Draft

Environmental Impact Statement

Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume I
This page intentionally left blank.
Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Draft Environmental Impact Statement

Volume I

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions
February 2007
Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation’s natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.
Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead
Draft Environmental Impact Statement

Lead Agency:
United States Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

Cooperating Agencies:
Bureau of Indian Affairs
National Park Service
Western Area Power Administration
United States Fish and Wildlife Service
United States Section of the International Boundary and Water Commission

Abstract:
The Secretary of the Department of the Interior (Department), acting through the Bureau of Reclamation, proposes adoption of specific Colorado River Lower Basin (Lower Basin) shortage guidelines and coordinated reservoir management strategies to address operations of Lake Powell and Lake Mead, particularly under drought and low reservoir conditions. This action is proposed in order to provide a greater degree of certainty to United States Colorado River water users and managers of the Colorado River Basin by providing detailed, and objective guidelines for the operations of Lake Powell and Lake Mead, thereby allowing water users in the Lower Basin to know when, and by how much, water deliveries will be reduced in drought and other low reservoir conditions. The Department proposes that these guidelines be interim in duration and extend through 2026. The environmental impact statement (EIS) process will provide an opportunity to develop the information needed to analyze and consider tradeoffs between the frequency and magnitude of shortages, and to describe potential effects on water storage in Lake Powell and Lake Mead, and on water supplies, power production, recreation, and other environmental resources.

This Draft EIS has been prepared pursuant to the National Environmental Policy Act to address the formulation and evaluation of specific interim criteria and to identify the potential environmental impacts of implementing such criteria.

For further information regarding this Draft EIS, contact:
Bureau of Reclamation
Attention: BCOO-1000
P.O. Box 61470
Boulder City, Nevada 89006-1470
Fax number: (702) 293-8156
Phone number: (702) 293-8500
E-mail: strategies@lc.usbr.gov

Comments Due:
Comments on the Draft EIS must be submitted to the above mail or E-mail address no later than Monday, April 30, 2007.
This page intentionally left blank.
This page intentionally left blank.
Volume I: Table of Contents

EXECUTIVE SUMMARY .............................................................................................................. ES-1
ES.1 Background ...................................................................................................................... ES-1
ES.1.1 Purpose and Need for Action ................................................................................ ES-1
ES.1.2 Proposed Federal Action ....................................................................................... ES-2
ES.1.3 Geographic Scope ................................................................................................ ES-3
ES.1.4 Alternatives .......................................................................................................... ES-3
ES.2 Summary of Potential Environmental Effects ........................................................ ES-7
ES.2.1 Methodology ....................................................................................................... ES-7
ES.2.2 Hydrologic Resources ....................................................................................... ES-7
ES.2.3 Water Deliveries ................................................................................................. ES-10
ES.2.4 Water Quality ..................................................................................................... ES-11
ES.2.5 Air Quality ........................................................................................................ ES-12
ES.2.6 Visual Resources ............................................................................................... ES-12
ES.2.7 Biological Resources ........................................................................................ ES-12
ES.2.8 Cultural Resources ............................................................................................ ES-14
ES.2.9 Indian Trust Assets ............................................................................................ ES-15
ES.2.10 Electrical Power Resources ........................................................................ ES-15
ES.2.11 Recreation ........................................................................................................ ES-15
ES.2.12 Transportation ................................................................................................. ES-16
ES.2.13 Socioeconomics and Land Use ...................................................................... ES-17
ES.3 Cumulative Impacts ................................................................................................. ES-17

CHAPTER 1 PURPOSE AND NEED ...................................................................................... 1-1
1.1 Introduction .................................................................................................................. 1-1
1.2 Proposed Federal Action .......................................................................................... 1-2
1.3 Purpose of and Need for Action .............................................................................. 1-3
1.4 Lead and Cooperating Agencies ............................................................................. 1-4
1.5 Scope of the EIS ........................................................................................................ 1-6
1.5.1 Affected Region and Interests ........................................................................ 1-7
1.5.2 Relevant Issues .................................................................................................. 1-7
1.6 Summary of Contents of this Draft EIS ................................................................. 1-8
1.7 Water Supply Management and Allocation .......................................................... 1-9
1.7.1 Colorado River System Water Supply .......................................................... 1-9
1.7.2 Apportionment of Water Supply .................................................................. 1-11
1.7.3 System Reservoirs and Diversion Facilities ............................................ 1-18
1.7.4 Flood Control Operation ............................................................................ 1-19
1.7.5 Hydropower Generation .............................................................................. 1-19
1.7.6 Annual Operating Plan and Long Range Operating Criteria ................. 1-19
1.8 Related Actions ........................................................................................................ 1-23
1.8.1 Operation of Glen Canyon Dam - Final EIS and ROD ............................... 1-23
1.8.2 Off-stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States................................................................. 1-24
1.8.3 Interim Surplus Criteria - Final EIS and ROD - Colorado River Interim Surplus Guidelines ........................................................................................................... 1-24
1.8.4 Implementation Agreement, Inadvertent Overrun and Payback Policy, and Related Federal Actions - Final EIS and ROD - Colorado River Water Delivery Agreement ......................................................................... 1-25
1.8.5 Lower Colorado River Multi-Species Conservation Program (LCR MSCP) - Final Programmatic EIS/EIR and ROD - Lower Colorado River Multi-Species Conservation Plan ......................................................... 1-25

CHAPTER 2 DESCRIPTION OF ALTERNATIVES ............................................................ 2-1

2.1 Development of Alternatives ........................................................................... 2-1
2.2 No Action Alternative ..................................................................................... 2-3
  2.2.1 Shortage Guidelines .................................................................................. 2-4
  2.2.2 Coordinated Reservoir Operations ......................................................... 2-6
  2.2.3 Storage and Delivery of Conserved Water .................................................. 2-7
  2.2.4 Interim Surplus Guidelines ........................................................................ 2-7
2.3 Basin States Alternative .................................................................................... 2-8
  2.3.1 Shortage Guidelines .................................................................................. 2-8
  2.3.2 Coordinated Reservoir Operations ......................................................... 2-9
  2.3.3 Storage and Delivery of Conserved Water .................................................. 2-10
  2.3.4 Interim Surplus Guidelines ........................................................................ 2-11
2.4 Conservation Before Shortage Alternative ..................................................... 2-11
  2.4.1 Shortage Guidelines .................................................................................. 2-11
  2.4.2 Coordinated Reservoir Operations ......................................................... 2-11
  2.4.3 Storage and Delivery of Conserved Water .................................................. 2-11
  2.4.4 Interim Surplus Guidelines ........................................................................ 2-12
  2.4.5 Funding Mechanisms ............................................................................... 2-12
2.5 Water Supply Alternative ................................................................................ 2-13
  2.5.1 Shortage Guidelines .................................................................................. 2-13
  2.5.2 Coordinated Reservoir Operations ......................................................... 2-13
  2.5.3 Storage and Delivery of Conserved Water .................................................. 2-13
  2.5.4 Interim Surplus Guidelines ........................................................................ 2-13
2.6 Reservoir Storage Alternative ......................................................................... 2-14
  2.6.1 Shortage Guidelines .................................................................................. 2-14
  2.6.2 Coordinated Reservoir Operations ......................................................... 2-14
  2.6.3 Storage and Delivery of Conserved Water .................................................. 2-15
  2.6.4 Interim Surplus Guidelines ........................................................................ 2-15
2.7 Summary Comparison of Alternatives ............................................................ 2-15
2.8 Summary of Potential Effects .......................................................................... 2-19
CHAPTER 3 AFFECTED ENVIRONMENT

