5-1995

Effects of Flaming Gorge Dam Hydropower Operations on Flow and Stage in the Green River, Utah and Colorado

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Effects of Flaming Gorge Dam Hydropower Operations on Flow and Stage in the Green River, Utah and Colorado


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May 1995

Work sponsored by United States Department of Energy,
Western Area Power Administration

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FOREWORD

This report is one of a series of technical memorandums prepared to support an environmental impact statement (EIS) on power marketing prepared by Argonne National Laboratory for the U.S. Department of Energy's Western Area Power Administration (Western). Western markets electricity produced at hydroelectric facilities operated by the Bureau of Reclamation. The facilities are known collectively as the Salt Lake City Area Integrated Projects (SLCA/IP) and include dams equipped for power generation on the Colorado, Green, Gunnison, and Rio Grande rivers and on Plateau Creek in the states of Arizona, Colorado, New Mexico, Utah, and Wyoming.

Western proposes to establish a level of commitment (sales) of long-term firm electrical capacity and energy from the SLCA/IP hydroelectric power plants; the impacts of this proposed action are evaluated in the EIS. Of the SLCA/IP facilities, only the Glen Canyon Dam, Flaming Gorge Dam, and Aspinall Unit (which includes Blue Mesa, Morrow Point, and Crystal dams) are influenced by Western's power scheduling and transmission decisions. For this reason, the impacts of hydropower operations at these three facilities were examined in the EIS.

The technical memorandums present detailed findings of studies conducted by Argonne National Laboratory specifically for the EIS. These studies are summarized in the EIS, and the results were used to assess environmental impacts related to alternative commitment levels. Technical memorandums were prepared on a number of socioeconomic and natural resource topics. Staff members of Argonne National Laboratory's Decision and Information Systems Division and Environmental Assessment Division prepared these technical memorandums and the EIS as part of a joint effort managed by the Environmental Assessment Division.
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EFFECTS OF FLAMING GORGE DAM HYDROPOWER OPERATIONS ON FLOW AND STAGE IN THE GREEN RIVER, UTAH AND COLORADO

by


ABSTRACT

This report presents the development of Flaming Gorge Reservoir release patterns and resulting downstream flows and stages for four potential hydropower operational scenarios. The release patterns were developed for three representative hydrologic years: moderate, dry, and wet. Computer models were used to estimate flows and stages in the Green River resulting from these release patterns for the moderate water year. The four hydropower operational scenarios for Flaming Gorge Dam were year-round high fluctuating flows, seasonally adjusted high fluctuating flows, seasonally adjusted moderate fluctuating flows, and seasonally adjusted steady flows. The year-round high fluctuating flow scenario assumes that the monthly total reservoir releases would be the same as historical releases. The remaining seasonally adjusted flow scenarios would comply with the 1992 Biological Opinion of the U.S. Fish and Wildlife Service, which requires high flows in the spring and limited hourly fluctuations, especially in summer and autumn releases, to protect endangered fish. Within one year, the maximum daily river stage fluctuations resulting from hydropower operations under the seasonally adjusted high fluctuating flow scenario would be similar to the maximum daily fluctuations under the year-round high fluctuating flow scenario. However, reduced or no fluctuations would occur in some time periods under the former scenario. The maximum daily river stage fluctuations under the seasonally adjusted moderate fluctuating flow scenario would be about half of those under the seasonally adjusted high fluctuating flow scenario.

1 INTRODUCTION

The Western Area Power Administration (Western) markets electricity produced at hydroelectric facilities operated by the Bureau of Reclamation on the Upper Colorado River. The facilities are known collectively as the Salt Lake City Area Integrated Projects. Hydropower operations at three of these facilities are affected by Western power marketing activities: Glen Canyon Dam on the Colorado River, Flaming Gorge Dam on the Green River,
and the Aspinall Unit on the Gunnison River (Figure 1*). This report presents the development of release patterns and resulting downstream flows and stages for four hydropower operational scenarios proposed for Flaming Gorge Dam. The results of this study were used for assessing potential impacts of the hydropower operational scenarios on sediment transport, ecology, cultural resources, and recreation below Flaming Gorge Dam. The results of these assessments are presented in the environmental impact statement (EIS) and, in some cases, separate technical memorandums.

1.1 FLAMING GORGE DAM

Flaming Gorge Dam, completed in 1963, is part of the Colorado River Storage Project and is used for hydropower production. The dam is located on the Green River near the Wyoming/Utah border (Figure 1). The study area for this report extends from Flaming Gorge Dam to the U.S. Geological Survey (USGS) gaging station near Jensen, Utah (about 93 mi downstream of the dam). This reach was chosen to be consistent with the Biological Opinion of the U.S. Fish and Wildlife Service (USFWS 1992), which specifies flow fluctuations below the dam and target flows at the Jensen gage.

After the completion of the dam, historical spring flows that averaged about 7,000 cfs between 1951 and 1962 were reduced to about 3,000 cfs (Smith and Green 1991). Water releases from the dam for power generation have ranged from 800 to 4,200 cfs, although an upgrade of the generators allows power releases up to 4,950 cfs. The maximum power release is limited by the capacity of the turbines, whereas the lower limit is set by an agreement with the State of Utah to maintain a high-quality cold-water fishery (Smith and Green 1991). An additional 4,000 cfs can be released through steel-lined jet tubes, and 28,800 cfs can be discharged over the spillway. Flows greater than 4,950 cfs are referred to as spills and produce no electric power.

1.2 GREEN RIVER BELOW FLAMING GORGE DAM

For the first 7 mi below Flaming Gorge Dam, the Green River flows through Red Canyon, a hard-rock canyon with fast currents and moderate rapids (Figure 2). The river has a pool-and-riffle form and ranges in depth from about 3 ft in the riffles to 25 ft in the pools; the average slope of the river is about 8.5 ft/mi. The river changes character abruptly about 2 mi below Red Creek as the canyon opens into Browns Park, about 11 mi downstream of the dam. The river meanders through Browns Park for about 36 mi, attaining widths of up to 500 ft. Under normal flow conditions, the current is slow and the river is fairly shallow, with depths of about 3 ft; the average slope is about 2.3 ft/mi. Many sandbars occur in this reach.

At the Gates of Lodore, 48 mi downstream of the dam, the Green River enters Lodore Canyon and flows through 19 mi of hard-rock canyon in Dinosaur National Monument. The current is swift, and numerous rapids are present; the average slope of the river is about

*For readability, all figures and tables are placed in sequence following Section 3 of this report.
13 ft/mi. Lodore Canyon ends in Echo Park where the Green River is joined by the Yampa River (about 65 mi below the dam), its main tributary in the study reach. At Echo Park, the combined flows of the Green and Yampa rivers enter Whirlpool Canyon. Farther downstream, the river meanders through open country in Island Park and Rainbow Park. Many wooded islands are present in this reach. At Split Mountain Canyon, the current again quickens as the river enters another hard-rock region. Below Split Mountain Canyon, the river enters a cultivated valley and flows slowly for the next 100 mi. Jensen, Utah, is about 18 mi below Split Mountain Canyon.
Four hydropower operational scenarios for Flaming Gorge Dam were considered in this study — year-round high fluctuating flows, seasonally adjusted high fluctuating flows, seasonally adjusted moderate fluctuating flows, and seasonally adjusted steady flows. The year-round high fluctuating flow scenario assumes that the monthly total reservoir releases would be the same as historical releases. The remaining scenarios assume seasonally adjusted flows that would comply with the USFWS Biological Opinion (USFWS 1992) and would include sustained high flows in the spring and limited hourly fluctuations, especially in summer and autumn releases, to protect downstream populations of endangered fish.

The main differences in the operational scenarios are as follows. With no changes in reservoir operating constraints, the maximum and minimum releases under the year-round high fluctuating flow scenario would be limited only by the water available for release, the reservoir minimum release requirement, and the power plant capacity. For the seasonally adjusted high fluctuating flow scenario, hourly releases would reach the maximum fluctuation feasible — as limited by the Biological Opinion, the water available for release, the minimum release requirement, and the power plant capacity except when ice cover is present on the Green River below the dam (assumed to be February and March). When ice cover is present, no hourly fluctuations would be allowed. For the seasonally adjusted moderate fluctuating flow scenario, hourly releases would have fluctuations equal to 50% of those in the seasonally adjusted high fluctuating flow scenario. On-peak durations would be adjusted so that the average daily releases would be the same as the preceding scenario. For the seasonally adjusted steady flow scenario, reservoir releases would be constant throughout the day in each season. Seasons here refer to periods of variable length, ranging from several weeks to one month, as defined by the Biological Opinion (USFWS 1992).

Reservoir release patterns were developed for three representative hydrologic years that were selected on the basis of streamflow records: moderate (1987), dry (1989), and wet (1983). (A water year begins on October 1 of the preceding calendar year and ends on September 31 of the current calendar year, e.g., water year 1987 begins on October 1, 1986, and ends on September 30, 1987.) Each release pattern has a minimum release for a certain duration starting at midnight, ramp up to a maximum release in one hour, hold at the maximum for the on-peak duration, and then ramp down in one hour to the minimum release. The on-peak period is assumed to center around 4:00 p.m. The derivation of the release patterns is discussed in Sections 2.1 through 2.3.

