Appendix P

Additional CRSS Modeling Output

This appendix contains additional supporting CRSS modeling output and hydrologic information. Hydrologic information provided in this appendix is referenced in the Hydrologic Resources, Water Deliveries, Water Quality, Air Quality, Biological Resources, Cultural Resources, and Electrical Power Resources sections of the EIS.
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Hydrologic Resources Information

This section contains additional information that was used in the hydrologic analysis (Section 4.3 of this Final EIS). The specific information provided in this section consists of a series of figures that provide comparisons of Lake Powell and Lake Mead under the modeled action alternatives to those under the modeled No Action Alternative. Also, this section contains the results of analysis that compares the probability of Beach/Habitat Building Flow release from Glen Canyon Dam under the No Action Alternative to the action alternatives.
Appendix P

Additional CRSS Modeling Output

Figure P-HR-1
Lake Powell Annual Evaporation Comparison of Action Alternatives to No Action Alternative Average Values

Evaporation (af)
Figure P-HR-3
Lake Mead Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Average Values

Evaporation (af)

Year

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P-HR-4
Lake Mead Annual Evaporation
Comparison of Action Alternatives to No Action Alternative
Median Values (50th Percentile)

Evaporation (af)

Year

Final EIS – Colorado River Interim Guidelines for
Lower Basin Shortages and Coordinated Operations for
Lake Powell and Lake Mead
P-HR.1  Beach/Habitat-Building Flows

P-HR.1.1  Introduction
The construction and operation of Glen Canyon Dam has caused two major changes related to sediment resources downstream in Glen Canyon and Grand Canyon. The first change is reduced sediment supply. Because Glen Canyon Dam and Lake Powell trap virtually all of the incoming sediment from the Upper Basin, releases from Glen Canyon Dam are mostly as clear water. The second major change is the reduction in the high water zone from pre-dam annual flood elevations to powerplant release elevations. Thus, the height of annual sediment deposition and erosion in the Colorado River reaches downstream of Glen Canyon Dam has been reduced.

During the investigations leading to the preparation of the *Operation of Glen Canyon Dam Final EIS* (Reclamation 1995), the relationships between releases from Glen Canyon Dam and downstream sedimentation processes were brought sharply into focus, and flow patterns designed to conserve sediment for building beaches and habitat (i.e., beach/habitat-building flow, or BHBF releases) were identified. The BHBF releases are scheduled high releases of short duration that exceed the hydraulic capacity of the powerplant. Such releases were presented as a commitment in the 1996 ROD for the *Operation of the Glen Canyon Dam FEIS* (Reclamation 1996e), at a then-assumed frequency of one in five years.

In addition to these BHBF releases that exceed the hydraulic capacity of Glen Canyon Powerplant, the *Operation of Glen Canyon Dam FEIS* identified the need for Beach/Habitat Maintenance Flow (BHMF) releases which do not exceed the hydraulic capacity of the powerplant. These flows were designed to prevent backwater habitat from filling with sediment and to reduce vegetation on camping beaches in years between BHBFs. BHBF and BHMF releases serve as a tool for maintaining a mass balance of sediment in Glen Canyon and Grand Canyon.

P-HR.1.2  Methodology

The frequencies at which BHBF releases from Glen Canyon Dam would occur under the No Action Alternative and the action alternatives were estimated through the use of the Colorado River Simulation System (CRSS) and modeling as described in Section 4.2.3 of this Final EIS.

The model was configured to simulate BHBF releases by incorporating the BHBF hydrologic triggering criteria (contained in Section P-HR.1.3) into the Glen Canyon Dam operating rules. The model was also configured to make no more than one BHBF release in any given year.

P-HR.1.3  Existing Conditions

Sediment along the Colorado River downstream of Glen Canyon Dam is an important and dynamic resource which affects fish and wildlife habitat along the river, creates camping beaches for recreation, and serves to protect cultural resources. Except for remnants of high river terraces deposited prior to the closure of Glen Canyon Dam, the now-limited sediment supply that exists along the river channel is affected by Glen Canyon Dam operations.
Since construction of Glen Canyon Dam, the measured suspended sediment load (sand, silt, and clay) at Phantom Ranch (in the Grand Canyon) averages 11 million tons per year. Most of this load comes from the Paria River and the Little Colorado River. Flash floods from other side canyons also contribute to the sediment supply (Reclamation 1995). The suspended sediment load is sporadic in occurrence, depending on Glen Canyon Dam releases and tributary inputs.

