

## CHAPTER 8.0

### EVALUATION AND COMPARISON OF FLOOD CONTROL ALTERNATIVES

This chapter summarizes the environmental and economic aspects of the flood control alternatives, and identifies the Federally-supportable flood control storage plan and conveyance plan. Because implementing Alternatives 2, 3, 4, and 8 would reduce flood damages and help resolve Folsom Dam's current dam safety deficiency (see discussion in Chapters 2, 4, and 5), only a portion of the estimated cost of each of these alternatives has been allocated to flood control based on the separable cost/remaining benefits procedure described in Appendix B.

#### 8.1 Alternative 2: 3.5-Foot Dam Raise/478-Foot Flood Pool Elevation

##### 8.1.1 Environmental Mitigation

Implementing best management practices would mitigate potential effects on fisheries, water quality, traffic, and public health and safety. Mitigation measures to reduce noise effects would include constructing a sound wall between the temporary construction bridge and a nearby apartment complex. Providing notification of trail closures and alternate routes would minimize potential effects on recreation. To reduce effects on vegetation and wildlife to a less-than-significant level, 12.72 acres of oak and pine-oak woodland and 1.3 acres of riparian woodland would be developed on project lands around Folsom Reservoir. Twenty-one elderberry shrubs would be removed under this alternative. Compensation for these shrubs would be included in the oak woodland plantings.

To address potential effects on cultural resources, a programmatic agreement between the Corps, Bureau, California State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation (ACHP) would be implemented.

The sponsor would implement an adaptive management plan as part of operation and maintenance (O&M) to ensure that there would be no unforeseen effects on vegetation and wildlife due to inundation from 474 feet elevation to 478 feet elevation.

##### 8.1.2 Plan Economics

The total first cost of Alternative 2, including environmental mitigation, is estimated at \$176.6 million (Table 8-1). With an interest rate of 6.125 percent and a 50-year period of economic evaluation, the total annual cost of Alternative 2 is estimated at \$13.7 million, including O&M costs of \$0.2 million. Because this is a dual-purpose alternative that would reduce flood damages and address Folsom Dam's dam safety deficiency, the separable cost/remaining benefit (SCRB) procedure has been used to determine the portion of this cost that is allocable to flood control (see tables 15 through 19 in Economics Appendix). The resulting allocation is \$5.2 million (Table 8-2).

The annual benefits generated by this alternative include flood damage reduction, advance replacement of the Folsom Dam spillway bridge, and Folsom Modification Project cost

savings. These benefits total \$12.5 million without implementation of advance release and \$12.3 million with implementation of moderate advance release (0-100,000-190,000 acre-feet) (Table 8-2). The net benefits are the total annual benefits minus the annual costs allocable to flood control. These net benefits are \$7.3 million (no advance release) and \$7.1 million (moderate advance release). Because the benefits exceed the costs, this alternative is considered to be economically feasible.

## **8.2 Alternative 3: Seven-Foot Dam Raise/482-Foot Flood Pool Elevation**

### **8.2.1 Environmental Mitigation**

Best management practices would be used to mitigate potential impacts to fisheries, water quality, traffic, and public health and safety, as described for Alternative 2. As with alternative 2, noise from the temporary construction bridge would be minimized by construction of a sound wall, and providing notification of road closures and alternative routes would minimize impacts to recreation.

Effects on vegetation and wildlife from the temporary construction bridge and enlarging the embankment dam and dikes would be mitigated by planting an additional 9 acres of riparian woodland and 0.3 acre of seasonal wetland at the Bureau's Mormon Island Wetland Preserve and planting 79 acres of oak and pine-oak woodland on project land around Folsom Reservoir. A total of 40 elderberry shrubs would be directly affected by construction. Compensation for these shrubs would be included in the oak woodland plantings around the reservoir.

To address potential effects on cultural resources, a programmatic agreement between the Corps, Bureau, California SHPO, and the ACHP would be implemented.

An adaptive management plan would be implemented by the sponsor as part of O&M to ensure that there would be no unforeseen effects on vegetation and wildlife due to inundation from 474 feet elevation to 482 feet elevation.

