerplant							
	Average annual generation and percent change from No Action Alternative value	4,247,880 MWh	(0.08)%	(0.07)%	(2.57)%	0.78%	0.08%	
	Average monthly capacity and percent change from No Action Alternative value	606 MW	(0.15)%	(0.13)%	(2.72)%	0.79%	0.03%	
	Average total economic value and percent change from No Action Alternative value	\$7,350,000,000	0.02%	0.04%	(2.25)%	0.88%	0.19%	
	Hoover Powerplant							
	Average annual generation and percent change from No Action Alternative value	3,127,523 MWh	(0.22)%	(0.05)%	(2.39)%	9.07%	1.4%	
	Average monthly capacity and percent change from No Action Alternative value	1,191 MW	0.31%	0.58%	(2.56)%	11.52%	2.31%	
	Average total economic value and percent change from No Action Alternative value	\$7,223,000,000	0.08%	0.34%	(2.51)%	10.63%	2.38%	
	Davis and Parker Powerplants							
	Average annual generation and percent change from No Action Alternative value	1,639,687 MWh	(0.56)%	(0.69)%	0.11%	(1.07)%	(0.68)%	
	Average monthly capacity and percent change from No Action Alternative value	331 MW	0%	0%	0%	0%	0%	
	Average total economic and percent change from No Action Alternative value	\$2,268,000,000	(0.53)%	(0.73)%	0.31%	(1.54)%	(0.81)%	
Headgate Rock Powerplant								
Average annual generation and percent change from No Action Alternative value	77,482 MWh	(1.21)%	(1.71)%	(0.28)%	(1.7)%	(1.5)%		
Average monthly capacity and percent change from No Action Alternative value	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable		
Average total economic value and percent change from No Action Alternative value	\$103,000,000	(1.29)%	(2.02)%	(0.17)%	(2.31)%	(1.83)%		

Table ES-2  
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives						Preferred Alternative
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage		
4.12	Recreation							
	Lake Powell							
	Probability of closure, Wahweap and lower Bullfrog launch ramps, 2026	7%	9%	9%	23%	3%	8%	
	Probability of navigation closures, Castle Rock, Gregory Butte, 2026	28%	36%	36%	52%	24%	32%	
	Effects on sport fish	--	None	None	None	None	None	
	Lake Mead							
	Probability of closure, Pearce Bay launch ramp, 2026	74%	76%	75%	78%	66%	74%	
4.13	Probability of closure, Echo Bay launch ramp, 2026	30%	23%	23%	29%	9%	21%	
	Probability of navigation difficulties, upper Lake Mead, 2026	73%	73%	73%	76%	64%	72%	
	Transportation							
	Probability of Lake Powell ferry closure, end of September 2026	5%	7%	7%	17%	3%	7%	
	Effects on Laughlin River taxis and tour boats	--	None	None	Minor positive	Minor negative	None	
	Effects on Lake Havasu ferry service	--	None	None	None	None	None	

Table ES-2  
Summary of Potential Effects of the Alternatives

Final EIS Section	Environmental Consequences by Resource, Year and Value	Alternatives						Preferred Alternative
		No Action	Basin States	Conservation Before Shortage	Water Supply	Reservoir Storage		
4.14	Socioeconomics and Land Use							
	Probability of 500,000 at shortage with loss of 561 jobs and \$18,000,000 in income, and \$5,900,000 in tax revenues in agricultural sector in Arizona, 2026	34%	15%	1%	--	--	24%	
	Probability of 500,000 at shortage with loss of 397 jobs and \$12,300,000 in income, and \$4,200,000 in tax revenues in agricultural sector in Arizona, 2060	54%	54%	50%	51%	53%	52%	
	Agricultural production and resulting effects on employment, income, and tax revenues in California and Nevada	--	None	None	None	None	None	None
	Recreation spending at Lake Powell	--	Same	Same	Decrease	Increase	Increase	
	Recreation spending at Lake Mead (LMNRA)	--	Same	Same	Same	Increase	Increase	
	Change in river recreation economic activity							
	Lake Powell to Lake Mead	--	None	None	None	None	None	None
	Downstream of Lake Mead	--	None	None	None	None	None	None
	Change in economic activity in Municipal & Industrial sector							
	Arizona	--	None	None	None	None	None	None
	California	--	None	None	None	None	None	None
	Nevada	--	None	None	None	None	None	None
4.15	Environmental Justice	--	None	None	None	None	None	None

Note: (1) "None" after a hyphen in the No Action Alternative column means no difference between the action alternative and the No Action Alternative.

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