Beneficial sediment mobilization and deposition downstream of Glen Canyon Dam depends on the interaction of two occurrences for full effectiveness: the addition of sediment to the river corridor and BHBF releases. The higher energy of BHBF releases mobilizes suspended and riverbed-stored sediment and deposits it as beaches in beach and shoreline areas. Once a BHBF release has been made, additional sediment supply from tributary inflows is needed before subsequent BHBF releases are fully effective in promoting further beach and sandbar deposition along the river.

Subsequent to the 1996 ROD, specific operating criteria were developed which further refined conditions under which BHBFs would be made. The criteria provide that under either of the following two triggering conditions, BHBF releases may be made from Glen Canyon Dam:

1) if the January forecast for the January-July unregulated spring runoff into Lake Powell exceeds 13 maf (about 140 percent of normal) when January 1 content is greater than 21.5 maf; or

2) any time a Lake Powell inflow forecast would require a monthly powerplant release greater than 1.5 maf.

Research concerning the relationships among dam operations, downstream sediment inflow, river channel and sandbar characteristics, and particle-size distribution along the river is ongoing.

**P-HR.1.4 Modeling Results**

The effects of the No Action Alternative and the action alternatives on BHBF releases from Glen Canyon Dam were analyzed in terms of the yearly frequency at which BHBF releases could be made. Specifically, the frequency was indicated by the occurrence of one or both of the triggering criteria cited above, during a calendar year. The following discussion presents probability of occurrence under the No Action Alternative, and then compares the probability of BHBF releases under each action alternative to the No Action Alternative.

Figure P-HR-5 shows the probabilities that BHBF releases could be made under the No Action Alternative and the action alternatives. This figure shows that in the initial two years of the modeling period (2008 and 2009), under the assumed hydrologic sequences and reservoir starting conditions, there is a zero probability of BHBF releases. From 2010 through about 2016, the probability of BHBF releases under the No Action Alternative increases each year to about ten percent. Between 2017 and 2039, the probability under the No Action Alternative varies between nine percent to 12 percent. Between 2040 and 2060, the probability under the No Action Alternative increases slightly and varies between nine percent to 15 percent.
The probability of BHBF releases under the Basin States, Conservation Before Shortage, and Water Supply Alternatives, and the Preferred Alternative, are similar to those observed under the No Action Alternative and differ no more than one percentage point in any one year. The exception to this occurs in 2042 when the probability under all of these alternatives is three percent lower than that of the No Action Alternative. This occurrence is the result of the relatively lower reservoir conditions in 2026 that occur under these alternatives.

The Reservoir Storage Alternative generally provides a higher probability of BHBF releases than the No Action Alternative and the other action alternatives between 2011 through 2045. This occurs due to the generally higher reservoir elevations that are provided under the Reservoir Storage Alternative. Because these elevations are higher than the first part of the BHBF release triggering criteria, The Reservoir Storage Alternative provides slightly higher probability for BHBF releases.

The probability of BHBF releases under the No Action Alternative and the action alternatives all converge in about 2046 and remain the same through 2060.

Table P-HR-1 summarizes the BHBF release probabilities during the interim period (2008 through 2026) and the subsequent period to 2060, based on the data plotted in Figure P-HR-5. The table reflects the higher average probability during the post-interim period than during the interim period due to the low reservoir starting conditions in 2008.

<table>
<thead>
<tr>
<th>Period</th>
<th>No Action</th>
<th>Basin States</th>
<th>Conservation Before Shortage</th>
<th>Water Supply</th>
<th>Reservoir Storage</th>
<th>Preferred Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 - 2026</td>
<td>6.9</td>
<td>6.9</td>
<td>7.1</td>
<td>6.8</td>
<td>8.0</td>
<td>7.4</td>
</tr>
<tr>
<td>2027 - 2060</td>
<td>11.5</td>
<td>11.4</td>
<td>11.4</td>
<td>11.4</td>
<td>12.1</td>
<td>11.4</td>
</tr>
</tbody>
</table>
Figure P-HR-5
Glen Canyon Dam Releases
Probability of Occurrence of BHBF Releases

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Year

Probability of Occurrence

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Water Deliveries Information