3.1 Introduction .............................................................................................................. 3-1
3.2 Geographic Scope ...................................................................................................... 3-1
  3.2.1 Definition of Colorado River Reaches ............................................................. 3-3
  3.2.2 Colorado River Water User Service Areas ..................................................... 3-10
3.3 Hydrologic Resources ............................................................................................. 3-15
  3.3.1 Hydrologic Overview ..................................................................................... 3-15
  3.3.2 Lake Powell and Glen Canyon Dam .............................................................. 3-17
  3.3.3 Glen Canyon Dam to Lake Mead ................................................................. 3-20
  3.3.4 Lake Mead and Hoover Dam ........................................................................ 3-20
  3.3.5 Hoover Dam to Davis Dam ............................................................................ 3-23
  3.3.6 Davis Dam to Parker Dam .............................................................................. 3-24
  3.3.7 Parker Dam to Cibola Gage ....................................................................... 3-25
  3.3.8 Cibola Gage to Imperial Dam ....................................................................... 3-26
  3.3.9 Imperial Dam to NIB .................................................................................. 3-26
  3.3.10 NIB to SIB ................................................................................................. 3-28
3.4 Water Deliveries ...................................................................................................... 3-31
  3.4.1 Apportionments to the Upper Division States ................................................ 3-31
  3.4.2 Apportionments to the Lower Division States and Water Entitlements within Each State ................................................................. 3-32
  3.4.3 Lower Division States Water Supply Determination .................................... 3-34
  3.4.4 Depletion Schedules for Lower Division States (Normal and Surplus) .......... 3-35
  3.4.5 Mexico’s Allotment ..................................................................................... 3-37
  3.4.6 Distribution of Shortages To and Within the Lower Division States ............ 3-38
3.5 Water Quality ......................................................................................................... 3-43
  3.5.1 Salinity ........................................................................................................... 3-43
  3.5.2 Temperature ................................................................................................... 3-46
  3.5.3 Sediment ......................................................................................................... 3-46
  3.5.4 Nutrients and Algae ...................................................................................... 3-48
  3.5.5 Dissolved Oxygen ........................................................................................ 3-49
  3.5.6 Metals ............................................................................................................. 3-49
  3.5.7 Perchlorate ...................................................................................................... 3-50
3.6 Air Quality ............................................................................................................... 3-51
  3.6.1 Federal Air Quality Requirements .................................................................. 3-51
  3.6.2 State and Local Air Quality Requirements .................................................... 3-52
  3.6.3 Ambient Air Quality by River Reach ............................................................ 3-53
3.7 Visual Resources ..................................................................................................... 3-55
  3.7.1 Lake Powell and Glen Canyon Dam Reach .................................................. 3-55
  3.7.2 Glen Canyon Dam to Lake Mead ................................................................. 3-56
  3.7.3 Lake Mead and Hoover Dam ....................................................................... 3-56
3.8 Biological Resources .............................................................................................. 3-57
  3.8.1 Vegetation ...................................................................................................... 3-57
  3.8.2 Wildlife .......................................................................................................... 3-61
  3.8.3 Special Status Species .................................................................................. 3-69
3.9  Cultural Resources ................................................................................................... 3-75
  3.9.1 Undertaking Determination ................................................................................ 3-75
  3.9.2 Definition of the Area of Potential Effects and Identification Efforts .......... 3-75
  3.9.3 Lake Powell and Glen Canyon Dam ............................................................... 3-76
  3.9.4 Glen Canyon Dam to Lake Mead ................................................................. 3-76
  3.9.5 Lake Mead and Hoover Dam ................................................................. 3-77
  3.9.6 Lake Mohave and Davis Dam ......................................................................... 3-78
  3.9.7 Davis Dam to Parker Dam ............................................................................. 3-78
3.10  Indian Trust Assets ................................................................................................. 3-81
  3.10.1 Introduction .................................................................................................... 3-81
  3.10.2 Water Rights and Trust Lands ................................................................. 3-81
  3.10.3 Hydroelectric Power Generation and Distribution ....................................... 3-89
  3.10.4 Cultural Resources ......................................................................................... 3-89
  3.10.5 Biological Resources ..................................................................................... 3-90
  3.10.6 Other Potentially Affected Tribes Asserting Colorado River Water Rights ... 3-90
3.11  Electrical Power Resources ................................................................................... 3-93
  3.11.1 Overview ........................................................................................................ 3-93
  3.11.2 Lake Powell and Glen Canyon Dam .............................................................. 3-96
  3.11.3 Lake Mead and Hoover Dam ......................................................................... 3-96
  3.11.4 Parker/Davis Projects ..................................................................................... 3-97
  3.11.5 Other Small Hydropower Facilities .............................................................. 3-98
  3.11.6 Basin Power Funds ......................................................................................... 3-98
  3.11.7 Water Supply System ................................................................................... 3-100
3.12  Recreation .............................................................................................................. 3-103
  3.12.1 Shoreline Public Use .................................................................................... 3-103
  3.12.2 Reservoir Boating ......................................................................................... 3-116
  3.12.3 River and Whitewater Boating ..................................................................... 3-119
  3.12.4 Sport Fishing ................................................................................................ 3-120
3.13  Transportation ....................................................................................................... 3-123
  3.13.1 Ferry Service ................................................................................................ 3-123
3.14  Socioeconomics and Land Uses .......................................................................... 3-127
  3.14.1 Study Area .................................................................................................... 3-127
  3.14.2 Water Use ..................................................................................................... 3-128
  3.14.3 Recreation ..................................................................................................... 3-132
3.15  Environmental Justice ............................................................................................ 3-135
  3.15.1 Minority, Low-Income Populations, and Indian Tribes ................................ 3-135

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES ................................................. 4-1