2.1 YEAR-ROUND HIGH FLUCTUATING FLOW SCENARIO

The year-round high fluctuating flow scenario assumes that the monthly total releases would be approximately the same as historical releases (Table 1) and that maximum fluctuation would occur daily throughout the year. The release patterns for this scenario assume that the maximum release would be 4,700 cfs and the minimum release would be 800 cfs as required by the Utah Division of Wildlife Resources. Ramp up and ramp down
between these flow limits would occur in one hour. On the basis of the assumptions that ramping would occur in one entire hour and on-peak periods would last one or more entire hours, the seasonal averages vary slightly from the historical releases. The calculated daily average releases would range from about 1,290 to 3,720 cfs for the moderate year, 865 to 1,290 cfs for the dry year, and 2,420 to 10,100 cfs for the wet year (Tables 2, 3, and 4). For average releases greater than 4,700 cfs, such as occurred in June to August 1983, a constant flow of 4,700 cfs would pass through the powerhouse and the remaining flow would bypass. This scenario would not comply with the Biological Opinion (USFWS 1992). It is representative of maximum power plant operations and was considered in the EIS to enable an evaluation of the effects of seasonal and daily adjustment of releases required by the Biological Opinion.

2.2 SEASONALLY ADJUSTED FLUCTUATING FLOW SCENARIOS

For the seasonally adjusted high fluctuating and moderate fluctuating flow scenarios, the Biological Opinion specifies allowable fluctuations within one day for Flaming Gorge Reservoir releases in summer and autumn months. For all three seasonally adjusted flow scenarios, the Biological Opinion also requires shifting seasonal releases to provide high flows in the spring and low flows in the summer and autumn (USFWS 1992).

2.2.1 Allowable Release Fluctuations for Summer and Autumn

The reservoir release fluctuations allowed for seasonally adjusted fluctuating flow scenarios are:

1. A target flow at Jensen, Utah, would be set between 1,100 and 1,800 cfs for summer and autumn, except that up to 2,400 cfs would be allowed after September 15 for wet years. The time periods covered are as follows:

   Moderate year: July 10 to October 31
   Dry year: June 20 to October 31
   Wet year: July 20 to October 31

2. Variations of flow at Jensen, Utah, for any 24-hour period would be limited to a total of 25% around the target flow. Variations above or below the target should be as close as possible.

3. Except for the effects of storm runoff, the flow at Jensen, Utah, should stay within the range of 1,100 to 1,800 cfs, or up to 2,400 cfs after September 15 for wet years.

Flaming Gorge Reservoir daily releases that comply with the above constraints are presented in Table 5. Each daily release pattern is expressed in terms of a base and a peak release rate with one hour on-peak. The ramp-up and ramp-down times are both one hour.
The average daily release was computed from the base and peak releases and the time on-peak. The minimum allowable base release and maximum allowable peak release for each month, or partial month when required by the Biological Opinion, were determined with the Streamflow Synthesis and Reservoir Regulation (SSARR) computer model being used by the Bureau of Reclamation for the Green River below Flaming Gorge Dam (Section 3.1). The flow of the Yampa River, which is a major tributary of the Green River between Flaming Gorge Dam and Jensen, Utah, was considered in calculating flows at Jensen. The target flows shown in Table 5 were selected on the basis of the Biological Opinion constraints.

2.2.2 Seasonal Reservoir Releases

In addition to constraints on fluctuations for summer and autumn releases, the Biological Opinion also requires altering the historical seasonal pattern of release to provide high flows in the spring and low flows in the summer and autumn. The criteria used in deriving the release volumes are summarized in Table 6. These criteria comply with the Biological Opinion whenever possible; other considerations include the minimum release requirement and reservoir safety.

On the basis of the above criteria, reservoir releases were developed for the seasonally adjusted flow scenarios for the three representative hydrologic years. The monthly release volumes for the three representative years are summarized in Table 7. The spreadsheet used to derive the monthly release volumes for the moderate hydrologic year is presented in Table 8 in three parts. Part 1 summarizes the monthly reservoir releases; part 2 shows the reservoir storage routing, which was performed to ensure that releases are feasible and that reservoir storage targets are attained as much as possible at various times; and part 3 shows the estimated releases for April through July based on the Biological Opinion. Similarly, Tables 9 and 10 present the spreadsheets used to derive the monthly release volumes for the dry and wet hydrologic years, respectively. The objective of the total annual releases is not always to make the annual total power release or total reservoir release (power and nonpower) equal to the respective actual historical releases. The total reservoir release for the wet year is less than the historical release so as to reduce power plant bypass while maintaining the reservoir level below the normal maximum water surface elevation. The total reservoir release for the dry year is greater than the historical release to comply with the Biological Opinion (USFWS 1992).

2.3 DAILY RESERVOIR RELEASE PATTERNS

On the basis of the criteria described in Section 2.2, reservoir release patterns were derived by trial and error. Table 2 summarizes the release patterns in a moderate hydrologic year for an average day in each month, or partial month where necessary to comply with the Biological Opinion. Tables 3 and 4 summarize the release patterns for the dry and wet hydrologic years, respectively.
3 RIVER FLOWS AND STAGES BELOW THE DAM

Flows in the Green River and the corresponding river stages resulting from reservoir releases under the four operational scenarios were estimated for five locations below Flaming Gorge Dam for the moderate hydrologic year. The five locations are Gates of Lodore, Hells Half Mile, Jones Hole, Rainbow Park, and the Jensen gage (Figure 2). The SSARR model for the Green River was used to calculate the downstream flows, and a water surface profile model for estimating the river stages was developed with the HEC-2 computer program (U.S. Army Corps of Engineers 1982).

3.1 MODELING RIVER FLOW

The SSARR model developed by the Bureau of Reclamation for the Green River was used to estimate river flows between Flaming Gorge Dam and the Jensen gage for different operational scenarios. The model uses the flow routing portion of the SSARR computer program to route river flow hydrographs through river channels (U.S. Army Corps of Engineers 1987). This routing method is a "cascade of reservoirs" technique, which simulates the delay and attenuation of the flood wave as it travels downstream by treating the channel as a series of small reservoirs (channel segments). The model user specifies the number of segments, also known as routing phases, and the routing characteristics of each segment. Routing through each segment is based on the law of continuity as expressed in the storage equation, which relates the change in the storage to the average inflow into and the average outflow from the segment. The outflow from each segment becomes the inflow to the next segment. If $S$, $I$, and $O$ represent the storage, inflow to, and outflow from the channel segment, respectively, the storage equation for the segment can be written as:

$$S_2 - S_1 = \frac{1}{2} (I_1 + I_2) t - \frac{1}{2} (O_1 + O_2) t,$$

where $t$ is the computational time interval and subscripts 1 and 2 denote values at the beginning and end of the time interval, respectively.

The storage of a channel segment can be expressed as a function of the outflow, with $T_s$ representing the proportionality factor between storage and outflow:

$$S = T_s O.$$

The factor $T_s$ is known as the time of storage and is approximately equal to the water travel time through the channel segment. By substitution, the following form of the storage equation can be derived and used to compute outflow from one channel segment:
Normally, when the river flow is confined to the channel, the time of storage decreases as the discharge increases — which can be expressed as

\[ O_2 = O_1 + \frac{t}{(T_s + \frac{t}{2})} \left[ \frac{1}{2} (I_1 + I_2) - O_1 \right] . \]

where

\[ K_T = \text{a constant determined by trial and error or estimated from measurements of flows and corresponding travel times, and} \]

\[ n = \text{a coefficient.} \]

The coefficient \( n \) is usually a positive number between 0 and 1, which indicates that the time of storage decreases as the flow increases. In the model calibration process, \( K_T \) and \( n \) (the number of routing phases) are adjusted to obtain the best match between the model-predicted and the observed flows (U.S. Army Corps of Engineers 1987).

The study reach for the Green River between Flaming Gorge Dam and Jensen gage was divided into five modeling reaches, with boundaries at Gates of Lodore, Hells Half Mile, Jones Hole, Rainbow Park, and the Jensen gage (Figure 2). The SSARR model was verified during this study by comparing the model-predicted flow with the recorded flow at the Jensen gage for the periods from April 1 to June 21, 1987, and from May 1 to June 30, 1992. The Yampa River is the only major tributary of the Green River between the dam and Jensen; its flow is accounted for in the model by the assumption that the tributary flow is equal to that recorded at the Deerlodge Park gage. The time interval used in the Green River SSARR model is one hour. Figure 3 shows the computed and recorded hourly flows at the Jensen gage. The correlation coefficients of the computed and recorded flows for the two verification periods are 0.96 and 0.98, respectively. Both the flow comparisons in Figure 3 and the correlation coefficients indicate that the model is relatively reliable. In particular, the model appears to predict reasonably well the general patterns of flow fluctuation at the Jensen gage. The model parameters for the modeling reach are shown in Table 11 (for flow in cubic feet per second and time in hours).

3.2 CALCULATED RIVER FLOWS

The verified SSARR model for the Green River and the reservoir release patterns presented in Table 2 were used to calculate hourly flows at selected downstream locations for the moderate hydrologic year for the four hydropower operational scenarios. The daily maximum and minimum flows at these locations are discussed in Sections 3.2.1 through 3.2.4.
3.2.1 Year-Round High Fluctuating Flow Scenario

Figure 4 and Table 12 show the daily maximum and minimum flows in the moderate water year 1987 under the year-round high fluctuating flow scenario at Flaming Gorge Dam, Gates of Lodore, and the Jensen gage. (Table 12 also shows the seasonal average inflow of the Yampa River.) Under this operational scenario, the maximum daily reservoir release fluctuation would be 3,900 cfs year-round, with releases fluctuating between 800 and 4,700 cfs. The fluctuations at Gates of Lodore would be reduced to about 30 to 82% of the fluctuations below the dam. The difference in the magnitude of reduction is mainly influenced by the on-peak duration of the reservoir release. A relatively short on-peak period, such as the two-hour duration in March, or a relatively long one, such as the 17-hour duration in November and December (Table 2), tends to reduce the flow fluctuation rapidly. A medium on-peak duration, such as the 10-hour duration in October, tends to maintain a high fluctuation for a longer distance down the river. At downstream locations, further reductions in fluctuations would be minor. At Hells Half Mile, the fluctuations would be 29 to 80% of those at the dam. At the Jensen gage, the fluctuations would still be 27 to 77%. Flow patterns at the Jensen gage are different from those at Gates of Lodore because of inflow from the Yampa River.