This section contains additional information used in the analysis of water deliveries (Section 4.4). Specifically, this information is used in the analysis of multi-year shortages. In this EIS, occurrences of shortages in consecutive years are termed multi-year shortages. The information consists of a series of figures that provide comparisons of the probability of multi-year shortages with volumes equal to or greater than 400 kafy, 500 kafy, 600 kafy, and 1,000 kafy. Consecutive year shortages with durations of two or more years, five or more years, ten or more years, and 15 or more years were considered for these shortage analyses.
Appendix P
Additional CRSS Modeling Output

Figure P-WD-1
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

[Graph showing probability of occurrence over years for different action alternatives]
Figure P-WD-2
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-3
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-4
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-5
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Probability of Occurrence
100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%
No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P-WD-6
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Year:
- 2005
- 2010
- 2015
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
- 2050
- 2055
- 2060

Probability of Occurrence:
- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%
Figure P-WD-7
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-8
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 500 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-9
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-10
Consecutive Shortages of Five Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-11
Consecutive Shortages of Ten Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Probability of Occurrence
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Figure P-WD-12
Consecutive Shortages of 15 Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WD-13
Consecutive Shortages of Two Years or Greater
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 1,000 kaf

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Probability of Occurrence
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
### Table P-WD-1
Consecutive Shortages With Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 400 kaf

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### Table P-WD-2
Consecutive Shortages With Durations of Two or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative

#### Probability of Shortage per Year Greater Than or Equal to 500 kaf

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### Table P-WD-3
Consecutive Shortages With Durations of Two Or More Years, Five or More Years, Ten or More Years, and 15 or More Years
Comparison of Action Alternatives to No Action Alternative
Probability of Shortage per Year Greater Than or Equal to 600 kaf

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<th>Conservation Before Shortage</th>
<th>Water Supply</th>
<th>Reservoir Storage</th>
<th>Preferred Alternative</th>
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Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Two or More Consecutive Years (percent)

| 2008      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2010      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2016      | 0.0          | 0.0                          | 0.0          | 0.0               | 20.0                  |
| 2020      | 0.0          | 0.0                          | 0.0          | 0.0               | 21.0                  |
| 2026      | 0.0          | 0.0                          | 0.0          | 0.0               | 24.0                  |
| 2030      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2035      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2040      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2050      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2060      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |

Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Five or More Consecutive Years (percent)

| 2008      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2010      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2016      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2020      | 0.0          | 0.0                          | 0.0          | 0.0               | 13.0                  |
| 2026      | 0.0          | 0.0                          | 0.0          | 0.0               | 19.0                  |
| 2030      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2035      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2040      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2050      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2060      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |

Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in Ten or More Consecutive Years (percent)

| 2008      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2010      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2016      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2020      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2026      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2030      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2035      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2040      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2050      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |
| 2060      | 0.0          | 0.0                          | 0.0          | 0.0               | 0.0                   |

Probability of Annual Shortage Volume Greater Than or Equal to 600 kaf Occurring in 15 or More Consecutive Years (percent)
This section contains additional information used in the water quality and air quality analyses (Section 4.5 and Section 4.6 of the EIS, respectively). This information consists of a series of figures that provide comparisons of flow-weighted annual average salinity concentrations under the modeled action alternatives to those under the modeled No Action Alternative. Additional figures that compare Lake Powell and Lake Mead elevations during different months (End-of-October and End-of-March elevations) are also included in this section.
Figure P-WAQ-2
Colorado River Salinity Downstream of Parker Dam
Comparison of Action Alternatives to No Action Alternative
Flow-weighted Annual Average Salinity Concentrations

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WAQ-3
Colorado River Salinity Upstream of Imperial Dam
Comparison of Action Alternatives to No Action Alternative
Flow-weighted Annual Average Salinity Concentrations

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-WAQ-4
Lake Powell End-of-October Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Elevation (feet msl)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P-WAQ-5

Lake Mead End-of-October Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Elevation (feet msl)