  4.1  Introduction ........................................................................................................... 4-1
  4.2  Methodology ......................................................................................................... 4-3
  4.2.1 Alternatives Modeled ....................................................................................... 4-3
  4.2.2 Period of Analysis ............................................................................................ 4-3
  4.2.3 Model Description ............................................................................................ 4-3
  4.2.4 Computational Procedures and Future Hydrology ........................................... 4-4
4.2.5 Post-processing and Interpretation Procedures ................................................ 4-5
4.2.6 Model Uncertainty............................................................................................ 4-6
4.2.7 Modeling Assumptions Common to All Alternatives...................................... 4-7
4.2.8 Modeling Assumptions Specific to Alternatives............................................ 4-11
4.3 Hydrologic Resources.............................................................................................. 4-15
  4.3.1 Methodology .................................................................................................. 4-15
  4.3.2 Lake Powell and Glen Canyon Dam .............................................................. 4-16
  4.3.3 Glen Canyon Dam to Lake Mead................................................................. 4-31
  4.3.4 Lake Mead and Hoover Dam ........................................................................ 4-38
  4.3.5 Hoover Dam to Davis Dam ........................................................................... 4-56
  4.3.6 Davis Dam to Parker Dam ............................................................................. 4-59
  4.3.7 Parker Dam to Cibola Gage and Cibola Gage to Imperial Dam .................... 4-65
  4.3.8 Imperial Dam to NIB...................................................................................... 4-74
  4.3.9 NIB to SIB...................................................................................................... 4-74
  4.3.10 Summary ...................................................................................................... 4-78
4.4 Water Deliveries ...................................................................................................... 4-81
  4.4.1 Methodology .................................................................................................. 4-81
  4.4.2 Apportionments to the Upper Division States................................................ 4-81
  4.4.3 Apportionments to the Lower Division States and Water Entitlements within Each State .................................................................................................. 4-82
  4.4.4 Lower Division States Water Supply Determination ...................................... 4-82
  4.4.5 Total Water Deliveries to the Lower Division States ................................... 4-102
  4.4.6 Water Deliveries to Mexico ......................................................................... 4-117
  4.4.7 Distribution of Shortages to and within the Lower Division States ............. 4-121
  4.4.8 Summary ...................................................................................................... 4-128
4.5 Water Quality......................................................................................................... 4-131
  4.5.1 Introduction .................................................................................................. 4-131
  4.5.2 Methodology ................................................................................................ 4-131
  4.5.3 Salinity ......................................................................................................... 4-133
  4.5.4 Temperature ................................................................................................. 4-134
  4.5.5 Sediment and Dissolved Oxygen .................................................................. 4-141
  4.5.6 Nutrients and Algae ...................................................................................... 4-144
  4.5.7 Metals ........................................................................................................... 4-145
  4.5.8 Perchlorate .................................................................................................... 4-145
  4.5.9 Summary ...................................................................................................... 4-146
4.6 Air Quality ............................................................................................................. 4-149
  4.6.1 Methodology ................................................................................................ 4-149
  4.6.2 Lake Powell and Glen Canyon Dam .............................................................. 4-149
  4.6.3 Glen Canyon Dam to Lake Mead, Lake Mead and Hoover Dam .................. 4-152
  4.6.4 Summary ...................................................................................................... 4-155
4.7 Visual Resources.................................................................................................... 157
  4.7.1 Methodology ................................................................................................ 157
  4.7.2 Lake Powell and Glen Canyon Dam .............................................................. 157
  4.7.3 Glen Canyon Dam to Lake Mead................................................................. 158
  4.7.4 Lake Mead and Hoover Dam ....................................................................... 159
  4.7.5 Summary ...................................................................................................... 160
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8</td>
<td>Biological Resources</td>
<td>4-161</td>
</tr>
<tr>
<td>4.8.1</td>
<td>Related Environmental Programs</td>
<td>4-161</td>
</tr>
<tr>
<td>4.8.2</td>
<td>Methodology</td>
<td>4-162</td>
</tr>
<tr>
<td>4.8.3</td>
<td>Effects on Vegetation and Wildlife</td>
<td>4-165</td>
</tr>
<tr>
<td>4.8.4</td>
<td>Special Status Species</td>
<td>4-171</td>
</tr>
<tr>
<td>4.8.5</td>
<td>Summary</td>
<td>4-202</td>
</tr>
<tr>
<td>4.9</td>
<td>Cultural Resources</td>
<td>4-207</td>
</tr>
<tr>
<td>4.9.1</td>
<td>Methodology</td>
<td>4-207</td>
</tr>
<tr>
<td>4.9.2</td>
<td>Lake Powell and Glen Canyon Dam</td>
<td>4-207</td>
</tr>
<tr>
<td>4.9.3</td>
<td>Glen Canyon Dam To Lake Mead</td>
<td>4-208</td>
</tr>
<tr>
<td>4.9.4</td>
<td>Lake Mead and Hoover Dam</td>
<td>4-208</td>
</tr>
<tr>
<td>4.9.5</td>
<td>Hoover Dam to Davis Dam</td>
<td>4-209</td>
</tr>
<tr>
<td>4.9.6</td>
<td>Davis Dam to Parker Dam</td>
<td>4-209</td>
</tr>
<tr>
<td>4.9.7</td>
<td>Parker Dam to Imperial Dam</td>
<td>4-210</td>
</tr>
<tr>
<td>4.9.8</td>
<td>Sacred Sites and Other Issues of Tribal Concern</td>
<td>4-210</td>
</tr>
<tr>
<td>4.9.9</td>
<td>Summary</td>
<td>4-211</td>
</tr>
<tr>
<td>4.10</td>
<td>Indian Trust Assets</td>
<td>4-213</td>
</tr>
<tr>
<td>4.10.1</td>
<td>Water Rights and Trust Lands</td>
<td>213</td>
</tr>
<tr>
<td>4.10.2</td>
<td>Hydroelectric Power Generation and Distribution</td>
<td>213</td>
</tr>
<tr>
<td>4.10.3</td>
<td>Cultural Resources</td>
<td>214</td>
</tr>
<tr>
<td>4.10.4</td>
<td>Biological Resources</td>
<td>214</td>
</tr>
<tr>
<td>4.10.5</td>
<td>Summary</td>
<td>214</td>
</tr>
<tr>
<td>4.11</td>
<td>Electrical Power Resources</td>
<td>4-215</td>
</tr>
<tr>
<td>4.11.1</td>
<td>Methodology</td>
<td>4-215</td>
</tr>
<tr>
<td>4.11.2</td>
<td>Electrical Power Generation Facilities</td>
<td>4-218</td>
</tr>
<tr>
<td>4.12</td>
<td>Recreation</td>
<td>4-243</td>
</tr>
<tr>
<td>4.12.1</td>
<td>Methodology</td>
<td>4-243</td>
</tr>
<tr>
<td>4.12.2</td>
<td>Recreation at Lake Powell</td>
<td>4-247</td>
</tr>
<tr>
<td>4.12.3</td>
<td>Recreation from Glen Canyon Dam to Lake Mead</td>
<td>4-249</td>
</tr>
<tr>
<td>4.12.4</td>
<td>Recreation at Lake Mead</td>
<td>4-252</td>
</tr>
<tr>
<td>4.12.5</td>
<td>Recreation from Hoover Dam to SIB</td>
<td>4-253</td>
</tr>
<tr>
<td>4.12.6</td>
<td>Summary</td>
<td>4-254</td>
</tr>
<tr>
<td>4.13</td>
<td>Transportation</td>
<td>4-257</td>
</tr>
<tr>
<td>4.13.1</td>
<td>Methodology</td>
<td>4-257</td>
</tr>
<tr>
<td>4.13.2</td>
<td>Lake Powell Ferry Service</td>
<td>4-257</td>
</tr>
<tr>
<td>4.13.3</td>
<td>Laughlin River Taxis and Tour Boats</td>
<td>4-258</td>
</tr>
<tr>
<td>4.13.4</td>
<td>Lake Havasu Ferry Service</td>
<td>4-259</td>
</tr>
<tr>
<td>4.13.5</td>
<td>Summary</td>
<td>4-259</td>
</tr>
<tr>
<td>4.14</td>
<td>Socioeconomics and Land Use</td>
<td>4-261</td>
</tr>
<tr>
<td>4.14.1</td>
<td>Methodology</td>
<td>4-261</td>
</tr>
<tr>
<td>4.14.2</td>
<td>Agriculture</td>
<td>4-269</td>
</tr>
<tr>
<td>4.14.3</td>
<td>Municipal and Industrial Water Uses</td>
<td>4-282</td>
</tr>
<tr>
<td>4.14.4</td>
<td>Recreation</td>
<td>4-284</td>
</tr>
<tr>
<td>4.14.5</td>
<td>Summary</td>
<td>4-285</td>
</tr>
<tr>
<td>4.15</td>
<td>Environmental Justice</td>
<td>4-289</td>
</tr>
<tr>
<td>4.15.1</td>
<td>Methodology</td>
<td>4-289</td>
</tr>
</tbody>
</table>
4.15.2 Hydrology, Water Deliveries, and Socioeconomics .................................... 4-289
4.15.3 Water Quality ............................................................................................... 4-289
4.15.4 Air Quality.................................................................................................... 4-290
4.15.5 Visual Resources .......................................................................................... 4-290
4.15.6 Biological Resources .................................................................................... 4-290
4.15.7 Cultural Resources ....................................................................................... 4-290
4.15.8 Indian Trust Assets ....................................................................................... 4-290
4.15.9 Electrical Power Resources .......................................................................... 4-290
4.15.10 Recreation ..................................................................................................... 4-291
4.15.11 Transportation .............................................................................................. 4-291
4.15.12 Summary ...................................................................................................... 4-291