3.2.2 Seasonally Adjusted High Fluctuating Flow Scenario

Figure 5 and Table 13 show the daily maximum and minimum flows in the moderate water year 1987 under the seasonally adjusted high fluctuating flow scenario. Under this operational scenario, the daily release fluctuations would range from 2,010 to 3,900 cfs, except that no fluctuations would be allowed in February and March (the assumed ice cover period), October would have a steady release of 800 cfs (the required minimum release), and June 1 through 21 would have a steady release of up to 4,700 cfs (as required by the Biological Opinion). The fluctuations at Gates of Lodore would be reduced to about 19 to 80% of the fluctuations at the dam. Similar to the year-round high fluctuating flow scenario, further downstream reductions in fluctuations would be minor. At Hells Half Mile, the fluctuations still would be 19 to 80% of those at the dam. At the Jensen gage, the fluctuations would be 17 to 78%.

3.2.3 Seasonally Adjusted Moderate Fluctuating Flow Scenario

Figure 6 and Table 14 show daily maximum and minimum flows in the moderate water year 1987 for the seasonally adjusted moderate fluctuating flow scenario. Under this operational scenario, the daily release fluctuations would range from 1,000 to 1,950 cfs, except that no fluctuations would be allowed in February and March because of ice cover, October would have a steady release of 800 cfs, and June 1 through 21 would have a steady release of up to 4,700 cfs (as required by the Biological Opinion). The fluctuations at Gates of Lodore would be reduced to about 0 to 88% of the fluctuations at the dam, depending on
the on-peak duration. Similar to the two preceding operational scenarios, reductions in fluctuations farther downstream would be minor. At Hells Half Mile, the fluctuations still would be 0 to 88% of those at the dam. At the Jensen gage, the fluctuations would be 0 to 83%.

3.2.4 Seasonally Adjusted Steady Flow Scenario

Under the seasonally adjusted steady flow scenario, the reservoir release in each season (which was defined to be several weeks to one month, depending on requirements of the Biological Opinion) would be steady (Tables 2 to 4). Figure 7 shows the flows at the dam, Gates of Lodore, and Jensen gage for the moderate water year. The flows at Gates of Lodore would be the same as reservoir releases and the flows at the Jensen gage would be the sums of the reservoir releases and the Yampa River inflows.

3.3 MODELING RIVER STAGE

- Stages of the Green River were estimated for the maximum and minimum river flows resulting from reservoir releases under the four hydropower operational scenarios for the same locations for which the flows were calculated. The river stage at a particular location depends mainly on the river flow and channel geometry in the area. The stages were estimated with the HEC-2 computer program from a water surface profile model for the Green River (U.S. Army Corps of Engineers 1982).

The HEC-2 model for the Green River was developed with the best data available, including USGS 7.5-minute topographic maps, cross-section data at river gages, and discharge rating tables for the gages; field data were not collected for the EIS. Except at the gages, all river cross sections used in the model were estimated from the USGS maps, which have elevation contour intervals of 20 to 40 ft. Channel roughness coefficients required for the model were estimated to be 0.03 to 0.06 for the main channel and 0.05 to 0.07 for the overbanks; these estimates were based on field observation and values in the literature (Chow 1959; Barnes 1967). The model was calibrated with the discharge ratings for the gages and the water surface elevations shown on the USGS maps, at 5- to 40-ft intervals. Because of the limitations in the data used to develop the Green River HEC-2 model, estimated changes in river stages are believed to be more reliable than the estimated water surface elevations.

3.4 CALCULATED RIVER STAGES

Maximum and minimum Green River stages resulting from reservoir releases under the four operational scenarios were estimated on the basis of the flows presented in Figures 4 to 7 and the stage-flow relationships calculated with the HEC-2 water surface profile model. Daily maximum and minimum stages above that for a flow of 800 cfs at Flaming Gorge Dam, Gates of Lodore, and Jensen gage are shown for the moderate year (1987) in Figures 8 to 10.
for the year-round high fluctuating flow, seasonally adjusted high fluctuating flow, and seasonally adjusted moderate fluctuating flow scenarios, respectively. River stage increases above the water surface elevation at 800 cfs flow are shown in Figure 11 for the seasonally adjusted steady flow scenario.

Under the year-round high fluctuating flow scenario, the daily stage fluctuations at the dam resulting from hydropower operations would be about 4.8 ft year-round at Flaming Gorge Dam, about 2.4 to 4.9 ft at the Gates of Lodore, and about 0.6 to 2.0 ft at the Jensen gage. Under the seasonally adjusted high fluctuating flow scenario, the daily stage fluctuations would be about 0 to 4.8 ft at the dam, about 0 to 4.9 ft at the Gates of Lodore, and about 0 to 2.2 ft at the Jensen gage. Under the seasonally adjusted moderate fluctuating flow scenario, the daily stage fluctuations would be about 0 to 2.2 ft at the dam, about 0 to 2.1 ft at the Gates of Lodore, and about 0 to 0.9 ft at the Jensen gage. Under the seasonally adjusted steady flow scenario, no daily stage fluctuations would result from hydropower operations.

3.5 CONCLUSIONS

The SSARR model developed by the Bureau of Reclamation for routing flow hydrographs has been shown to be a reliable tool for predicting flow fluctuations in the Green River below Flaming Gorge Dam. The combined use of the SSARR model and the water surface profile model developed during this study has provided useful information for evaluating the potential impacts of hydropower operations on natural resources downstream of the dam.

The maximum daily river stage fluctuations from hydropower operations under the seasonally adjusted high fluctuating flow scenario would be similar to the maximum daily fluctuations under the year-round high fluctuating flow scenario. However, no fluctuations would occur in some time periods under the former scenario. The maximum daily river stage fluctuations under the seasonally adjusted moderate fluctuating flow scenario would be about half of those under the seasonally adjusted high fluctuating flow scenario.
FIGURE 1 Locations of Flaming Gorge Dam, Glen Canyon Dam, and the Aspinall Unit
FIGURE 2 Green River from Flaming Gorge Dam to Jensen, Utah
FIGURE 8 Comparison of Computed and Recorded Hourly Flows at the Jensen Utech Gage

Flow at Jensen Gage (cfs)

May 1 - June 30, 1992

Flow at Jensen Gage (cfs)

April 1 - June 21, 1987
FIGURE 4 Maximum and Minimum River Flows under the Year-Round High Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 5 Maximum and Minimum River Flows under the Seasonally Adjusted High Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 6 Maximum and Minimum River Flows under the Seasonally Adjusted Moderate Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 7 River Flows under the Seasonally Adjusted Steady Flow Scenario for a Moderate Water Year
FIGURE 8 Maximum and Minimum River Stage Increases under the Year-Round High Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 9 Maximum and Minimum River Stage Increases under the Seasonally Adjusted High Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 10 Maximum and Minimum River Stage Increases under the Seasonally Adjusted Moderate Fluctuating Flow Scenario for a Moderate Water Year
FIGURE 11 River Stage Increases under the Seasonally Adjusted Steady Flow Scenario for a Moderate Water Year
**TABLE 1 Flaming Gorge Reservoir Historical Releases**