### **8.2.2 Plan Economics**

The total first cost of Alternative 3, including environmental mitigation, is estimated at \$191.6 million (Table 8-3). With an interest rate of 6.125 percent and a 50-year period of economic evaluation, the total annual cost of Alternative 3 is estimated at \$15.1 million, including O&M costs of \$ 0.2 million. Because this is a dual-purpose alternative that would reduce flood damages and address Folsom Dam's dam safety deficiency, the separable cost/remaining benefit procedure has been used to determine the portion of this cost that is allocable to flood control. The resulting allocation is \$7.8 million (Table 8-4).

The annual benefits generated by this alternative include flood damage reduction, advance replacement of the Folsom Dam spillway bridge, and Folsom Dam Modification Project cost savings. These benefits total \$20.8 million without implementation of advance release and \$19.2 million with implementation of moderate advance release (0-100,000-190,000 acre-feet) (Table 8-4). The net benefits are the total annual benefits minus the annual costs allocable to flood control. These net benefits are \$13.0 million (no advance release) and \$11.4 million

**TABLE 8-1.** Estimated Costs of Alternative 2 (3.5-Foot Dam Raise/478-Foot Flood Pool Elevation) (\$ millions)

<b>MCACES Account</b>	<b>Item</b>	<b>Costs</b>
	<b>First Cost <sup>a</sup></b>	
01	Lands and damages	1.9
02	Relocations	0.0
04	Construction	125.6
06	Environmental mitigation	6.0
14	Recreation	0.7
18	Cultural resources	0.0
30	Engineering & design	18.1
31	Supervision & administration	11.4
	Sunk PED costs	12.9
	<b>Total first cost</b>	<b>176.6</b>

<sup>a</sup> Costs are October 2001 price level.

**TABLE 8-2.** Benefits and Costs of Alternative 2 (3.5-Foot Dam Raise/478-Foot Flood Pool Elevation) (\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	176.6
Less cultural resources (data recovery)	0.0
Interest during construction	44.8
Less PED sunk cost	(12.9)
<b>Total investment cost<sup>a</sup></b>	<b>208.5</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	13.5
Operation and maintenance cost	0.2
<b>Total annual cost</b>	<b>13.7</b>
<b>Annual Cost Allocable to Flood Control</b>	<b>5.2</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	9.2
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>12.5</b>
<b>Net annual benefits<sup>e</sup></b>	<b>7.3</b>
<b>Benefit-to-cost ratio<sup>e</sup></b>	<b>2.4</b>
<i>Moderate Advance Release (0-100,000-190,000 Acre-Feet)</i>	
Flood damage reduction	9.0
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>12.3</b>
<b>Net annual benefits<sup>e</sup></b>	<b>7.1</b>
<b>Benefit-to-cost ratio<sup>e</sup></b>	<b>2.4</b>

<sup>a</sup> Does not include PED sunk cost.

<sup>b</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>c</sup> The annual cost of the surcharge component of Folsom Modifications Project would no longer be necessary with this alternative.

<sup>d</sup> Spillway bridge would be built earlier than it would otherwise be under the No-Action Plan resulting in a cost savings.

<sup>e</sup> Net annual benefits and benefit-to-cost ratio use the annual cost allocable to flood control. Total net annual benefit is shown in Table 8-15.

**TABLE 8-3.** Estimated Costs of Alternative 3 (Seven-Foot Dam Raise/482-Foot Flood Pool Elevation) (\$ millions)

<b>MCACES Account</b>	<b>Item</b>	<b>Costs</b>
	<b>First Cost <sup>a</sup></b>	
01	Lands and damages	6.5
02	Relocations	2.3
04	Construction	126.9
06	Environmental mitigation	4.0
18	Cultural resources <sup>b</sup>	1.4
30	Engineering & design	13.4
31	Supervision & administration	24.2
	Sunk PED Costs	12.9
	<b>Total first cost</b>	<b>191.6</b>