CHAPTER 5 OTHER CONSIDERATIONS AND CUMULATIVE IMPACTS ................ 5-1

5.1 Federal Statutes and Policies ........................................................................... 5-1
5.1.1 Endangered Species Act of 1973, as Amended (16 U.S.C. §§ 1531-1544) ........ 5-1
5.1.2 Fish and Wildlife Coordination Act of 1934, as Amended (16 U.S.C. §§ 661-667d) 5-1
5.1.7 Bald Eagle Protection Act of 1940 (16 U.S.C. § 668) .............................. 5-3
5.1.8 Clean Air Act of 1963, as Amended (42 U.S.C. § 7506) ....................... 5-3
5.1.9 Federal Water Pollution Control Act (Clean Water Act) of 1972, as Amended (33 U.S.C. chapter 26) ................................................................. 5-3
5.1.10 River and Harbors Act of 1899 (33 U.S.C. §§ 401-403) ......................... 5-3
5.1.11 National Historic Preservation Act of 1966, as Amended (16 U.S.C. § 470) 5-3
5.1.12 Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. §§ 3001-3013 ) ................................................................. 5-4
5.1.13 Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470) ......... 5-4
5.1.15 Executive Order No. 11988, Floodplain Management, May 24, 1977 ...... 5-4
5.1.16 Executive Order No. 11990, Protection of Wetlands, May 24, 1977 ...... 5-5
5.1.17 Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994 ................................................................. 5-5
5.1.18 Executive Order No. 13007, Indian Sacred Sites, May 24, 1996 ......... 5-5
5.1.19 Executive Order No. 12114, Environmental Impacts Abroad of Major Federal Actions, January 4, 1979 ......................................................... 5-5
5.1.20 Secretarial Order No. 3206, American Indian Tribal Rights, Federal- Tribal Trust Responsibility, and the Endangered Species Act, June 7, 1997 ................................................................. 5-6
5.1.21 SNWA Virgin River and Muddy River Surface Water Development Project ................................................................. 5-7
5.1.22 SNWA Coyote Spring Well and Moapa Transmission System Project ........ 5-8
5.1.23 SNWA Clark, Lincoln, and White Pine Counties Groundwater Development Project ................................................................. 5-8
5.1.24 SNWA Lake Mead Intake No. 3 Project ................................................................. 5-8
5.1.25 Systems Conveyance and Operations Program ................................................................. 5-9
5.1.26 Lower Colorado River Multi-Species Conservation Program ................................................................. 5-9
5.1.27 Lower Colorado River Drop 2 Storage Reservoir Project ................................................................. 5-10
5.1.28 Long-Term Experimental Plan for the Operation of Glen Canyon Dam and Other Associated Management Activities ................................................................. 5-11
5.1.29 Cumulative Impacts by Resource ......................................................................................... 5-12
5.2 Relationship Between Short-term Uses of the Environment and Long-term Productivity ......................................................................................... 5-15
5.3 Irreversible and Irretrievable Commitments of Resources ......................................................................................... 5-16

CHAPTER 6 CONSULTATION AND COORDINATION ................................................................. 6-1

6.1 Introduction ............................................................................................................................................................................. 6-1
6.2 General Public Involvement Activities ............................................................................................................................................................................. 6-1
6.3 Cooperating Agency Involvement ............................................................................................................................................................................. 6-2
  6.3.1 Bureau of Indian Affairs ............................................................................................................................................................................. 6-2
  6.3.2 Fish and Wildlife Service ............................................................................................................................................................................. 6-2
  6.3.3 National Park Service ............................................................................................................................................................................. 6-3
  6.3.4 Western Area Power Administration ......................................................................................................................................................... 6-3
  6.3.5 United States Section of the International Boundary and Water Commission ............................................................................................................................................................................. 6-3
6.4 Tribal Consultation ............................................................................................................................................................................. 6-3
6.5 State and Local Water and Power Agency Coordination ............................................................................................................................................................................. 6-4
6.6 Non-Governmental Organizations Coordination ............................................................................................................................................................................. 6-4
6.7 Other Consultations ............................................................................................................................................................................. 6-5
6.8 Consultation with Mexico ............................................................................................................................................................................. 6-5
6.9 Summary of Coordination and Consultation Contacts ............................................................................................................................................................................. 6-5
6.10 Federal Register Notices ............................................................................................................................................................................. 6-8

INDEX ............................................................................................................................................................................. IND-1

REFERENCES CITED ............................................................................................................................................................................. REF-1

ACRONYMS ............................................................................................................................................................................. ACR-1

GLOSSARY ............................................................................................................................................................................. GLO-1

LIST OF PREPARERS ............................................................................................................................................................................. LOP-1
List of Figures

Figure ES-1 Geographic Scope .................................................................................................... ES-4

Figure 1.7-1 The Colorado River Basin ....................................................................................... 1-10
Figure 1.7-2 Lees Ferry Gaging Station ..................................................................................... 1-11
Figure 1.7-3 Upper and Lower Division States of the Colorado River ......................................... 1-14
Figure 1.7-4 Colorado River Reservoirs and Diversion ............................................................. 1-16
Figure 1.7-5 Lower Basin Dams and Reservoirs ......................................................................... 1-20

Figure 2.2-1 Level 1 Shortage Trigger Elevations Under No Action Alternative ......................... 2-5

Figure 3.2-1 Geographic Scope .................................................................................................. 3-4
Figure 3.2-2 Colorado River Reaches ......................................................................................... 3-5
Figure 3.2-3 CAP Service Area ................................................................................................ 3-11
Figure 3.2-4 SNWA Service Area ............................................................................................. 3-13
Figure 3.2-5 MWD Service Area ............................................................................................. 3-14
Figure 3.3-1 Natural Flow of the Colorado River at Lees Ferry Gaging Station, Arizona, 1906 through 2004 ........................................................................ 3-16
Figure 3.3-2 Historic Annual Flow of the Colorado River at Lees Ferry Gaging Station, Arizona, 1922 through 2005 ........................................................................ 3-17
Figure 3.3-3 Historic Annual Lake Powell Water Levels (Annual Highs and Lows) .................... 3-18
Figure 3.3-4 Historic Annual Lake Mead Elevations (Annual Highs and Lows) ......................... 3-21
Figure 3.3-5 Water Routing from Imperial Dam to NIB, Deliveries to Mexico Pursuant to the 1944 Treaty .................................................................................. 3-27
Figure 3.4-1 Upper Basin Scheduled Depletions, Years 2008 to 2060 ........................................ 3-32
Figure 3.4-2 Arizona’s Projected Colorado River Water Depletion Schedules Under No Action Alternative .................................................................................. 3-35
Figure 3.4-3 California’s Projected Colorado River Water Depletion Schedules Under No Action Alternatives ........................................................................ 3-36
Figure 3.4-4 Nevada’s Projected Colorado River Water Depletion Schedules Under No Action Alternative .................................................................................. 3-37
Figure 3.5-1 Historic Salinity Concentrations and Flows below Hoover Dam from 1941 to 2005 .................................................................................. 3-44
Figure 3.5-2 Historic Salinity Concentrations and Flows below Parker Dam from 1941 to 2005 .................................................................................. 3-45
Figure 3.5-3 Historic Salinity Concentrations and Flows at Imperial Dam from 1941 to 2005 .................................................................................. 3-45
Figure 3.5-4 Historic Elevation and Dam Release Temperatures at Lake Powell ......................... 3-47
Figure 3.5-5 Historic Elevation and Dam Release Temperatures at Lake Mead ......................... 3-47
Figure 3.12-1 Lake Powell Shoreline Access Points .................................................................. 3-105
Figure 3.12-2 Lake Mead Shoreline Access Points .................................................................. 3-111
Figure 3.12-3 Lake Mohave Shoreline Access Points ................................................................ 3-113
Figure 3.13-1 John Atlantic burr Ferry Route – Lake Powell ......................................................... 3-124
Figure 3.13-2 Laughlin River Taxi and Tour Boat Crossing .......................................................... 3-125
Figure 3.13-3 Lake Havasu Ferry Route ..................................................................................... 3-126
Figure 3.15-1 Minority Population by County ............................................................................ 3-136
Table of Contents