<table>
<thead>
<tr>
<th>Water Year/Month</th>
<th>Power Release (acre-feet)</th>
<th>Other Release (acre-feet)</th>
<th>Total Release (acre-feet)</th>
<th>Average Release (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate Water Year, 1987</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>163,970</td>
<td>0</td>
<td>163,970</td>
<td>2,667</td>
</tr>
<tr>
<td>November</td>
<td>226,320</td>
<td>0</td>
<td>226,320</td>
<td>3,804</td>
</tr>
<tr>
<td>December</td>
<td>230,760</td>
<td>0</td>
<td>230,760</td>
<td>3,754</td>
</tr>
<tr>
<td>January</td>
<td>199,970</td>
<td>0</td>
<td>199,970</td>
<td>3,253</td>
</tr>
<tr>
<td>February</td>
<td>179,700</td>
<td>0</td>
<td>179,700</td>
<td>3,236</td>
</tr>
<tr>
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<td>0</td>
<td>75,330</td>
<td>1,225</td>
</tr>
<tr>
<td>April</td>
<td>75,270</td>
<td>0</td>
<td>75,270</td>
<td>1,265</td>
</tr>
<tr>
<td>May</td>
<td>96,940</td>
<td>0</td>
<td>96,940</td>
<td>1,577</td>
</tr>
<tr>
<td>June</td>
<td>74,850</td>
<td>0</td>
<td>74,850</td>
<td>1,258</td>
</tr>
<tr>
<td>July</td>
<td>100,820</td>
<td>0</td>
<td>100,820</td>
<td>1,640</td>
</tr>
<tr>
<td>August</td>
<td>92,500</td>
<td>0</td>
<td>92,500</td>
<td>1,505</td>
</tr>
<tr>
<td>September</td>
<td>101,160</td>
<td>0</td>
<td>101,160</td>
<td>1,700</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,617,590</strong></td>
<td>0</td>
<td><strong>1,617,590</strong></td>
<td><strong>2,234</strong></td>
</tr>
<tr>
<td><strong>Dry Water Year, 1989</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
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<td>0</td>
<td>57,900</td>
<td>942</td>
</tr>
<tr>
<td>November</td>
<td>57,070</td>
<td>0</td>
<td>57,070</td>
<td>959</td>
</tr>
<tr>
<td>December</td>
<td>58,670</td>
<td>0</td>
<td>58,670</td>
<td>954</td>
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<tr>
<td>January</td>
<td>56,570</td>
<td>0</td>
<td>56,570</td>
<td>920</td>
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<tr>
<td>February</td>
<td>50,620</td>
<td>0</td>
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<td>912</td>
</tr>
<tr>
<td>March</td>
<td>55,080</td>
<td>0</td>
<td>55,080</td>
<td>896</td>
</tr>
<tr>
<td>April</td>
<td>58,370</td>
<td>0</td>
<td>58,370</td>
<td>981</td>
</tr>
<tr>
<td>May</td>
<td>56,376</td>
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<td>56,376</td>
<td>917</td>
</tr>
<tr>
<td>June</td>
<td>78,644</td>
<td>0</td>
<td>78,644</td>
<td>1,322</td>
</tr>
<tr>
<td>July</td>
<td>53,380</td>
<td>0</td>
<td>53,380</td>
<td>888</td>
</tr>
<tr>
<td>August</td>
<td>80,493</td>
<td>0</td>
<td>80,493</td>
<td>1,309</td>
</tr>
<tr>
<td>September</td>
<td>53,468</td>
<td>0</td>
<td>53,468</td>
<td>899</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>716,641</strong></td>
<td>0</td>
<td><strong>716,641</strong></td>
<td><strong>990</strong></td>
</tr>
<tr>
<td><strong>Wet Water Year, 1983</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>215,920</td>
<td>33,000</td>
<td>248,920</td>
<td>4,049</td>
</tr>
<tr>
<td>November</td>
<td>221,510</td>
<td>0</td>
<td>221,510</td>
<td>3,723</td>
</tr>
<tr>
<td>December</td>
<td>180,320</td>
<td>0</td>
<td>180,320</td>
<td>2,933</td>
</tr>
<tr>
<td>January</td>
<td>182,960</td>
<td>0</td>
<td>182,960</td>
<td>2,976</td>
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<tr>
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<td>0</td>
<td>131,030</td>
<td>2,360</td>
</tr>
<tr>
<td>March</td>
<td>150,240</td>
<td>0</td>
<td>150,240</td>
<td>2,444</td>
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<tr>
<td>April</td>
<td>185,780</td>
<td>0</td>
<td>185,780</td>
<td>2,787</td>
</tr>
<tr>
<td>May</td>
<td>156,160</td>
<td>0</td>
<td>156,160</td>
<td>2,912</td>
</tr>
<tr>
<td>June</td>
<td>246,180</td>
<td>234,000</td>
<td>480,180</td>
<td>8,072</td>
</tr>
<tr>
<td>July</td>
<td>254,000</td>
<td>366,000</td>
<td>620,000</td>
<td>10,086</td>
</tr>
<tr>
<td>August</td>
<td>241,050</td>
<td>67,000</td>
<td>308,050</td>
<td>5,011</td>
</tr>
<tr>
<td>September</td>
<td>219,050</td>
<td>0</td>
<td>219,050</td>
<td>3,682</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,393,200</strong></td>
<td>700,000</td>
<td><strong>3,093,200</strong></td>
<td><strong>4,274</strong></td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of Reclamation, Colorado River Storage Project Database.
<table>
<thead>
<tr>
<th>Period</th>
<th>Year-Round High Fluctuation</th>
<th>Seasonally Adjusted High Fluctuation</th>
<th>Seasonally Adjusted Moderate Fluctuation</th>
<th>Seasonally Adjusted Steady Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>800</td>
<td>4,700</td>
<td>10</td>
<td>2,590</td>
</tr>
<tr>
<td>Nov</td>
<td>800</td>
<td>4,700</td>
<td>17</td>
<td>3,720</td>
</tr>
<tr>
<td>Dec</td>
<td>800</td>
<td>4,700</td>
<td>17</td>
<td>3,720</td>
</tr>
<tr>
<td>Jan</td>
<td>800</td>
<td>4,700</td>
<td>12</td>
<td>3,240</td>
</tr>
<tr>
<td>Feb</td>
<td>800</td>
<td>4,700</td>
<td>14</td>
<td>3,240</td>
</tr>
<tr>
<td>Mar</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>1,290</td>
</tr>
<tr>
<td>Apr</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>1,290</td>
</tr>
<tr>
<td>May</td>
<td>800</td>
<td>4,700</td>
<td>4</td>
<td>1,610</td>
</tr>
<tr>
<td>Jun 1-21</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>1,290</td>
</tr>
<tr>
<td>Jun 22-30</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>1,290</td>
</tr>
<tr>
<td>Jul 1-9</td>
<td>800</td>
<td>4,700</td>
<td>4</td>
<td>1,610</td>
</tr>
<tr>
<td>Jul 10-31</td>
<td>800</td>
<td>4,700</td>
<td>4</td>
<td>1,610</td>
</tr>
<tr>
<td>Aug</td>
<td>800</td>
<td>4,700</td>
<td>3</td>
<td>1,450</td>
</tr>
<tr>
<td>Sep</td>
<td>800</td>
<td>4,700</td>
<td>5</td>
<td>1,780</td>
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</table>

$^a$ The annual average release is 2,230 cfs for the year-round high fluctuation, seasonally adjusted high and moderate fluctuations, and the steady release.

$^b$ Maximum release of 4,700 cfs assumes full reservoir conditions.
<table>
<thead>
<tr>
<th>Period</th>
<th>Year-Round High Fluctuation</th>
<th>Seasonally Adjusted High Fluctuation</th>
<th>Seasonally Adjusted Moderate Fluctuation</th>
<th>Seasonally Adjusted Steady Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>800</td>
<td>2,370</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Nov</td>
<td>800</td>
<td>2,750</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Dec</td>
<td>800</td>
<td>2,740</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Jan</td>
<td>800</td>
<td>2,350</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Feb</td>
<td>800</td>
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<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Mar</td>
<td>800</td>
<td>1,570</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Apr</td>
<td>800</td>
<td>3,130</td>
<td>1</td>
<td>870</td>
</tr>
<tr>
<td>May</td>
<td>800</td>
<td>2,350</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Jun 1-7</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>4,000</td>
</tr>
<tr>
<td>Jun 8-19</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>800</td>
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<tr>
<td>Jun 20-30</td>
<td>800</td>
<td>4,700</td>
<td>2</td>
<td>800</td>
</tr>
<tr>
<td>Jul</td>
<td>800</td>
<td>1,680</td>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>Aug</td>
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<tr>
<td>Sep</td>
<td>800</td>
<td>1,970</td>
<td>1</td>
<td>1,000</td>
</tr>
</tbody>
</table>

a The annual average release is 990 cfs for the year-round high fluctuation, 1,150 cfs for the seasonally adjusted high and moderate fluctuations, and 1,150 cfs for the steady release.

b Maximum release of 4,700 cfs assumes full reservoir conditions.
<table>
<thead>
<tr>
<th>Period</th>
<th>Year-Round High Fluctuation</th>
<th>Seasonally Adjusted High Fluctuation</th>
<th>Seasonally Adjusted Moderate Fluctuation</th>
<th>Seasonally Adjusted Steady Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>800</td>
<td>4,700</td>
<td>19</td>
<td>4,050</td>
</tr>
<tr>
<td>Nov</td>
<td>800</td>
<td>4,700</td>
<td>17</td>
<td>3,720</td>
</tr>
<tr>
<td>Dec</td>
<td>800</td>
<td>4,700</td>
<td>12</td>
<td>2,910</td>
</tr>
<tr>
<td>Jan</td>
<td>800</td>
<td>4,700</td>
<td>12</td>
<td>2,910</td>
</tr>
<tr>
<td>Feb</td>
<td>800</td>
<td>4,700</td>
<td>9</td>
<td>2,420</td>
</tr>
<tr>
<td>Mar</td>
<td>800</td>
<td>4,700</td>
<td>9</td>
<td>2,420</td>
</tr>
<tr>
<td>Apr</td>
<td>800</td>
<td>4,700</td>
<td>11</td>
<td>2,750</td>
</tr>
<tr>
<td>May</td>
<td>800</td>
<td>4,700</td>
<td>13</td>
<td>3,080</td>
</tr>
<tr>
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<td>8,070</td>
<td>8,070</td>
<td>24</td>
<td>8,070</td>
</tr>
<tr>
<td>Jul 1-19</td>
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<td>Jul 20-31</td>
<td>10,100</td>
<td>10,100</td>
<td>24</td>
<td>10,100</td>
</tr>
<tr>
<td>Aug</td>
<td>5,010</td>
<td>5,010</td>
<td>24</td>
<td>5,010</td>
</tr>
<tr>
<td>Sep 1-15</td>
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<td>3,720</td>
</tr>
<tr>
<td>Sep 16-30</td>
<td>800</td>
<td>4,700</td>
<td>17</td>
<td>3,720</td>
</tr>
</tbody>
</table>

---

*a The annual average release is 4,270 cfs for the year-round high fluctuation, 3,870 cfs for the seasonally adjusted high and moderate fluctuations, and 3,870 cfs for the steady release.