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Figure P-WAQ-6

Lake Powell End-of-March Elevations 90th, 50th, and 10th Percentile Values

Comparison of Action Alternatives to No Action Alternative
This section contains additional information used in the biological and cultural resources impact analyses (Section 4.8 and Section 4.9 of the EIS, respectively). The information consists of a series of graphs and tables. The initial group of graphs provides comparisons of Lake Powell and Lake Mead elevations under the modeled action alternatives to those under the modeled No Action Alternative. These graphs compare Lake Powell end-of-month elevations for the months of July and September, and Lake Mead end-of-month elevations for the months of March, July, and September under each alternative. The second group of graphs provide a comparison of monthly release volumes (January through December) from Glen Canyon Dam, Hoover Dam, Davis Dam, and Parker Dam. The next graph provides a comparison of the probability of occurrence for excess flows downstream of Morelos Diversion Dam under each alternative. The last group of graphs provide comparisons of the modeled water temperature for various locations along the mainstream Colorado River, including downstream Glen Canyon Dam (Glen Canyon Dam releases), at Lees Ferry, downstream of the Little Colorado River, and near Diamond Creek. The remainder of the information provided in this section consists of tables that provide comparisons of the average modeled water temperature along the mainstream of the Colorado River at Lees Ferry, downstream of the Little Colorado River, and near Diamond Creek.
Figure P-BCR-1
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Elevation (feet msl)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

10th Percentile
50th Percentile
90th Percentile

Legend:
- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P. BCR-2

Lake Powell End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

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<th>Water Supply</th>
<th>Reservoir Storage</th>
<th>Preferred Alternative</th>
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Elevation (feet msl)
Figure P. BCR-3
Lake Mead End-of-February Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

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Figure P. BCR-4

Lake Mead End-of-March Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values

Elevation (feet msl)
Figure P- BCR-5
Lake Mead End-of-April Elevations
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-6: Lake Mead End-of-July Elevations Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values

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- No Action
- Basin States Conservation Before Shortage
- Water Supply Reservoir Storage
- Preferred Alternative
Figure P. BCR-7
Lake Mead End-of-September Elevations
Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values

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Elevation (feet msl)
Figure P - BCR-8
Glen Canyon Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

34,000 32,000 30,000 28,000 26,000 24,000 22,000 20,000 18,000 16,000 14,000 12,000 10,000 8,000 6,000

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

10th Percentile
50th Percentile
90th Percentile
Figure P- BCR-9
Glen Canyon Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

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10th Percentile
50th Percentile
90th Percentile
Figure P- BCR-10
Glen Canyon Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Monthly Releases (cfs)

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

10th Percentile
50th Percentile
90th Percentile
Figure P-BCR-11
Glen Canyon Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P- BCR-12
Glen Canyon Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

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Figure P- BCR-13
Glen Canyon Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

90th Percentile
50th Percentile
10th Percentile
Figure P. BCR-14

Glen Canyon Dam July Releases 90th, 50th, and 10th Percentile Values

Comparison of Action Alternatives to No Action Alternative

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<th>Water Supply</th>
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Monthly Releases (cfs)

10th Percentile

50th Percentile

90th Percentile
Figure P- BCR-15
Glen Canyon Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-16
Glen Canyon Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Monthly Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Appendix P

Additional CRSS Modeling Output

Figure P-BCR-17
Glen Canyon Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-BCR-18
Glen Canyon Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- BCR-19
Glen Canyon Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-21
Hoover Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

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Figure P- BCR-22
Hoover Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- 90th Percentile
- 50th Percentile
- 10th Percentile

Monthly Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P- BCR-25
Hoover Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-26

Hoover Dam July Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Figure P-BCR-28
Hoover Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Monthly Releases (cfs)
20,000
17,500
15,000
12,500
10,000
7,500
5,000
10th Percentile
50th Percentile
90th Percentile
Figure P-BCR-29
Hoover Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- BCR-30
Hoover Dam November Releases
Comparison of Action Alternatives to No Action Alternative  
90th, 50th, and 10th Percentile Values

No Action  
Basin States  
Conservation Before Shortage  
Water Supply  
Reservoir Storage  
Preferred Alternative

- 90th Percentile
- 50th Percentile
- 10th Percentile

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

Monthly Releases (cfs)
5,000 7,500 10,000 12,500 15,000 17,500 20,000
Figure P-BCR-31
Hoover Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-32
Davis Dam January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs) vs. Year

- No Action
- Basin States Conservation Before Shortage
- Water Supply Reservoir Storage
- Preferred Alternative


- 90th Percentile
- 50th Percentile
- 10th Percentile
Figure P-BCR-33
Davis Dam February Releases Comparison of Action Alternatives to No Action Alternative 90th, 50th, and 10th Percentile Values

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Year

Monthly Releases (cfs)