<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.15-2</td>
<td>Low Income Population by County</td>
<td>3-137</td>
</tr>
<tr>
<td>4.3-1</td>
<td>Lake Powell End-of-July Elevations Under the No Action Alternative 90th, 50th and 10th Percentile Values</td>
<td>4-17</td>
</tr>
<tr>
<td>4.3-2</td>
<td>Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values</td>
<td>4-18</td>
</tr>
<tr>
<td>4.3-3</td>
<td>Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 3,695 feet msl</td>
<td>4-20</td>
</tr>
<tr>
<td>4.3-4</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,650 feet msl</td>
<td>4-21</td>
</tr>
<tr>
<td>4.3-5</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,626 feet msl</td>
<td>4-22</td>
</tr>
<tr>
<td>4.3-6</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,620 feet msl</td>
<td>4-24</td>
</tr>
<tr>
<td>4.3-7</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,588 feet msl</td>
<td>4-25</td>
</tr>
<tr>
<td>4.3-8</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,560 feet msl</td>
<td>4-27</td>
</tr>
<tr>
<td>4.3-9</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,555 feet msl</td>
<td>4-28</td>
</tr>
<tr>
<td>4.3-10</td>
<td>Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,550 feet msl</td>
<td>4-29</td>
</tr>
<tr>
<td>4.3-11</td>
<td>Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl</td>
<td>4-30</td>
</tr>
<tr>
<td>4.3-12</td>
<td>Glen Canyon Dam Water Year Releases Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values</td>
<td>4-33</td>
</tr>
<tr>
<td>4.3-13</td>
<td>Glen Canyon Dam Water Year Releases Comparison of Action Alternatives to No Action Alternative Water Years 2009 through 2060</td>
<td>4-34</td>
</tr>
<tr>
<td>4.3-14</td>
<td>Glen Canyon Dam 10-Year Running Total of Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060</td>
<td>4-37</td>
</tr>
<tr>
<td>4.3-15</td>
<td>Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values</td>
<td>4-38</td>
</tr>
</tbody>
</table>
Figure 4.3-16  Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 1,200 feet msl ................................................................. 4-40
Figure 4.3-17  Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,178 feet msl ................................................................. 4-42
Figure 4.3-18  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,175 feet msl ................................................................. 4-43
Figure 4.3-19  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,125 feet msl ................................................................. 4-46
Figure 4.3-20  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,100 feet msl ................................................................. 4-49
Figure 4.3-21  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl ................................................................. 4-51
Figure 4.3-22  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,000 feet msl ................................................................. 4-54
Figure 4.3-23  Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Minimum Water Elevation Values (feet msl) .... 4-52
Figure 4.3-24  Lake Mead End-of-December Elevations Comparison of Action Alternatives With Storage and Delivery Mechanism Removed to No Action Alternative 10th, 50th, and 90th Percentile Values .............................. 4-54
Figure 4.3-25  Lake Mead End-of-July Elevations Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism 10th, 50th, and 90th Percentile Values .................................................. 4-55
Figure 4.3-26  Hoover Dam Annual Releases Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values ................. 4-57
Figure 4.3-27  Hoover Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060 ........................................ 4-58
Figure 4.3-28  Davis Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 2060 ........................................ 4-60
Figure 4.3-29  Colorado River Annual Flow Near Havasu NWR - RM 2423 (af) Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values ................................................ 4-61
Figure 4.3-30  Davis Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Annual Median (50th Percentile) Values (cfs) ............ 4-62
Figure 4.3-33  Parker Dam Annual Releases Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values.......................... 4-67
Figure 4.3-34  Parker Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Years 2008 through 6020......................................... 4-68
Figure 4.3-35  Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8 (af) Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values .............................................. 4-69
Figure 4.3-36  Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8 (af) Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values .......................... 4-70
Figure 4.3-37  Parker Dam Annual Releases Comparison of Action Alternatives to No Action Alternative Annual Median (50th Percentile) Values.......................... 4-71
Figure 4.3-38  Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1 (af) Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values.................................. 4-72
Figure 4.3-39  Excess Flows Below Mexico Diversion at Morelos Diversion Dam Comparison of Action Alternatives to No Action Alternative Cumulative Distribution - Years 2008 through 2060................................. 4-73
Figure 4.4-1  Involuntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Probability of Occurrence of Any Amount................................................. 4-74
Figure 4.4-2  Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Probability of Occurrence of Any Amount................................................. 4-75
Figure 4.4-3  Involuntary and Voluntary Lower Basin Shortage Comparison of Action Alternatives to No Action Alternative Average Shortage Volumes................................................................................................... 4-76
Figure 4.4-4  Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Years 2006 through 2026...................................................... 4-77
Figure 4.4-5  Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Years 2027 through 2060...................................................... 4-78
Figure 4.4-6  Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives to No Action Alternative Maximum Amounts.................. 4-79
Figure 4.4-7  Involuntary and Voluntary Lower Basin Shortages Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism Probability of Occurrence of Any Amount................................................. 4-80
Figure 4.4-8  Surplus Conditions Comparison of Action Alternatives to No Action Alternative Probability of Occurrence................................................................. 4-81
Figure 4.4-9  Partial Domestic Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence...................................................... 4-82
Figure 4.4-10 Full Domestic Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence...................................................... 4-83
<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4-12</td>
<td>Flood Control Surplus Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence</td>
</tr>
<tr>
<td>4.4-11</td>
<td>Quantified Surplus (70R Strategy) Deliveries to Lower Basin States Comparison of Action Alternatives to No Action Alternative Probability of Occurrence</td>
</tr>
<tr>
<td>4.4-13</td>
<td>Surplus Deliveries to Lower Basin States Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism Probability of Occurrence</td>
</tr>
<tr>
<td>4.4-14</td>
<td>Probability of Normal Conditions Comparison of Action Alternatives to No Action Alternative years 2008 through 2060</td>
</tr>
<tr>
<td>4.4-15</td>
<td>Surplus, Normal, and Shortage (Involuntary and Voluntary) Conditions Comparison of Action Alternatives to No Action Alternatives Probability of Occurrence</td>
</tr>
<tr>
<td>4.4-16</td>
<td>Arizona Modeled Annual Depletions No Action Alternative 90th, 50th, and 10th Percentile Values</td>
</tr>
<tr>
<td>4.4-17</td>
<td>Arizona Modeled Annual Depletion Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026</td>
</tr>
<tr>
<td>4.4-18</td>
<td>Arizona Modeled Annual Depletion Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060</td>
</tr>
<tr>
<td>4.4-19</td>
<td>Arizona Modeled Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2008 through 2026</td>
</tr>
<tr>
<td>4.4-20</td>
<td>Arizona Modeled Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2027 through 2060</td>
</tr>
<tr>
<td>4.4-21</td>
<td>California Modeled Annual Depletion No Action Alternative 90th, 50th, and 10th Percentile Values</td>
</tr>
<tr>
<td>4.4-22</td>
<td>California Modeled Annual Depletion Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026</td>
</tr>
<tr>
<td>4.4-23</td>
<td>California Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060</td>
</tr>
<tr>
<td>4.4-24</td>
<td>California Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2008 through 2026</td>
</tr>
<tr>
<td>4.4-25</td>
<td>California Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2027 through 2060</td>
</tr>
<tr>
<td>4.4-26</td>
<td>Nevada Modeled Annual Depletions No Action Alternative 90th, 50th, and 10th Percentile Values</td>
</tr>
</tbody>
</table>
Figure 4.4-27 Nevada Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026 ........................................................................ 4-114