<sup>a</sup> Costs are October 2001 price level

<sup>b</sup> Cultural Resources are based on recovery costs only

**TABLE 8-4.** Benefits and Costs of Alternative 3 (Seven-Foot Dam Raise/482-Foot Flood Pool Elevation)  
(\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	191.6
Less cultural resources (data recovery)	(1.3)
Interest during construction	52.6
Less PED sunk cost	(12.9)
<b>Total investment cost <sup>a</sup></b>	<b>230.0</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	14.9
Operation and maintenance cost	0.2
<b>Total annual cost</b>	<b>15.1</b>
<b>Annual Cost Allocable to Flood Control</b>	<b>7.8</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	17.5
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>20.8</b>
<b>Net annual benefits <sup>e</sup></b>	<b>13.0</b>
<b>Benefit-to-cost ratio <sup>e</sup></b>	<b>2.7</b>
<i>Moderate Advance Release (0-100,000-190,000 Acre-Feet)</i>	
Flood damage reduction	15.9
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>19.2</b>
<b>Net annual benefits <sup>e</sup></b>	<b>11.4</b>
<b>Benefit-to-cost ratio <sup>e</sup></b>	<b>2.5</b>

<sup>a</sup> Does not include PED sunk cost.

<sup>b</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>c</sup> The annual cost of the surcharge component of Folsom Modifications Project would no longer be necessary with this alternative.

<sup>d</sup> Spillway bridge would be built earlier than it would otherwise be under the No-Action Plan resulting in a cost savings.

<sup>e</sup> Net annual benefits and benefit -to-cost ratio use the annual cost allocable to flood control. Total net annual benefit is shown in Table 8-15.

(moderate advance release). Because the benefits exceed the costs, this alternative is considered to be economically feasible.

### **8.3 Alternative 4: Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation**

#### **8.3.1 Environmental Mitigation**

Best management practices would be used to mitigate potential impacts to fisheries, water quality, traffic, and public health and safety, as described for Alternative 2. As with alternative 2, noise from the temporary construction bridge would be minimized by construction of a sound wall, and providing notification of road closures and alternative routes would minimize impacts to recreation.

Mitigation of effects on vegetation and wildlife from the temporary construction bridge and enlarging the embankment dam and dikes would consist of planting an additional 9 acres of riparian woodland and 0.3 acre of seasonal wetland at the Bureau's Mormon Island Wetland Preserve and planting 79 acres of oak and pine-oak woodland on project land around Folsom Reservoir. A total of 40 elderberry shrubs would be directly affected by construction. Compensation for these shrubs would be included in the oak woodland plantings around the reservoir.

To address potential effects on cultural resources, a programmatic agreement between the Corps, Bureau, California SHPO, and the ACHP would be implemented.

As described in Section 7.8, operational effects on vegetation and wildlife are considered less than significant; therefore, no upfront mitigation is proposed. However, the local sponsor has agreed to develop an adaptive management plan that would be implemented in O&M of the project to ensure that there would be no unforeseen effects on vegetation and wildlife.

#### **8.3.2 Plan Economics**

The total first cost of Alternative 4, including environmental mitigation, is estimated at \$321.1 million (Table 8-5). With an interest rate of 6.125 percent and a 50-year period of economic evaluation, the total annual cost of Alternative 4 is estimated at \$26.7 million, including O&M costs of \$1.3 million. Because this is a dual-purpose alternative that would reduce flood damages and address Folsom Dam's dam safety deficiency, the separable cost/remaining benefit procedure has been used to determine the portion of this cost that is allocable to flood control. The resulting allocation is \$17.5 million (Table 8-6).

The total annual benefits generated by this alternative include flood damage reduction, advance replacement of Folsom Dam's spillway bridge, and Folsom Dam Modification Project cost savings. These benefits total \$28.0 million without implementation of advance release and \$23.4 million with implementation of moderate advance release (0-100,000-190,000 acre-feet) (Table 8-6). The net benefits are the total annual benefits minus the annual costs allocable to flood control. These net benefits are \$10.5 million (no advance release) and \$5.9 million (moderate advance release). Because the benefits exceed the costs, this alternative is considered to be economically feasible.

## **8.4 Alternative 5: Stepped Release to 160,000 cfs**

### **8.4.1 Environmental Mitigation**

Best management practices would be used to mitigate potential impacts to fisheries, water quality, traffic, public health and safety, and noise.