No Action
Basin States Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P- BCR-34
Davis Dam March Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

Monthly Releases (cfs)
6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000 15,000 16,000 17,000 18,000 19,000 20,000

Legend:
- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

10th Percentile
50th Percentile
90th Percentile
Figure P-BCR-35
Davis Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- BCR-36
Davis Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

10th Percentile
50th Percentile
90th Percentile
Figure P- BCR-37
Davis Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

Monthly Releases (cfs)
6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000 15,000 16,000 17,000 18,000 19,000 20,000

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

10th Percentile
50th Percentile
90th Percentile
Figure P-BCR-38
Davis Dam July Releases Comparison of Action Alternatives to No-Action Alternative
90th, 50th, and 10th Percentile Values

- 90th Percentile
- 50th Percentile
- 10th Percentile

Monthly Releases (cfs)

Year

Comparison of Action Alternatives to No-Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P- BCR-39
Davis Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P- BCR-40
Davis Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- 90th Percentile
- 50th Percentile
- 10th Percentile

Monthly Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P-BCR-41
Davis Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

20,000 19,000 18,000 17,000 16,000 15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000 0
Figure P-BOR-42
Davis Dam November Releases
Comparison of Action Alternatives to No-Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)

Year

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

90th Percentile
50th Percentile
10th Percentile
Figure P-BCR-43
Davis Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Monthly Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

20,000 19,000 18,000 17,000 16,000 15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000

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

P-73 October 2007
Figure P-BCR-44

Parker Dam, January Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Monthly Releases (cfs)

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000 5,000 4,000
Figure P- BCR-45
Parker Dam February Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-46
Parker Dam March Releases:
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- BCR-47
Parker Dam April Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BOR-48
Parker Dam May Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Month Releases (cfs)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000 5,000 4,000

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P-BCR-49
Parker Dam June Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Monthly Releases (cfs)
Figure P-BCR-50
Parker Dam July Releases
Comparison of Action Alternatives to No-Action Alternative
90th, 50th, and 10th Percentile Values
Figure P-BCR-51
Parker Dam August Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

P-81 October 2007
Appendix P
Additional CRSS Modeling Output
Figure P-BCR-52
Parker Dam September Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- BCR-53
Parker Dam October Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Monthly Releases (cfs)

Year

Graph showing monthly releases from 2005 to 2060, with 90th, 50th, and 10th percentile values for different categories.
Figure P-BCR-54
Parker Dam November Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Monthly Releases (cfs)

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000 0
Figure P- BCR-55
Parker Dam December Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

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Legend:
- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative
Figure P- BCR-56
Flows Downstream of Morelos Diversion Dam
Comparison of Action Alternatives to No Action Alternative
Probability of Occurrence

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Percent of Values Less than or Equal to

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Figure P-BCR-57
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No-Action Alternative
Percent of Values Greater than or Equal to Elevation 3,660 feet msl

Percent of Values Greater than or Equal To

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Figure P- BCR-58
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds

Temperature (°C)

No Action
Conservation Before Shortage / Basin States
Preferred Alternative
Figure P- BCR-59
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds
Figure P-BCR-60
Glen Canyon Dam Release Temperatures
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds
Figure P- BCR-61
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds

![Temperature Graph](image-url)
Figure P- BCR-62
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds

No Action
Preferred Alternative / Basin States / Conservation Before Shortage

Water Supply
Reservoir Storage
Figure P- BCR-63
Colorado River at Lees Ferry
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds

Upper Bound

Lower Bound

No Action
Preferred Alternative / Basin States / Conservation Before Shortage

No Action
Water Supply
Reservoir Storage

Month
Temperature (°C)
Upper Bound
Lower Bound
Figure P-BCR-64
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds

0 2 4 6 8 10 12 14 16
Jan Mar May Jul Sep Nov
Month

Temperature (°C)

No Action
Preferred Alternative / Basin States / Conservation Before Shortage

Upper Bound
Lower Bound

Water Supply
Reservoir Storage

No Action
Figure P- BCR-65
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds
Figure P- BCR-66
Colorado River Downstream of Little Colorado River Confluence
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds
Figure P- BCR-67
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
90th Percentile Temperatures Upper and Lower Bounds

- No Action
- Preferred Alternative / Basin States / Conservation Before Shortage
- Water Supply
- Reservoir Storage

Temperature (°C)