*b Maximum release of 4,700 cfs assumes full reservoir conditions.
TABLE 5 Allowable Daily Release Fluctuations for Flaming Gorge Reservoir

<table>
<thead>
<tr>
<th>Year/Month</th>
<th>Average Yampa River Flow&lt;sup&gt;a&lt;/sup&gt; (cfs)</th>
<th>Target Flow at Jensen&lt;sup&gt;b&lt;/sup&gt; (cfs)</th>
<th>Daily Reservoir Release&lt;sup&gt;c&lt;/sup&gt; (cfs)</th>
<th>Daily Flow at Jensen&lt;sup&gt;d&lt;/sup&gt; (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Base Flow</td>
<td>Peak Flow</td>
<td>Min.</td>
</tr>
<tr>
<td>1987 (Moderate)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Jul 10-31</td>
<td>425</td>
<td>1,060</td>
<td>2,900</td>
<td>1,320</td>
</tr>
<tr>
<td>Aug</td>
<td>325</td>
<td>1,160</td>
<td>3,000</td>
<td>1,320</td>
</tr>
<tr>
<td>Sep</td>
<td>242</td>
<td>1,240</td>
<td>3,100</td>
<td>1,320</td>
</tr>
<tr>
<td>1989 (Dry)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun 20-30</td>
<td>1,350</td>
<td>800</td>
<td>800</td>
<td>1,110</td>
</tr>
<tr>
<td>Jul</td>
<td>313</td>
<td>920</td>
<td>2,280</td>
<td>1,110</td>
</tr>
<tr>
<td>Aug</td>
<td>155</td>
<td>1,070</td>
<td>2,400</td>
<td>1,110</td>
</tr>
<tr>
<td>Sep</td>
<td>101</td>
<td>1,120</td>
<td>2,450</td>
<td>1,100</td>
</tr>
<tr>
<td>1983 (Wet)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 20-31</td>
<td>3,460</td>
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<td>800</td>
<td>1,360</td>
</tr>
<tr>
<td>Aug</td>
<td>1,400</td>
<td>800</td>
<td>800</td>
<td>1,360</td>
</tr>
<tr>
<td>Sep 1-15</td>
<td>555</td>
<td>1,000</td>
<td>3,250</td>
<td>1,800</td>
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<tr>
<td>Sep 16-30</td>
<td>333</td>
<td>1,720</td>
<td>4,410</td>
<td>1,800</td>
</tr>
</tbody>
</table>

<sup>a</sup> As recorded at Deerlodge Park gage (Figure 2).

<sup>b</sup> Based on the Biological Opinion (USFWS 1992).

<sup>c</sup> Base and peak flows were determined such that the maximum and minimum flows at Jensen would comply closely with the constraint of 25% fluctuations around the target flows at Jensen. The reservoir also has a minimum release requirement of 800 cfs.

<sup>d</sup> Flows computed with the SSARR model.

<sup>e</sup> Flows at Jensen not computed for cases where the reservoir releases would be constant at 800 cfs.
### TABLE 6 Criteria for Developing Flaming Gorge Seasonally Adjusted Releases

<table>
<thead>
<tr>
<th>Month</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>The Biological Opinion indicates that October flow should be a continuation of summer flow, which should be 1,100 to 1,800 cfs at Jensen. The flow might be as high as 2,400 cfs at Jensen for wet years. Target flows of 1,500, 1,100, and 2,400 cfs at Jensen were assumed for moderate, dry, and wet years, respectively.</td>
</tr>
<tr>
<td>November-March</td>
<td>The Biological Opinion calls for relatively stable flows and indicates that the months of November through March can be used to manage reservoir storage so that spring peak and summer low flows can be provided. Therefore, average release rates were assumed to be the same for these months.</td>
</tr>
<tr>
<td>April-July</td>
<td>Reservoir releases would gradually increase (up to 400 cfs/d) beginning between April 1 and May 15. The release should reach 2,000 cfs during May. Release of 4,000 to 4,700 cfs (if possible) for one to six weeks begins between May 15 and June 1. This range of releases would last for one week in dry years; post-peak decline would be no more than 400 cfs/d. During moderate years, the entire spring peak would last six to eight weeks. During wet years, additional releases required to maintain reservoir levels would occur during or prior to the spring peak of the Yampa River (mid-April through June). In dry years, flows would decrease to a target flow between 1,100 and 1,800 cfs at Jensen beginning June 20 and remain at that level throughout the summer. The target flow would be reached on about July 10 in moderate years and about July 20 in wet years. Hourly fluctuations in flow would be no more than 25% around the target flow and would remain within 1,100 to 1,800 cfs.</td>
</tr>
<tr>
<td>August-September</td>
<td>Reservoir releases in August and September would be adjusted to maintain flows of 1,100 to 1,800 cfs at Jensen. The target flow in wet years might be increased to within the range of 1,100 to 2,400 cfs beginning September 15. The 25% fluctuation limit would remain in effect.</td>
</tr>
<tr>
<td>All</td>
<td>Releases through the power plant would range from 800 to 4,700 cfs (if possible). The minimum release is required by an agreement with the Utah Division of Wildlife Resources, and the maximum release is considered a typical maximum release.</td>
</tr>
</tbody>
</table>
TABLE 7 Flaming Gorge Reservoir Releases for Seasonally Adjusted Fluctuating Flow Scenarios

<table>
<thead>
<tr>
<th>Water Year/ Month</th>
<th>Power Release (acre-feet)</th>
<th>Other Release (acre-feet)</th>
<th>Total Release (acre-feet)</th>
<th>Average Release (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate Water Year, 1987</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>49,190</td>
<td>0</td>
<td>49,190</td>
<td>800</td>
</tr>
<tr>
<td>November</td>
<td>141,800</td>
<td>0</td>
<td>141,800</td>
<td>2,383</td>
</tr>
<tr>
<td>December</td>
<td>146,500</td>
<td>0</td>
<td>146,500</td>
<td>2,383</td>
</tr>
<tr>
<td>January</td>
<td>146,500</td>
<td>0</td>
<td>146,500</td>
<td>2,383</td>
</tr>
<tr>
<td>February</td>
<td>132,300</td>
<td>0</td>
<td>132,300</td>
<td>2,383</td>
</tr>
<tr>
<td>March</td>
<td>146,500</td>
<td>0</td>
<td>146,500</td>
<td>2,383</td>
</tr>
<tr>
<td>April</td>
<td>154,600</td>
<td>0</td>
<td>154,600</td>
<td>2,598</td>
</tr>
<tr>
<td>May</td>
<td>208,600</td>
<td>0</td>
<td>208,600</td>
<td>3,393</td>
</tr>
<tr>
<td>June</td>
<td>262,600</td>
<td>0</td>
<td>262,600</td>
<td>4,413</td>
</tr>
<tr>
<td>July</td>
<td>82,280</td>
<td>0</td>
<td>82,280</td>
<td>1,338</td>
</tr>
<tr>
<td>August</td>
<td>71,300</td>
<td>0</td>
<td>71,300</td>
<td>1,160</td>
</tr>
<tr>
<td>September</td>
<td>73,780</td>
<td>0</td>
<td>73,780</td>
<td>1,240</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,616,000</td>
<td>0</td>
<td>1,616,000</td>
<td>2,232</td>
</tr>
</tbody>
</table>

| **Dry Water Year, 1989** |
| October           | 51,590                    | 0                         | 51,590                   | 839                   |
| November          | 47,600                    | 0                         | 47,600                   | 800                   |
| December          | 49,190                    | 0                         | 49,190                   | 800                   |
| January           | 49,190                    | 0                         | 49,190                   | 800                   |
| February          | 44,430                    | 0                         | 44,430                   | 800                   |
| March             | 49,190                    | 0                         | 49,190                   | 800                   |
| April             | 71,130                    | 0                         | 71,130                   | 1,195                 |
| May               | 149,000                   | 0                         | 149,000                  | 2,424                 |
| June              | 130,100                   | 0                         | 130,100                  | 2,187                 |
| July              | 56,570                    | 0                         | 56,570                   | 920                   |
| August            | 65,790                    | 0                         | 65,790                   | 1,070                 |
| September         | 66,640                    | 0                         | 66,640                   | 1,120                 |
| **TOTAL**         | 830,500                   | 0                         | 830,500                  | 1,147                 |

| **Wet Water Year, 1983** |
| October           | 91,430                    | 0                         | 91,430                   | 1,487                 |
| November          | 279,700                   | 0                         | 279,700                  | 4,700                 |
| December          | 289,000                   | 0                         | 289,000                  | 4,700                 |
| January           | 289,000                   | 0                         | 289,000                  | 4,700                 |
| February          | 281,000                   | 0                         | 281,000                  | 4,700                 |
| March             | 289,000                   | 0                         | 289,000                  | 4,700                 |
| April             | 279,700                   | 0                         | 279,700                  | 4,700                 |
| May               | 289,000                   | 0                         | 289,000                  | 4,700                 |
| June              | 279,700 165,000           | 0                         | 444,700                  | 7,473                 |
| July              | 157,500                   | 0                         | 157,500                  | 2,561                 |
| August            | 49,190                    | 0                         | 49,190                   | 800                   |
| September         | 80,930                    | 0                         | 80,930                   | 1,360                 |
| **TOTAL**         | 2,635,000                 | 165,000                  | 2,800,000                | 3,868                |
### TABLE 8 Flaming Gorge Reservoir Operations for a Moderate Water Year