Effects from project construction along the Lower American River would be mitigated by developing 6 acres of riparian woodland at an appropriate site, such as Mississippi Bar, and 5.4 acres of oak woodland at Rossmoor Bar. Mitigation for loss of three elderberry shrubs would be included in the riparian and oak woodland plantings.

Creating 18 acres of riparian woodland and 17.7 acres of oak woodland on Egbert Tract would minimize effects from construction of the hydraulic mitigation features. To mitigate for adverse effects on Federally-listed species, 141 acres of wetlands would be developed at Egbert Tract. Mitigation for the State-listed Swainson's hawk would consist of a buffer of up to 1/2 mile around any active nest site.

To address potential effects on cultural resources, a programmatic agreement between the Corps, Bureau, California SHPO, and the ACHP would be implemented.

### **8.4.2 Plan Economics**

The total first cost of Alternative 5, including environmental mitigation, is estimated at \$176.7 million (Table 8-7), and the total annual cost is estimated at \$14.7 million, including interest and amortization and O&M costs (Table 8-8). The total annual benefits generated by this alternative are approximately \$8.2 million without implementation of the advance release and \$5.8 million with implementation of moderate advance release.

Because the benefits are less than the costs for the scenarios with and without moderate advance release, Alternative 5 is not considered to be economically feasible. Thus, there is no Federal interest in this alternative.

## **8.5 Alternative 6: Stepped Release to 160,000 cfs and New Outlet at Folsom Dam**

### **8.5.1 Environmental Mitigation**

Environmental mitigation would be the same as described for Alternative 5.

### **8.5.2 Plan Economics**

The total first cost of Alternative 6, including environmental mitigation, is estimated at \$203.9 million (Table 8-9), and the total annual cost is estimated at \$16.8 million, including estimated interest and amortization and O&M costs (Table 8-10). The total annual benefits generated by this alternative are approximately \$11.9 million without implementation of advance release and \$8.8 million with implementation of moderate advance release.

**TABLE 8-5.** Estimated Costs of Alternative 4 (Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation) (\$ millions)

<b>MCACES Account</b>	<b>Item</b>	<b>Costs</b>
	<b>First Cost <sup>a</sup></b>	
01	Lands and damages	7.3
02	Relocations	0.0
04	Construction	238.8
06	Environmental mitigation	5.7
14	Recreation	0.7
18	Cultural resources <sup>b</sup>	1.4
30	Engineering & design	33.1
31	Supervision, & administration	21.2
	Sunk PED costs	12.9
	<b>Total first cost</b>	<b>321.1</b>

<sup>a</sup> Costs are October 2001 price level.

<sup>b</sup> Cultural Resources are based on recovery costs only

**TABLE 8-6.** Benefits and Costs of Alternative 4 (Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation) (\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	321.1
Less cultural resources (data recovery)	(1.4)
Interest during construction	86.0
Less PED sunk cost	(12.9)
<b>Total investment cost<sup>a</sup></b>	<b>392.8</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	25.4
Operation and maintenance cost	1.3
<b>Total annual cost</b>	<b>26.7</b>
<b>Annual Cost Allocable to Flood Control</b>	<b>17.5</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	24.7
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>28.0</b>
<b>Net annual benefits<sup>e</sup></b>	<b>10.5</b>
<b>Benefit-to-cost ratio<sup>e</sup></b>	<b>1.6</b>
<i>Moderate Advance Release (0-100,000-190,000 Acre-Feet)</i>	
Flood damage reduction	20.1
Folsom modification project surcharge cost savings <sup>c</sup>	3.1
Advance replacement of spillway bridge <sup>d</sup>	0.2
<b>Total benefits</b>	<b>23.4</b>
<b>Net annual benefits<sup>e</sup></b>	<b>5.9</b>
<b>Benefit-to-cost ratio<sup>e</sup></b>	<b>1.3</b>

<sup>a</sup> Does not include PED sunk cost.

<sup>b</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>c</sup> The annual cost of the surcharge component of Folsom Modifications Project would no longer be necessary with this alternative.

<sup>d</sup> Spillway bridge would be built earlier than it would otherwise be under the No-Action Plan resulting in a cost savings.