Month

Jan Mar May Jul Sep Nov

0 5 10 15 20 25 30

Temperature (°C)

Month

Jan Mar May Jul Sep Nov

0 5 10 15 20 25 30
Figure P - BCR-68
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
50th Percentile Temperatures Upper and Lower Bounds

Temperature (°C)

Jan  Mar  May  Jul  Sep  Nov
Month

No Action
Preferred Alternative / Basin States / Conservation Before Shortage

Upper Bound
Lower Bound

Upper Bound
Lower Bound

No Action
Water Supply
Reservoir Storage
Figure P-B CR-69
Colorado River Near Diamond Creek
Comparison of Action Alternatives to No Action Alternative
10th Percentile Temperatures Upper and Lower Bounds

[Graph showing temperature variations over months for different alternatives]
## Table P-BCR-1
**Average Monthly Temperature (°C)**
*Colorado River at Lees Ferry*

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This section contains additional information used in the electrical power resources impact analyses (Section 4.11 of this Final EIS). This information consists of three groups of graphs. The initial group of graphs provide a comparison of the energy production at Glen Canyon, Hoover, Davis, and Parker Powerplants. The second group of graphs provide a comparison of the Lake Powell and Lake Mead elevations under the modeled action alternatives to those under the modeled No Action Alternative. These graphs compare Lake Powell end-of-July and Lake Mead end-of-December elevations. The last group of graphs provide a comparison of the Headgate Rock Dam annual releases and energy production values under the modeled action alternatives to those under the modeled No Action Alternative.
Figure P-EP-1
Glen Canyon Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
50th, 95th, and 10th Percentile Values

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Energy (GWh)
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000
Figure P-EP-2

Hoover Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Energy (GWh)

No Action
Basin States Conservation Before Shortage Water Supply Reservoir Storage Preferred Alternative

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

10th Percentile
50th Percentile
90th Percentile
Figure P- EP-3
Davis Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values
Figure P- EP-4
Parker Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

- No Action
- Basin States
- Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Energy (GWh)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060
Figure P- EP-5
Lake Powell End-of-July Elevations
Comparison of Action Alternatives to No Action Alternative
50th and 10th Percentile Values

<table>
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<tr>
<th>Elevation (feet msl)</th>
<th>No Action</th>
<th>Basin States</th>
<th>Conservation Before Shortage</th>
<th>Water Supply</th>
<th>Reservoir Storage</th>
<th>Preferred Alternative</th>
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Year

- 2005
- 2010
- 2015
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
- 2050
- 2055
- 2060
Figure P-EP-6

Lake Mead End-of-December Elevations
Comparison of Action Alternatives to No Action Alternative 50th and 10th Percentile Values

- No Action
- Basin States Conservation Before Shortage
- Water Supply Reservoir Storage
- Preferred Alternative

50th Percentile
10th Percentile

Elevation (feet msl)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

1,200 1,225 1,250 1,275 1,300 1,325 1,350 1,375 1,400 1,425 1,450 1,475 1,500
Figure P-EP-7
Headgate Rock Dam Annual Releases
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Year
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

Release (af)
8,500,000 8,000,000 7,500,000 7,000,000 6,500,000 6,000,000 5,500,000 5,000,000

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative

90th Percentile
50th Percentile
10th Percentile
Figure P-EP-8
Comparison of Action Alternatives to No Action Alternative
Average Values

Headgate Rock Dam Annual Releases

- No Action
- Basin States Conservation Before Shortage
- Water Supply
- Reservoir Storage
- Preferred Alternative

Release (af)

Year

2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

5,000,000 5,250,000 5,500,000 5,750,000 6,000,000 6,250,000 6,500,000 6,750,000 7,000,000

5,250,000 5,500,000 5,750,000 6,000,000 6,250,000 6,500,000 6,750,000 7,000,000
Figure P- EP-9
Headgate Rock Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
90th, 50th, and 10th Percentile Values

Year:
2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060

Energy (GWh):
65 70 75 80 85 90 95 100 105

No Action
Basin States
Conservation Before Shortage
Water Supply
Reservoir Storage
Preferred Alternative
Figure P-EP-10
Headgate Rock Powerplant Annual Energy Production
Comparison of Action Alternatives to No Action Alternative
Average Values

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<th>Conservation Before Shortage</th>
<th>Water Supply</th>
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