<table>
<thead>
<tr>
<th>Month</th>
<th>Base Release</th>
<th>Adjustments&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Power Release (base plus 1987 Power Release)</th>
<th>Difference (acre-feet)</th>
<th>Secondary Release Adjustment</th>
<th>Projected Total Power Release</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cfs</td>
<td>acre-feet</td>
<td>acre-feet</td>
<td>acre-feet</td>
<td>acre-feet</td>
<td>acre-feet</td>
</tr>
<tr>
<td>October</td>
<td>800</td>
<td>49,190</td>
<td>49,190</td>
<td>164,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>November</td>
<td>800</td>
<td>47,603</td>
<td>94,196</td>
<td>226,000</td>
<td>0</td>
<td>141,791</td>
</tr>
<tr>
<td>December</td>
<td>800</td>
<td>49,190</td>
<td>146,526</td>
<td>231,000</td>
<td>0</td>
<td>146,517</td>
</tr>
<tr>
<td>January</td>
<td>800</td>
<td>49,190</td>
<td>146,526</td>
<td>199,000</td>
<td>0</td>
<td>146,517</td>
</tr>
<tr>
<td>February</td>
<td>800</td>
<td>44,430</td>
<td>87,917</td>
<td>132,346</td>
<td>0</td>
<td>132,338</td>
</tr>
<tr>
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<td>1,070</td>
<td>65,792</td>
<td>146,526</td>
<td>75,000</td>
<td>-71,526</td>
<td>0</td>
</tr>
<tr>
<td>April</td>
<td>2,598</td>
<td>154,575</td>
<td>154,575</td>
<td>75,000</td>
<td>-79,575</td>
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<tr>
<td>May</td>
<td>3,393</td>
<td>208,598</td>
<td>208,598</td>
<td>97,000</td>
<td>-111,598</td>
<td>0</td>
</tr>
<tr>
<td>June</td>
<td>4,413</td>
<td>262,570</td>
<td>262,570</td>
<td>75,000</td>
<td>-187,570</td>
<td>0</td>
</tr>
<tr>
<td>July</td>
<td>1,338</td>
<td>82,276</td>
<td>82,276</td>
<td>101,000</td>
<td>0</td>
<td>82,276</td>
</tr>
<tr>
<td>August</td>
<td>1,160</td>
<td>71,326</td>
<td>71,326</td>
<td>92,000</td>
<td>0</td>
<td>71,326</td>
</tr>
<tr>
<td>September</td>
<td>1,240</td>
<td>73,785</td>
<td>73,785</td>
<td>101,000</td>
<td>0</td>
<td>73,785</td>
</tr>
</tbody>
</table>

Total: 19,211, 1,158,525, 457,520, 1,616,045, 1,616,000, -450,269, 450,224, -45, 1,616,000

<sup>a</sup> Notes on base release (minimum, 800 cfs):
- October: Median allowed at the Jensen gage (1,500 cfs) minus Yampa River flow for October 1987 (1,080 cfs).
- November to March: Assumed equal to median monthly pre-dam releases (1951-1962), but not less than 800 cfs, to simulate pre-dam releases for moderate years.
- April to July: From calculated spring and summer release patterns (see part 3 of this table).
- August to September: Based on data presented in Table 5.

<sup>b</sup> To approximate historical total yearly releases, additional releases were assumed for up to a total release of 2,382 cfs.

<sup>c</sup> Nonpower release in 1987 = 0 acre-feet.
TABLE 8 (Cont.)

<table>
<thead>
<tr>
<th>Month</th>
<th>Inflow</th>
<th>Power</th>
<th>Other</th>
<th>Releases</th>
<th>Volume Change</th>
<th>End-of-Month Storage</th>
<th>End-of-Month Elevation</th>
<th>End-of-Month Elevation Difference</th>
<th>Storage Curve</th>
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<tr>
<td></td>
<td>(10^3 acre-feet)</td>
<td>(10^3 acre-feet)</td>
<td></td>
<td>(10^3 acre-feet)</td>
<td>(10^3 acre-feet)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft/10^3 acre-feet)</td>
</tr>
<tr>
<td>October</td>
<td>122</td>
<td>49</td>
<td>0</td>
<td>72.81</td>
<td>3,418.73</td>
<td>6,031.87</td>
<td>1.87</td>
<td>0.0257</td>
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<tr>
<td>November</td>
<td>86</td>
<td>142</td>
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<td>3,362.99</td>
<td>6,030.44</td>
<td>-1.43</td>
<td>0.0256</td>
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<tr>
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<td>50</td>
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<td>0</td>
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<td>3,266.48</td>
<td>6,027.92</td>
<td>-2.52</td>
<td>0.0261</td>
<td></td>
</tr>
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<td>42</td>
<td>147</td>
<td>0</td>
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<td>0.0267</td>
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<td>February</td>
<td>46</td>
<td>132</td>
<td>0</td>
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<td>3,075.62</td>
<td>6,022.77</td>
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<td>0.0273</td>
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<tr>
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<td>87</td>
<td>147</td>
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<td>3,016.10</td>
<td>6,021.11</td>
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</tr>
<tr>
<td>April</td>
<td>231</td>
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<td>0</td>
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<td>3,092.53</td>
<td>6,023.24</td>
<td>2.13</td>
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<tr>
<td>May</td>
<td>341</td>
<td>209</td>
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<td>3,224.93</td>
<td>6,026.82</td>
<td>3.58</td>
<td>0.0271</td>
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<tr>
<td>June</td>
<td>221</td>
<td>263</td>
<td>0</td>
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<td>3,183.36</td>
<td>6,025.75</td>
<td>-1.07</td>
<td>0.0268</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>159</td>
<td>82</td>
<td>0</td>
<td>76.72</td>
<td>3,260.08</td>
<td>6,027.75</td>
<td>2.00</td>
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</tr>
<tr>
<td>August</td>
<td>98</td>
<td>71</td>
<td>0</td>
<td>26.67</td>
<td>3,286.76</td>
<td>6,028.46</td>
<td>0.71</td>
<td>0.0263</td>
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</tr>
<tr>
<td>September</td>
<td>61</td>
<td>74</td>
<td>0</td>
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<td>3,273.97</td>
<td>6,028.12</td>
<td>-0.34</td>
<td>0.0263</td>
<td></td>
</tr>
</tbody>
</table>

\( ^a \) Assumptions:
- Initial storage = 3,346,000 acre-feet.
- Initial elevation = 6,030 ft, the median end-of-month elevation for 1976 to 1992 and assumed representative of moderate conditions.
- Vacant target (March) = 6,020 ft.
- Fill target (August 1) = 6,035 ft.
- Maximum normal water surface elevation = 6,042.5 ft.
- End-of-September elevation target = 6,038 ft.

\( ^b \) Inflows based on historical monthly inflows for 1987.
### TABLE 8 (Cont.)

#### Spring and Summer Average Daily Releases

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
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<td>2,400</td>
<td>2,609</td>
<td>4,700</td>
<td>2,784</td>
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<tr>
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<td>2,414</td>
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<td>4,700</td>
<td>2,693</td>
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<tr>
<td>3</td>
<td>2,427</td>
<td>2,636</td>
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<td>2,401</td>
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<tr>
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<td>2,441</td>
<td>2,650</td>
<td>4,700</td>
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<td>1,635</td>
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<tr>
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<td>1,443</td>
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<tr>
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<tr>
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<tr>
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<tr>
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<td>24</td>
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<td>1,060</td>
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<td>30</td>
<td>2,795</td>
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<td>4,700</td>
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<tr>
<td>Avg.</td>
<td>2,598</td>
<td>3,393</td>
<td>4,413</td>
<td>1,338</td>
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</table>

#### Spring and Summer Release Patterns

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Release (cfs)</th>
<th>Change (cfs)</th>
<th>Number of Days</th>
<th>Change Rate (cfs/d)</th>
</tr>
</thead>
<tbody>
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<td></td>
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<tr>
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<td>3,000</td>
<td>600</td>
<td>44</td>
<td>13.6</td>
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<td>1,700</td>
<td>17</td>
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<tr>
<td>7/31</td>
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<td>0</td>
<td>22</td>
<td>0.0</td>
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</tbody>
</table>

*April, May, and June based on the USFWS Biological Opinion (USFWS 1992); July based on data presented in Table 5.*
### TABLE 9 Flaming Gorge Reservoir Operations for a Dry Water Year

<table>
<thead>
<tr>
<th>Month</th>
<th>Base Release</th>
<th>Adjustments&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Power Release&lt;sup&gt;a&lt;/sup&gt; (base plus adjustment, acre-feet)</th>
<th>1989 Power Release&lt;sup&gt;c&lt;/sup&gt; (acre-feet)</th>
<th>Difference (acre-feet)</th>
<th>Secondary Release Adjustment (acre-feet)</th>
<th>Projected Total Power Release</th>
<th>acre-feet</th>
<th>cfs</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>839 51,588</td>
<td>0</td>
<td>51,588 57,900</td>
<td>0</td>
<td>6,312</td>
<td></td>
<td>51,588 839</td>
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<td>49,190 800</td>
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<td>44,430 800</td>
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<td>49,190 800</td>
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<td>71,134 1,195</td>
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<tr>
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<td>2,424 149,031</td>
<td>149,031</td>
<td>149,031 56,376</td>
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<td>0</td>
<td></td>
<td>149,031 2,424</td>
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<tr>
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<td>2,187 130,116</td>
<td>130,116</td>
<td>130,116 78,644</td>
<td>-51,472</td>
<td>0</td>
<td></td>
<td>130,116 2,187</td>
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<tr>
<td>July</td>
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<td>56,569</td>
<td>56,569 53,380</td>
<td>-3,189</td>
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<td>56,569 920</td>
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<td>65,792</td>
<td>65,792 80,493</td>
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<td>14,701</td>
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<td>65,792 1,070</td>
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<td>66,645</td>
<td>66,645 53,468</td>
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<td>66,645 1,120</td>
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<td>830,477 716,641</td>
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<td>830,477 -113,836</td>
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</tr>
</tbody>
</table>

<sup>a</sup> Notes on base release (minimum, 800 cfs):
- October: Minimum allowed at the Jensen gage (1,100 cfs) minus Yampa River flow for October 1989 (261 cfs).
- November to March: Assumed equal to minimum monthly pre-dam releases (1951-1962), but not less than 800 cfs, to simulate pre-dam releases for dry years.
- April to June: From calculated spring and summer release patterns (see part 3 of this table).
- July to September: Based on data presented in Table 5.