<sup>e</sup> Net annual benefits and benefit -to-cost ratio use the annual cost allocable to flood control. Total net annual benefit is shown in Table 8-15.

**TABLE 8-7.** Estimated Costs of Alternative 5 (Stepped Release to 160,000 cfs) (\$ millions)

<b>MCACES Account</b>	<b>Item</b>	<b>Costs</b>
	<b>First Cost<sup>a</sup></b>	
01	Lands and damages	2.2
02	Relocations	49.2
06	Environmental mitigation	24.5
11	Levees and floodwalls	32.0
13	Pumping plants	22.9
18	Cultural resources <sup>b</sup>	1.1
30	Engineering & design	16.7
31	Supervision & administration	15.2
	Sunk PED costs	12.9
	<b>Total first cost</b>	<b>176.7</b>

<sup>a</sup> Costs are October 2001 price level

<sup>b</sup> Cultural Resources are based on recovery costs only

**TABLE 8-8.** Benefits and Costs of Alternative 5 (Stepped Release to 160,000 cfs) (\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	176.7
Less cultural resources (data recovery)	(1.1)
Interest during construction	35.5
Less PED sunk cost	(12.9)
<b>Total investment cost <sup>a</sup></b>	<b>198.2</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	12.8
Operation and maintenance cost	1.7
Replacement costs for pumping plants <sup>c</sup>	0.2
<b>Total annual cost</b>	<b>14.7</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	8.2
<b>Total benefits</b>	<b>8.2</b>
<b>Net annual benefits</b>	<b>(6.5)</b>
<b>Benefit-to-cost ratio</b>	<b>0.6</b>
<i>Moderate Advance Release (0-100,000-190,000 Acre-Feet)</i>	
Flood damage reduction	5.8
<b>Total benefits</b>	<b>5.8</b>
<b>Net annual benefits</b>	<b>(8.9)</b>
<b>Benefit-to-cost ratio</b>	<b>0.4</b>

<sup>a</sup> Does not include PED sunk cost.

<sup>b</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>c</sup> The higher water surface elevations caused by the increased releases could adversely affect the operation of many pumping and drainage facilities in the City and County of Sacramento without the replacement of pumping plants.

**TABLE 8-9.** Estimated Costs of Alternative 6 (Stepped Release to 160,000 cfs and New Outlet at Folsom Dam)  
(\$ millions)

MCACES Account	Item	Costs
<b>First Cost <sup>a</sup></b>		
01	Lands and damages	2.2
02	Relocations	49.2
06	Environmental mitigation	24.5
11	Levees and Floodwalls	32.0
13	Pumping Plants	22.9
18	Cultural resources <sup>b</sup>	1.1
30	Engineering & design	17.5
31	Supervision & administration	15.9
	New Outlet	25.6
	Sunk PED Costs	12.9
<b>Total First Cost</b>		<b>203.9</b>

<sup>a</sup> Costs are October 2001 price level

<sup>b</sup> Cultural Resources are based on recovery costs only

**TABLE 8-10.** Benefits and Costs of Alternative 6 (Stepped Release to 160,000 cfs and New Outlet at Folsom Dam)  
(\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	203.9
Less cultural resources (data recovery)	(1.1)
Interest during construction	39.4
Less PED sunk cost	(12.9)
<b>Total investment cost<sup>a</sup></b>	<b>219.7</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	14.8
Operation and maintenance cost	1.8
Replacement costs for pumping plants <sup>c</sup>	0.2
<b>Total annual cost</b>	<b>16.8</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	11.9
<b>Total benefits</b>	<b>11.9</b>
<b>Net annual benefits</b>	<b>(4.9)</b>
<b>Benefit-to-cost ratio</b>	<b>0.7</b>
<i>Moderate Advance Release 0-100,000-190,000 Acre-Feet</i>	
Flood damage reduction	8.8
<b>Total benefits</b>	<b>8.8</b>
<b>Net annual benefits</b>	<b>(8.0)</b>
<b>Benefit-to-cost ratio</b>	<b>0.5</b>

<sup>a</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>b</sup> The higher water surface elevations caused by the increased releases could adversely affect the operation of many pumping and drainage facilities in the City and County of Sacramento.