Figure 4.4-28 Nevada Modeled Annual Depletion Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060 ........................................................................ 4-115

Figure 4.4-29 Nevada Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2008 through 2026 ........................................................................ 4-116

Figure 4.4-30 Nevada Modeled Annual Depletions Comparison of Action Alternatives With and Without Storage and Delivery Mechanism Years 2027 through 2060 ........................................................................ 4-117

Figure 4.4-31 Mexico Modeled Annual Depletions No Action Alternative 90th, 50th, and 10th Percentile Values ........................................................................ 4-118

Figure 4.4-32 Mexico Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2008 through 2026 ........................................................................ 4-119

Figure 4.4-33 Mexico Modeled Annual Depletions Comparison of Action Alternatives (Without Storage and Delivery Mechanism) to No Action Alternative Years 2027 through 2060 ........................................................................ 4-120

Figure 4.5-1 Historic Data and CE-Qual-W2 Model Results for Lake Powell Release Temperatures by Elevation........................................................................ 4-121

Figure 4.6-1 Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values ........................................................................ 4-122

Figure 4.6-2 Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th and 10th Percentile Values ........................................................................ 4-123

Figure 4.11-1 Glen Canyon Powerplant Average Values of Annual Electrical Energy Production ........................................................................ 4-124

Figure 4.11-2 Hoover Powerplant Average Values of Annual Electrical Energy Production ........................................................................ 4-125

Figure 4.11-3 Davis Powerplant Average Values of Annual Electrical Energy Production ........................................................................ 4-126

Figure 4.11-4 Parker Powerplant Average Values of Annual Electrical Energy Production ........................................................................ 4-127

Figure 4.11-5 Headgate Rock Powerplant Average Values of Electrical Energy Production ........................................................................ 4-128

Figure 4.11-6 Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl ........................................................................ 4-129

Figure 4.11-7 Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl ........................................................................ 4-130

Figure 4.14-1 Steps in Analyzing Changes in Agricultural Production and Resulting Changes in Employment, Income, and Tax Revenue ........................................................................ 4-131
Figure 4.14-2 Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative, 90th, 50th and 10th Percentile Values ............................................................. 4-268
Figure 4.14-3 Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative, 90th, 50th and 10th Percentile Values .......... 4-268