<sup>b</sup> To approximate historical total yearly releases, additional releases were assumed for up to a total release of 800 cfs.

<sup>c</sup> Nonpower release in 1989 = 0 acre-feet.
<table>
<thead>
<tr>
<th>Month</th>
<th>Inflow</th>
<th>Power</th>
<th>Other</th>
<th>Volume Change (10^3 acre-feet)</th>
<th>End-of-Month Storage (10^3 acre-feet)</th>
<th>End-of-Month Elevation (ft)</th>
<th>End-of-Month Elevation Difference (ft)</th>
<th>Storage Curve (ft/10^3 acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>70</td>
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<td>3,371.78</td>
<td>6,030.67</td>
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<td>0.0258</td>
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<tr>
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<td>0</td>
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<td>3,379.59</td>
<td>6,030.87</td>
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<td>0.0257</td>
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<tr>
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<td>6,030.06</td>
<td>-0.80</td>
<td>0.0258</td>
</tr>
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<td>6,029.53</td>
<td>-0.53</td>
<td>0.0259</td>
</tr>
<tr>
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<td>6,029.97</td>
<td>0.44</td>
<td>0.0260</td>
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<td>6,030.02</td>
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<td>0.0259</td>
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<tr>
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<td>3,223.50</td>
<td>6,026.78</td>
<td>-1.49</td>
<td>0.0265</td>
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<tr>
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<td>57</td>
<td>0</td>
<td>0.43</td>
<td>3,223.93</td>
<td>6,026.79</td>
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<td>0.0266</td>
</tr>
<tr>
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<td>3,228.14</td>
<td>6,026.91</td>
<td>0.11</td>
<td>0.0266</td>
</tr>
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<td>3,234.50</td>
<td>6,027.08</td>
<td>0.17</td>
<td>0.0266</td>
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</tbody>
</table>

**a** Assumptions:
- Initial storage = 3,346,000 acre-feet.
- Initial elevation = 6,030 ft, the median end-of-month elevation for 1976 to 1992 and assumed representative of moderate conditions.
- Vacant target (March) = 6,020 ft.
- Fill target (August 1) = 6,035 ft.
- Maximum normal water surface elevation = 6,042.5 ft.
- End-of-September elevation target = 6,038 ft.

**b** Inflows based on historical monthly inflows for 1989.
### TABLE 9 (Cont.)

#### Spring and Summer Average Daily Releases

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
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<td>800</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>827</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>855</td>
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<tr>
<td>4</td>
<td>882</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>909</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>936</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>964</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>991</td>
<td>8</td>
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<td>9</td>
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<td>1,182</td>
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<td>1,209</td>
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<tr>
<td>17</td>
<td>1,236</td>
<td>17</td>
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<tr>
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<td>1,264</td>
<td>18</td>
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<td>19</td>
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<td>19</td>
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<td>20</td>
<td>1,318</td>
<td>20</td>
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<td>1,455</td>
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<tr>
<td>28</td>
<td>1,536</td>
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</tr>
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<td>29</td>
<td>1,564</td>
<td>29</td>
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<tr>
<td>30</td>
<td>1,591</td>
<td>30</td>
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<td>31</td>
<td>1,618</td>
<td>31</td>
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<td>Avg.</td>
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</table>

#### Spring and Summer Release Patterns

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<tr>
<th>Start Date</th>
<th>Release (cfs)</th>
<th>Change (cfs)</th>
<th>Number of Days</th>
<th>Change Rate (cfs/d)</th>
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</tr>
<tr>
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<td>1,200</td>
<td>44</td>
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<td>6/1</td>
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<td>17</td>
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<td>7</td>
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<tr>
<td>6/30</td>
<td>800</td>
<td></td>
<td>11</td>
<td>0.0</td>
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* April, May, and June 1 and 7 based on the USFWS Biological Opinion (USFWS 1992); June 20 and 30 based on data presented in Table 5.
TABLE 10  Flaming Gorge Reservoir Operations for a Wet Water Year

<table>
<thead>
<tr>
<th>Month</th>
<th>Base Release</th>
<th>Adjustments&lt;sup&gt;a&lt;/sup&gt; (acre-feet)</th>
<th>Power Release (base plus adjustment, acre-feet)</th>
<th>1983 Power Release&lt;sup&gt;c&lt;/sup&gt; (acre-feet)</th>
<th>Difference (acre-feet)</th>
<th>Surplus</th>
<th>Deficit</th>
<th>Secondary Release Adjustment (acre-feet)</th>
<th>Projected Total Power Release&lt;sup&gt;a&lt;/sup&gt;</th>
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</thead>
<tbody>
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<td>91,432</td>
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<td>4,700</td>
<td>4,700</td>
<td>279,672</td>
<td>4,700</td>
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<tr>
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<td>0</td>
<td>288,995</td>
<td>0</td>
<td>0</td>
<td>288,995</td>
<td>4,700</td>
</tr>
<tr>
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<td>50,051</td>
<td>288,995</td>
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<td>288,995</td>
<td>0</td>
<td>0</td>
<td>288,995</td>
<td>4,700</td>
</tr>
<tr>
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<td>83,472</td>
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<td>0</td>
<td>261,027</td>
<td>0</td>
<td>0</td>
<td>288,995</td>
<td>4,700</td>
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<tr>
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<td>288,994</td>
<td>0</td>
<td>0</td>
<td>288,994</td>
<td>4,700</td>
</tr>
<tr>
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<td>0</td>
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<td>550,965</td>
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<td>-241,049</td>
<td>2,635,049</td>
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</tbody>
</table>

<sup>a</sup> Notes on base release (minimum, 800 cfs):
- October: Maximum allowed at the Jensen gage (2,400 cfs) minus Yampa River flow for October 1983 (913 cfs).
- November to March: Assumed equal to maximum monthly pre-dam releases (1951-1962) to simulate pre-dam releases for wet years.
- April to July: From calculated spring and summer release patterns (see part 3 of this table).
- August to September: Based on data presented in Table 5.

<sup>b</sup> To reduce power plant bypass in later months, additional releases were assumed for up to a total release of 4,700 cfs.

<sup>c</sup> Nonpower release in 1983 = 700,000 acre-feet.
TABLE 10 (Cont.)

<table>
<thead>
<tr>
<th>Month</th>
<th>Inflow(^b) (10^3 acre-feet)</th>
<th>Power</th>
<th>Other(^c)</th>
<th>Total</th>
<th>Total Release (cfs)</th>
<th>Volume Change (10^3 acre-feet)</th>
<th>End-of-Month Storage (10^3 acre-feet)</th>
<th>End-of-Month Elevation (ft)</th>
<th>End-of-Month Elevation Difference (ft)</th>
<th>Storage Curve (ft/10^3 acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>91</td>
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<tr>
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<td>289</td>
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<tr>
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<td>157</td>
<td>2,561</td>
<td>448.51</td>
<td>3,575.94</td>
<td>6,035.79</td>
<td>11.62</td>
<td>0.0259</td>
</tr>
<tr>
<td>August</td>
<td>246</td>
<td>49</td>
<td>0</td>
<td>49</td>
<td>800</td>
<td>196.81</td>
<td>3,771.85</td>
<td>6,040.53</td>
<td>4.74</td>
<td>0.0241</td>
</tr>
<tr>
<td>September</td>
<td>163</td>
<td>81</td>
<td>0</td>
<td>81</td>
<td>1,360</td>
<td>82.07</td>
<td>3,853.93</td>
<td>6,042.46</td>
<td>1.93</td>
<td>0.0236</td>
</tr>
</tbody>
</table>

\(^a\) Assumptions:
- Initial storage = 3,346,000 acre-feet.
- Initial elevation = 6,030 ft., the median end-of-month elevation for 1976 to 1992 and assumed representative of moderate conditions.
- Vacant target (March) = 6,020 ft.
- Fill target (August 1) = 6,035 ft.
- Maximum normal water surface elevation = 6,042.5 ft.
- End-of-September elevation target = 6,038 ft.

\(^b\) Inflows based on historical monthly inflows for 1983.

\(^c\) Biological Opinion (USFWS 1992) dictates that other releases occur during or prior to Yampa River peak flows (mid-April through June); releases selected so that reservoir maximum normal surface elevation not exceeded.
### TABLE 10 (Cont.)