<sup>c</sup> The spillway bridge would be built earlier than it would otherwise be under the No-Action Plan resulting in a cost savings.

Because the benefits are less than the costs for the scenarios with and without moderate advance release, Alternative 6 is not considered to be economically feasible. Thus, there is no Federal interest in this alternative.

## **8.6 Alternative 7: Stepped Release to 180,000 cfs**

### **8.6.1 Environmental Mitigation**

Best management practices would be used to mitigate potential impacts to fisheries, water quality, traffic, public health and safety, and noise. Impacts to recreation would be offset through notification and alternative trails, access, and parking.

In addition, loss of vegetation due to project construction would be mitigated by developing 31.8 acres of riparian woodland at an appropriate site, such as Mississippi Bar, and 71 acres of oak woodland at Rossmoor Bar. A minimum of 0.3 acre of shaded riverine aquatic habitat would be planted at the Howe Avenue bridge-raising site. Compensation for the 137 elderberry shrubs would be included in the riparian and oak woodland plantings.

Creating 18 acres of riparian woodland and 17.7 acres of oak woodland on Egbert Tract would mitigate loss of habitat due to construction of the hydraulic mitigation features. To mitigate for adverse effects on Federally-listed species, 141 acres of wetlands would be developed at Egbert Tract. Mitigation for the State-listed Swainson's hawk would consist of a buffer of up to 1/2 mile around any active nest.

To address potential effects on cultural resources, a programmatic agreement between the Corps, Bureau, California SHPO, and the ACHP would be implemented.

### **8.6.2 Plan Economics**

The total first cost of Alternative 7, including environmental mitigation, is estimated at \$194.6 million (Table 8-11), and the total annual cost is estimated at \$16.2 million (Table 8-12). The total annual benefits generated by this alternative are approximately \$15.9 million without implementation of advance release and \$12.2 million with implementation of moderate advance release.

Because the benefits are less than the costs for the scenario with moderate advance release, Alternative 7 is not considered to be economically feasible. Thus, there is no Federal interest in this alternative.

## **8.7 Alternative 8: Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation**

### **8.7.1 Environmental Effects and Mitigation**

The potential environmental effects of implementing Alternative 8 are described above, under the discussions of Alternatives 3 and 5.

## 8.7.2 Plan Economics

The total first cost of Alternative 8, including environmental mitigation, is estimated at \$355.4 million (Table 8-13). With an interest rate of 6.125 percent and a 50-year period of economic evaluation, the total annual cost of Alternative 8 is estimated at \$29.7 million, including O&M costs of \$1.9 million. Because this is a dual-purpose alternative that would reduce flood damages and address Folsom Dam's dam safety deficiency, the separable cost/remaining benefit procedure has been used to determine the portion of this cost that is allocable to flood control. The resulting allocation is \$19.1 million (Table 8-14).

The total annual benefits are \$29.8 million without implementation of advance release and \$23.6 million with implementation of moderate advance release (0-100,000-190,000 acre-feet) (Table 8-14). The net benefits are the total annual benefits minus the annual costs allocable to flood control. These net benefits are \$10.7 million (no advance release) and \$4.5 million (moderate advance release). This alternative appears to be economically feasible because the benefits exceed costs. However, more detailed cost estimates may show increased costs for bridge raising and mitigation features along the Sacramento and American Rivers and Steamboat Slough. Moreover, assuming the dam raise is treated as the first increment, the addition of downstream improvements to accommodate stepped release as a second increment would not be economically justified, so there would be no Federal interest in this increment.

## 8.8 Summary Comparison of Flood Damage Reduction Alternatives

### 8.8.1 Comparison of Alternatives

Table 8-15 is a summary comparison of the physical features and costs and benefits of the No-Action Alternative and the seven action alternative plans. The table shows basic physical differences in the two classes of flood control alternatives: Folsom Dam enlargement and downstream levees modification.

Folsom Dam enlargement relies on increasing storage in Folsom Dam without further modifying downstream flows. In addition, Folsom Dam enlargement resolves the issue of dam safety. Because dam safety is an existing problem, the resolution of which is beneficial to the dam's existing uses, the flood control cost is made separate and economic analysis is based on this separate flood control cost.