List of Tables

Table ES-1 Matrix of Alternatives .................................................................................. ES-5
Table ES-2 Summary of Potential Effects of the Alternative .............................................. ES-18
Table 1.5-1 Relevant Issues .............................................................................................. 1-7
Table 1.7-1 Selected Documents Included in the “Law of the River” ................................. 1-13
Table 2.2-1 Modeling Assumptions for Distribution of Shortages ..................................... 2-5
Table 2.3-1 Basin States Alternative Lake Powell Equalization Elevations .......................... 2-9
Table 2.3-2 Basin States Alternative Volume Limitations of Storage and Delivery Mechanism.................................................................................................. 2-11
Table 2.4-1 Conservation Before Shortage Alternative Volume Limitations of Storage and Delivery Mechanism ................................................................. 2-12
Table 2.6-1 Reservoir Storage Alternative Volume Limitations of Storage and Delivery Mechanism.............................................................................. 2-15
Table 2.7-1 Matrix of Alternatives .................................................................................... 2-17
Table 2.7-2 Comparison of Alternatives – Lake Powell ......................................................... 2-18
Table 2.7-3 Comparison of Alternatives – Lake Mead .......................................................... 2-19
Table 2.8-1 Summary of Potential Effects of the Alternatives .............................................. 2-21
Table 3.2-1 Colorado River Reaches and Reach Limits ....................................................... 3-6
Table 3.2-2 CAP Water Users ............................................................................................ 3-12
Table 3.3-1 Glen Canyon Dam Release Constraints .......................................................... 3-19
Table 3.4-1 Upper Division States Apportionment ............................................................... 3-31
Table 3.4-2 Lower Division States Apportionment ............................................................... 3-32
Table 3.4-3 Volumes of Water Apportioned to PPRs in the Lower Division States ....... 3-33
Table 3.4-4 Arizona Priority System for Mainstream Colorado River ................................. 3-39
Table 3.4-5 California’s Seven-Party Agreement for Mainstream Colorado River ................. 3-40
Table 3.4-6 Nevada’s Priority System for Mainstream Colorado River ................................. 3-41
Table 3.5-1 Numeric Salinity Standards for the Colorado River ........................................ 3-44
Table 3.6-1 Clean Air Act Prevention of Significant Deterioration Designations.............. 3-51
Table 3.6-2 Clean Air Act Allowable Particulate Matter Concentration Increases over the Baseline Concentrations................................................................. 3-52
Table 3.6-3 National and State Ambient Air Quality Standards for Particulate Matter ............ 3-52
Table 3.6-4 State and Local Air Pollution Control Agencies Having Jurisdiction within the Lake Powell and Lake Mead Areas ......................................................... 3-53
Table 3.8-1 Summary of Vegetation Cover Types from Lake Mead to the SIB .................. 3-59
Table 3.8-2  Summary of Vegetation Cover Types from Lake Mead to the NIB (acres)........................................................................................................... 3-60
Table 3.8-3  Summary of Vegetation Cover Types in the United States from NIB to SIB ................................................................................................... 3-60
Table 3.8-4  Native and Non-Native Fish Species Present in the Study Area by Reach..................................................................................................... 3-61
Table 3.8-5  The Fifteen Generally Most Common Terrestrial Breeding Bird Species Found in Riparian Habitats Along the Colorado River in Grand Canyon .............................................................................................. 3-67
Table 3.8-6  The Ten Generally Most Common Overwintering Aquatic Bird Species Encountered During Surveys Along the Colorado River below Glen Canyon Dam .......................................................................................... 3-67
Table 3.8-7  Special Status Species Potentially Affected by the Proposed Federal Action........................................................................................................... 3-67
Table 3.10-1  Colorado River Mainstream Diversion Entitlement (Water Rights) in Favor of Indian Reservations ........................................................................... 3-70
Table 3.10-2  Central Arizona Project Indian Tribal Diversion Entitlements (Water Rights) ........................................................................................................... 3-70
Table 3.11-1  Generation Capability in WECC Areas ........................................................................................................... 3-70
Table 3.12-1  Glen Canyon National Recreation Area Recreational Visitors.......................................................................................................................... 3-70
Table 3.12-2  Glen Canyon National Recreation Area Visits by Visitor Segment for 2003 ........................................................................................................... 3-70
Table 3.12-3  Critical Elevations for Lake Powell by Boating Facility .......................................................................................................................... 3-70
Table 3.12-4  Number of Camping Beaches by Camp Size for High- and Low-Water Camps ..................................................................................................... 3-70
Table 3.12-5  Lake Mead National Recreation Area Recreational Visitors .......................................................................................................................... 3-70
Table 3.12-6  Lake Mead National Recreation Area Visits by Visitor Segment for 2003 ........................................................................................................... 3-70
Table 3.12-7  Critical Elevations and Surface Area for Lake Mead by Recreational Facility ........................................................................................................... 3-70
Table 3.12-8  Visitation at Arizona’s Lake Havasu and Cattail Cove State Parks .................................................................................................................. 3-70
Table 3.12-9  Estimates of Watercraft Use in Glen Canyon National Recreation Area by Month in 2001 .................................................................................. 3-70
Table 3.14-1  Central Arizona Irrigated Agricultural Land in 2002 .......................................................................................................................... 3-70
Table 3.14-2  Southern Nevada (Clark County) Agricultural Land in 2002 .......................................................................................................................... 3-70
Table 3.14-3  Southern California Agricultural Land in the Seven-County Study Area (2004) ........................................................................................................... 3-70
Table 3.14-4  Glen Canyon National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003 .................................................................................................................. 3-70
Table 3.14-5  Lake Mead National Recreation Area Economic Impacts of Visitor Spending by Sector for 2003 .................................................................................................................. 3-70
Table 4.2-1  Modeling Assumptions for Distribution of Stage 1 Shortages .......................................................................................................................... 4-10
Table 4.2-2  Modeling Assumptions for Distribution of Stage 2 Shortages .......................................................................................................................... 4-10
Table 4.2-3  Modeling Assumptions for Storage and Delivery of Conserved System and Non-System Water .................................................................................. 4-10
Table 4.3-1  Lake Powell End-of-July Elevations (feet msl) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values .......................................................... 4-19
Table 4.3-2  Lake Powell End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 3,695 feet msl .......................................................... 4-20
Table 4.3-3  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,650 feet msl .......................................................... 4-22
Table 4.3-4  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,626 feet msl .......................................................... 4-23
Table 4.3-5  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,620 feet msl .......................................................... 4-24
Table 4.3-6  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,588 feet msl .......................................................... 4-26
Table 4.3-7  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,560 feet msl .......................................................... 4-27
Table 4.3-8  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,555 feet msl .......................................................... 4-28
Table 4.3-9  Lake Powell End-of-September Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,550 feet msl .......................................................... 4-30
Table 4.3-10 Lake Powell End-of-March Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 3,490 feet msl .......................................................... 4-31
Table 4.3-11 Glen Canyon Dam Water Year Releases Probability of Occurrence of Different Size Annual Releases Comparison of Action Alternatives to No Action Alternative Water Years 2009 through 2060 ........................................... 4-32
Table 4.3-12 Average Daily Glen Canyon Dam Releases (cfs) Corresponding to Various Annual Release Volumes .......................................................... 4-35
Table 4.3-13 Minimum Hourly Glen Canyon Dam Release (cfs) Corresponding to Various Annual Release Volumes .......................................................... 4-35
Table 4.3-14 Maximum Hourly Glen Canyon Dam Release (cfs) Corresponding to Various Annual Release Volumes .......................................................... 4-36
Table 4.3-15 Lake Mead End-of-December Elevations (feet msl) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values .......................................................... 4-39
Table 4.3-16 Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Greater Than or Equal to Elevation 1,200 feet msl .......................................................... 4-41
Table 4.3-17  Lake Mead End-of-December Water Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less than or Equal to Elevation 1,178 feet msl ................................................................. 4-42
Table 4.3-18  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,175 feet msl ................................................................. 4-44
Table 4.3-19  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,170 feet msl ................................................................. 4-45
Table 4.3-20  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,125 feet msl ................................................................. 4-47
Table 4.3-21  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,080 feet msl ................................................................. 4-48
Table 4.3-22  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,050 feet msl ................................................................. 4-50
Table 4.3-23  Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative Percent of Values Less Than or Equal to Elevation 1,000 feet msl ................................................................. 4-51
Table 4.3-24  Lake Mead End-of-December Elevations Comparison of Action Alternatives to No Action Alternative Minimum Elevation Values (feet msl) ................................................................. 4-53
Table 4.3-25  Increase / Decrease ( ) in Lake Mead Elevations (feet msl) Resulting From a Storage and Delivery Mechanism Comparison of Action Alternatives With and Without a Storage and Delivery Mechanism 90th, 50th, and 10th Percentile Values ................................................................. 4-55