**Spring and Summer Average Daily Releases**

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4,700</td>
<td>1</td>
<td>4,700</td>
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<tr>
<td>2</td>
<td>4,700</td>
<td>2</td>
<td>4,700</td>
</tr>
<tr>
<td>3</td>
<td>4,700</td>
<td>3</td>
<td>4,700</td>
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<tr>
<td>4</td>
<td>4,700</td>
<td>4</td>
<td>4,700</td>
</tr>
<tr>
<td>5</td>
<td>4,700</td>
<td>5</td>
<td>4,700</td>
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<tr>
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<td>6</td>
<td>4,700</td>
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<td>4,700</td>
</tr>
<tr>
<td>8</td>
<td>4,700</td>
<td>8</td>
<td>4,700</td>
</tr>
<tr>
<td>9</td>
<td>4,700</td>
<td>9</td>
<td>4,700</td>
</tr>
<tr>
<td>10</td>
<td>4,700</td>
<td>10</td>
<td>4,700</td>
</tr>
<tr>
<td>11</td>
<td>4,700</td>
<td>11</td>
<td>4,700</td>
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<td>12</td>
<td>4,700</td>
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<tr>
<td>13</td>
<td>4,700</td>
<td>13</td>
<td>4,700</td>
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<td>14</td>
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<td>14</td>
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<td>4,700</td>
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<td>18</td>
<td>4,700</td>
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<td>19</td>
<td>4,700</td>
<td>19</td>
<td>4,700</td>
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<td>28</td>
<td>4,700</td>
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<tr>
<td>29</td>
<td>4,700</td>
<td>29</td>
<td>4,700</td>
</tr>
<tr>
<td>30</td>
<td>4,700</td>
<td>30*</td>
<td>4,700</td>
</tr>
<tr>
<td>31</td>
<td>4,700</td>
<td>31</td>
<td>4,700</td>
</tr>
</tbody>
</table>

**Avg.** 4,700 4,700 4,700 7/1-7/19 3,674

**Spring and Summer Release Patterns**

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Release (cfs)</th>
<th>Change (cfs)</th>
<th>Number of Days</th>
<th>Change Rate (cfs/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/1</td>
<td>4,700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/15</td>
<td>4,700</td>
<td>0</td>
<td>30</td>
<td>0.0</td>
</tr>
<tr>
<td>6/1</td>
<td>4,700</td>
<td>0</td>
<td>31</td>
<td>0.0</td>
</tr>
<tr>
<td>7/29</td>
<td>4,700</td>
<td>0</td>
<td>29</td>
<td>0.0</td>
</tr>
<tr>
<td>7/20</td>
<td>800</td>
<td>-3,900</td>
<td>11</td>
<td>-354.5</td>
</tr>
<tr>
<td>8/1</td>
<td>800</td>
<td>0</td>
<td>11</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*April, May, and June based on the USFWS Biological Opinion (USFWS 1992); July and August based on data presented in Table 5.*
TABLE 11 Parameters for the Green River SSARR Model

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Number of Routing Phases</th>
<th>$n$</th>
<th>$K_r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaming Gorge Dam to Gates of Lodore</td>
<td>30</td>
<td>0.20</td>
<td>3.0</td>
</tr>
<tr>
<td>Gates of Lodore to Hells Half Mile</td>
<td>40</td>
<td>0.50</td>
<td>3.0</td>
</tr>
<tr>
<td>Hells Half Mile to Jones Holes</td>
<td>45</td>
<td>0.50</td>
<td>4.0</td>
</tr>
<tr>
<td>Jones Hole to Rainbow Park</td>
<td>30</td>
<td>0.40</td>
<td>3.0</td>
</tr>
<tr>
<td>Rainbow Park to Jensen Gage</td>
<td>28</td>
<td>0.37</td>
<td>2.9</td>
</tr>
<tr>
<td>Month</td>
<td>Daily Reservoir Release (cfs)</td>
<td>Daily Flows at 48 and 58 Miles* (cfs)</td>
<td>Yampa River Average Inflow at 65 Miles* (cfs)</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------</td>
<td>-------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gates of Lodore (48 mi)</td>
<td>Hells Half Mile (58 mi)</td>
</tr>
<tr>
<td>Oct</td>
<td>800</td>
<td>1,150</td>
<td>4,340</td>
</tr>
<tr>
<td>Nov</td>
<td>800</td>
<td>2,270</td>
<td>4,690</td>
</tr>
<tr>
<td>Dec</td>
<td>800</td>
<td>2,270</td>
<td>4,690</td>
</tr>
<tr>
<td>Jan</td>
<td>800</td>
<td>1,620</td>
<td>4,630</td>
</tr>
<tr>
<td>Feb</td>
<td>800</td>
<td>1,620</td>
<td>4,630</td>
</tr>
<tr>
<td>Mar</td>
<td>800</td>
<td>836</td>
<td>2,010</td>
</tr>
<tr>
<td>Apr</td>
<td>800</td>
<td>836</td>
<td>2,010</td>
</tr>
<tr>
<td>May</td>
<td>800</td>
<td>867</td>
<td>2,820</td>
</tr>
<tr>
<td>Jun 1-21</td>
<td>800</td>
<td>836</td>
<td>2,010</td>
</tr>
<tr>
<td>Jun 22-30</td>
<td>800</td>
<td>836</td>
<td>2,010</td>
</tr>
<tr>
<td>Jul 1-9</td>
<td>800</td>
<td>867</td>
<td>2,820</td>
</tr>
<tr>
<td>Jul 10-31</td>
<td>800</td>
<td>867</td>
<td>2,820</td>
</tr>
<tr>
<td>Aug</td>
<td>800</td>
<td>850</td>
<td>2,420</td>
</tr>
<tr>
<td>Sep</td>
<td>800</td>
<td>892</td>
<td>3,180</td>
</tr>
</tbody>
</table>

* Distance in river miles below Flaming Gorge Dam.
TABLE 13 Daily Green River Flows under the Seasonally Adjusted High Fluctuating Flow Scenario during a Moderate Water Year

<table>
<thead>
<tr>
<th>Month</th>
<th>Daily Reservoir Release (cfs)</th>
<th>Daily Flows at 48 and 58 Miles&lt;sup&gt;a&lt;/sup&gt; (cfs)</th>
<th>Yampa River Average Inflow at 65 Miles&lt;sup&gt;a&lt;/sup&gt; (cfs)</th>
<th>Daily Flows at 72, 82, and 93 Miles&lt;sup&gt;a&lt;/sup&gt; (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gates of Lodore (48 mi)</td>
<td>Hells Half Mile (55 mi)</td>
<td>Jones Hole (72 mi)</td>
</tr>
<tr>
<td>Oct</td>
<td>800</td>
<td>800</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Nov</td>
<td>800</td>
<td>4,700</td>
<td>1,070</td>
<td>1,080</td>
</tr>
<tr>
<td>Dec</td>
<td>800</td>
<td>4,700</td>
<td>1,070</td>
<td>1,080</td>
</tr>
<tr>
<td>Jan</td>
<td>800</td>
<td>4,700</td>
<td>1,070</td>
<td>1,080</td>
</tr>
<tr>
<td>Feb</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
</tr>
<tr>
<td>Mar</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
</tr>
<tr>
<td>Apr</td>
<td>800</td>
<td>4,700</td>
<td>1,150</td>
<td>1,150</td>
</tr>
<tr>
<td>May</td>
<td>800</td>
<td>4,700</td>
<td>1,810</td>
<td>1,830</td>
</tr>
<tr>
<td>Jun 1-21</td>
<td>4,700</td>
<td>4,700</td>
<td>4,700</td>
<td>4,700</td>
</tr>
<tr>
<td>Jun 22-30</td>
<td>800</td>
<td>4,700</td>
<td>2,270</td>
<td>2,320</td>
</tr>
<tr>
<td>Jul 1-9</td>
<td>800</td>
<td>4,700</td>
<td>925</td>
<td>933</td>
</tr>
<tr>
<td>Jul 10-31</td>
<td>890</td>
<td>2,900</td>
<td>902</td>
<td>903</td>
</tr>
<tr>
<td>Aug</td>
<td>990</td>
<td>3,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Sep</td>
<td>1,070</td>
<td>3,100</td>
<td>1,080</td>
<td>1,080</td>
</tr>
</tbody>
</table>

<sup>a</sup> Distance in river miles below Flaming Gorge Dam.
TABLE 14  Daily Green River Flows under the Seasonally Adjusted Moderate Fluctuating Flow Scenario during a Moderate Water Year

<table>
<thead>
<tr>
<th>Month</th>
<th>Daily Reservoir Release (cfs)</th>
<th>Daily Flows at 48 and 58 Miles$^a$ (cfs)</th>
<th>Yampa River Average Inflow at 65 Miles$^a$ (cfs)</th>
<th>Daily Flows at 72, 82, and 93 Miles$^a$ (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gates of Lodore (48 mi)</td>
<td>Hells Half Mile (55 mi)</td>
<td>Jones Hole (72 mi)</td>
</tr>
<tr>
<td>Oct</td>
<td>800</td>
<td>800</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Jan</td>
<td>2,220</td>
<td>4,170</td>
<td>2,220</td>
<td>2,670</td>
</tr>
<tr>
<td>Feb</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
<td>2,380</td>
</tr>
<tr>
<td>Apr$^b$</td>
<td>2,440</td>
<td>4,390</td>
<td>2,440</td>
<td>2,890</td>
</tr>
<tr>
<td>May$^b$</td>
<td>2,740</td>
<td>4,700</td>
<td>2,770</td>
<td>4,300</td>
</tr>
<tr>
<td>Jun 1-21</td>
<td>4,700</td>
<td>4,700</td>
<td>4,700</td>
<td>4,700</td>
</tr>
<tr>
<td>Jun 22-30</td>
<td>2,770</td>
<td>4,700</td>
<td>2,900</td>
<td>4,600</td>
</tr>
<tr>
<td>Jul 1-9</td>
<td>3,810</td>
<td>1,860</td>
<td>3,810</td>
<td>2,290</td>
</tr>
<tr>
<td>Jul 10-31</td>
<td>1,980</td>
<td>976</td>
<td>1,170</td>
<td>1,170</td>
</tr>
<tr>
<td>Aug</td>
<td>2,080</td>
<td>1,080</td>
<td>1,280</td>
<td>1,270</td>
</tr>
<tr>
<td>Sep</td>
<td>2,160</td>
<td>1,160</td>
<td>1,360</td>
<td>1,360</td>
</tr>
</tbody>
</table>

$^a$ Distance in river miles below the Flaming Gorge Dam.

$^b$ Maximum and minimum flows presented are based on the average release for the month; actual daily maximum and minimum flows would differ through the month.
4 REFERENCES


USFWS: see U.S. Fish and Wildlife Service.