Table 4.3-26  Hoover Dam Annual Releases Probability of Occurrence of Different Annual Release Volumes Comparison of Action Alternatives to No Action Alternative Calendar Years 2008 through 2060 ................................................................. 4-59
Table 4.3-27  Colorado River Annual Flow Near Havasu NWR - RM 242.3 (maf) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values ................................................................. 4-63
Table 4.3-28  Davis Dam Annual Median Releases Differences of Action Alternatives Compared to No Action Alternative1 (cfs) ................................................................. 4-65
Table 4.3-29  Colorado River Annual Flow Upstream of CRIR Diversion - RM 180.8 (mafy) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values ................................................................. 4-70
Table 4.3-30  Colorado River Annual Flow Downstream of Palo Verde Diversion Dam - RM 133.8 (maf) Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values ................................................................. 4-72
Table 4.3-31  Parker Dam Annual Median Releases Differences of Action Alternatives Compared to No Action Alternative1, (cfs) ................................................................. 4-73
Table 4.3-32  Colorado River Annual Flow Below Mexico Diversion at Morelos Diversion Dam - RM 21.1 (maf) Comparison of Action Alternatives to No Action Alternative  90th, 50th, and 10th Percentile Values .......................... 4-77
Table 4.4-1  First Year of Occurrence of Involuntary Shortage  Comparison of Action Alternatives and No Action Alternative.......................................................... 4-83
Table 4.4-2  Probability of Occurrence of Any Amount of Involuntary Shortage Comparison of Action Alternatives to No Action Alternative .................. 4-84
Table 4.4-3  First Year of Occurrence of Involuntary or Voluntary Shortage Comparison of Action Alternatives to No Action Alternative .................. 4-85
Table 4.4-4  Probability of Occurrence of Involuntary and Voluntary Shortages of Any Amount Comparison of Action Alternatives to No Action Alternative.......................................................... 4-86
Table 4.4-5  Distribution of Shortages, Year 2017 ............................................. 4-90
Table 4.4-6  Distribution of Shortages, Year 2026 ............................................. 4-90
Table 4.4-7  Distribution of Shortages, Year 2027 ............................................. 4-91
Table 4.4-8  Distribution of Shortages, Year 2040 ............................................. 4-91
Table 4.4-9  Distribution of Shortages, Year 2060 ............................................. 4-92
Table 4.4-10 Maximum Occurrence of Involuntary and Voluntary Shortage to the Lower Basin (af) Comparison of Action Alternatives to No Action Alternative .......................................................... 4-93
Table 4.4-11 Shortage Allocation to Arizona (af) .............................................. 4-121
Table 4.4-12 Probability of Occurrence of Shortages Less Than or Equal to, Years 2008 through 2026 (percent).......................................................... 4-122
Table 4.4-13 Probability of Occurrence of Shortages Less Than or Equal to, Years 2027 through 2060 (percent).......................................................... 4-122
Table 4.4-14 Maximum Shortage Allocation to Arizona (af) .................................. 4-122
Table 4.4-15 Distribution of Shortages Among Arizona Entities (af) ....................... 4-123
Table 4.4-16 Shortage Allocation to California (af) ............................................. 4-125
Table 4.4-17 Maximum Shortage Allocation to California (af) .................................. 4-126
Table 4.4-18 Shortage Allocation to Nevada (af) .................................................. 4-126
Table 4.4-19 Maximum Shortage Allocation to Nevada (af) .................................. 4-127
Table 4.4-20 Shortage Distribution to Mexico (af) .............................................. 4-127
Table 4.4-21 Maximum Shortage Allocation to Mexico (af) .................................. 4-128
Table 4.5-1  Projected Colorado River Salinity in 2008 ........................................ 4-134
Table 4.5-2  Projected Colorado River Salinity in 2026 ........................................ 4-134
Table 4.5-3  Projected Colorado River Salinity in 2060 ........................................ 4-134
Table 4.5-4  Lake Powell July Elevations and Release Temperatures 90th, 50th, and 10th Percentile Values .................................................................................. 4-136
Table 4.5-5  Lake Powell October Elevations and Release Temperatures 90th, 50th, and 10th Percentile Values .................................................................................. 4-137
Table 4.5-6  Colorado River at Little Colorado River Confluence July Water Temperatures 90th, 50th, and 10th Percentile Values ................................................ 4-138
Table 4.5-7  Colorado River at Little Colorado River Confluence October Water Temperatures 90th, 50th, and 10th Percentile Values ................................................ 4-139
Table 4.5-8  Colorado River Below Diamond Creek July Water Temperatures 90th, 50th, and 10th Percentile Values ................................................ 4-140
Table 4.5-9  Colorado River Below Diamond Creek October Water Temperatures
90th, 50th, and 10th Percentile Values .......................................................... 4-141
Table 4.5-10 Relationship of Glen Canyon Dam Annual Release Volumes to
Sediment Transport .................................................................................. 4-142
Table 4.5-11 Comparison of Sediment Export among Alternatives (Normalized to
8.23 maf annual releases) 2008.................................................................... 4-143
Table 4.5-12 Comparison of Sediment Export among Alternatives (Normalized to
8.23 maf annual releases) 2016................................................................. 4-143
Table 4.5-13 Comparison of Sediment Export among Alternatives (Normalized to
8.23 maf annual releases) 2026................................................................. 4-144
Table 4.6-1 Lake Powell End-of-March 10th Percentile Elevation and Exposed
Shoreline ( Rounded to Nearest Whole Number) ....................................... 4-151
Table 4.6-2 Lake Mead End-of-December 10th Percentile Elevation and Exposed
Shoreline (Rounded to Nearest Whole Number) ....................................... 4-154
Table 4.8-1 Vegetation and Wildlife Impact Summary ...................................... 4-172
Table 4.8-2 Lake Powell Special Status Species Impact Summary ................. 4-175
Table 4.8-3 Months When Water Temperatures may be Adequate to Support
Growth of Fish Under the No Action Alternative ...................................... 4-178
Table 4.8-4 Glen Canyon Dam to Lake Mead Special Status Species Impact
Summary ..................................................................................................... 4-187
Table 4.8-5 Lake Mead Special Status Species Impact Summary ...................... 4-192
Table 4.8-6 Davis Dam to Lake Havasu Special Status Species Impact Summary.... 4-196
Table 4.8-7 Parker Dam to NIB Special Status Species Impact Summary .......... 4-199
Table 4.8-8 NIB to SIB Special Status Species Impact Summary ..................... 4-201
Table 4.11-1 No Action Alternative Values at Glen Canyon Powerplant ................ 4-218
Table 4.11-2 Change in Glen Canyon Powerplant Annual Energy Generation
(MWh) ........................................................................................................ 4-218
Table 4.11-3 Percent Change in Glen Canyon Powerplant Annual Generation .................. 4-218
Table 4.11-4 Change in Glen Canyon Powerplant Generation Capacity .................. 4-220
Table 4.11-5 Change in Glen Canyon Powerplant Generation Capacity (Percent) .......... 4-220
Table 4.11-6 Change in Glen Canyon Powerplant Total Economic Value of
Electrical Power Generation (PV 2008 $ million) ..................................... 4-220
Table 4.11-7 Change in Glen Canyon Powerplant Total Economic Value of
Electrical Power Generation (Percent) ..................................................... 4-221
Table 4.11-8 No Action Alternative Values at Hoover Powerplant....................... 4-221
Table 4.11-9 Change in Hoover Powerplant Annual Electrical Energy Generation
(MWh) ....................................................................................................... 4-221
Table 4.11-10 Change in Hoover Powerplant Annual Electrical Energy Generation
(Percent) .............................................................................................. 4-222
Table 4.11-11 Change in Hoover Powerplant Monthly Generation Capacity (MW) .... 4-223
Table 4.11-12 Change in Hoover Powerplant Monthly Generation Capacity (Percent) ... 4-223
Table 4.11-13 Change in Hoover Powerplant Total Economic Value of Electrical
Power Generated (PV 2008 $ million) ................................................... 4-223
Table 4.11-14 Change in Hoover Powerplant Total Economic Value of Electrical
Power Generated (Percent) ..................................................................... 4-224
Table 4.11-15 No Action Alternative Values at Parker and Davis Powerplants .......... 4-224
Table 4.11-16 Change in Parker and Davis Powerplants Annual Electrical Energy Generation (MWh) ................................................................. 4-225
Table 4.11-17 Change in Parker and Davis Powerplants Annual Electrical Energy Generation (Percent) ............................................................... 4-225
Table 4.11-18 Change in Parker and Davis Powerplants Monthly Generation Capacity (MW) ............................................................................. 4-225
Table 4.11-19 Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generation (PV 2008 $ million) ................. 4-227
Table 4.11-20 Change in Parker and Davis Powerplants Total Economic Value of Electrical Power Generated (Percent) ........................................ 4-227
Table 4.11-21 No Action Alternative Values at Headgate Rock Power Plant ................................................................. 4-228
Table 4.11-22 Change in Headgate Rock Powerplant Annual Electrical Energy Generation (MWh) ................................................................. 4-228
Table 4.11-23 Change in Headgate Rock Powerplant Annual Electrical Energy Generation (Percent) ............................................................... 4-228
Table 4.11-24 Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated (PV 2008 $ million) ......................... 4-229
Table 4.11-25 Change in Headgate Rock Powerplant Total Economic Value of Electrical Power Generated (Percent) ........................................ 4-230
Table 4.11-26 Change in Navajo Generating Station Intake Electrical Power Requirements at Lake Powell ............................................................... 4-237
Table 4.11-27 Change in City of Page Intake Electrical Power Requirements at Lake Powell .................................................................................. 4-237
Table 4.11-28 Change in Estimated SNWA Pumping Costs ......................................................................................................................... 4-238
Table 4.11-29 Summary Comparison of Action Alternatives to No Action Alternative Mean Values for Electrical Energy Generation, Generation Capacity, and Economic Value ........................................................................ 4-239
Table 4.12-1 Water Temperature Tolerances of Rainbow Trout ......................................................................................................................... 4-246
Table 4.12-2 Life History of the Rainbow Trout, Phases by Months .................................................................................................................. 4-246
Table 4.13-1 Range of Probabilities of Lake Powell Elevations Less Than or Equal to Elevation 3,550 feet msl .................................................................... 4-257
Table 4.14-2 Estimated Change in Agricultural Production Value Resulting from Involuntary Land Fallowing in Arizona under Various Levels of Shortage for Various Years ........................................................................... 4-270
Table 4.14-3 Estimated Changes in Employment as a Result of Shortages to Agricultural Lands for the No Action, Basin States, and Conservation Before Shortage, Water Supply and Reservoir Storage Alternatives, by Selected Years and Shortage Amounts ........................................................................ 4-272

Volume II: Appendices

See Volume II Table of Contents
This page intentionally left blank.