The downstream levee modification class of alternatives relies on increasing the objective release and, in one instance, increasing the emergency release from Folsom Dam. These alternatives rely on strengthening and extending levees and the attendant relocation of bridges and utilities as well as modification of local drainage facilities. A major cost of this class of alternatives is mitigation for downstream hydraulic effects that tend to increase flood risk. These downstream levee improvements have high costs that far exceed the benefits, making the stepped release alternatives uneconomical from a Federal planning perspective.

**TABLE 8-11.** Estimated Costs of Alternative 7 (Stepped Release to 180,000 cfs) (\$ millions)

<b>MCACES Account</b>	<b>Item</b>	<b>Costs</b>
	<b>First Cost <sup>a</sup></b>	
01	Lands and damages	2.2
02	Relocations	62.5
06	Environmental mitigation	24.6
11	Levees and Floodwalls	34.4
13	Pumping Plants	22.8
18	Cultural resources <sup>b</sup>	1.1
30	Engineering & design	19.0
31	Supervision & administration	15.1
	Sunk PED Costs	12.9
	<b>Total first cost</b>	<b>194.6</b>

<sup>a</sup> Costs are October 2001 price level.

<sup>b</sup> Cultural Resources are based on recovery costs only.

**TABLE 8-12.** Benefits and Costs of Alternative 7 (Stepped Release to 180,000 cfs) (\$ millions)

<b>Item</b>	<b>Cost</b>
<b>Investment Cost</b>	
Total first cost	194.6
Less cultural resources (data recovery)	(1.1)
Interest during construction	39.1
Less PED sunk cost	(12.9)
<b>Total investment cost</b>	<b>219.7</b>
<b>Annual Cost</b>	
Interest & amortization <sup>a</sup>	14.2
Operation and maintenance cost	1.8
Replacement costs for pumping plants <sup>b</sup>	0.2
<b>Total annual cost</b>	<b>16.2</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	14.7
Advance replacement of Howe Avenue Bridge <sup>c</sup>	1.2
<b>Total benefits</b>	<b>15.9</b>
<b>Net annual benefits</b>	<b>(0.3)</b>
<b>Benefit-to-cost ratio</b>	<b>1.0</b>
<i>Advance Release 0-100,000-190,000 Acre-Feet</i>	
Flood damage reduction	11.0
Advance replacement of Howe Avenue Bridge <sup>c</sup>	1.2
<b>Total benefits</b>	<b>12.2</b>
<b>Net annual benefits</b>	<b>(4.0)</b>
<b>Benefit-to-cost ratio</b>	<b>0.8</b>

<sup>a</sup> Interest and amortization rates are 6.125 and 0.330 percent, respectively.

<sup>b</sup> The higher water surface elevations caused by the increased releases could adversely affect the operation of many pumping and drainage facilities in the City and County of Sacramento

<sup>c</sup> The Howe Avenue bridge would be replaced earlier than it would otherwise be under the No-Action Plan resulting in a cost savings.

**TABLE 8-13.** Estimated Costs of Alternative 8 (Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation) (\$ millions)

MCACES Account	Item	Seven-Foot Raise	160,000 cfs	Subtotals
		Costs	Costs	
<b>First Cost <sup>a</sup></b>				
01	Lands and damages	6.5	2.2	8.7
02	Relocations	2.3	49.2	51.5
04	Construction	126.9	0.0	126.9
06	Environmental mitigation	4.0	24.5	28.5
11	Levees and Floodwalls	0.0	32.0	32.0
13	Pumping Plants	0.0	22.9	22.9
18	Cultural resources <sup>c</sup>	1.4	1.0	2.4
30	Engineering & design	13.5	16.7	30.2
31	Supervision & administration	24.2	15.2	39.4
	Sunk PED Costs	12.9	12.9	12.9 <sup>b</sup>
<b>Total first cost</b>		<b>191.7</b>	<b>176.7</b>	<b>355.4</b>

<sup>a</sup> Costs are October 2001 price level.

<sup>b</sup> Sunk PED cost counted only once.

<sup>c</sup> Cultural Resources are based on recovery costs only.

**TABLE 8-14.** Benefits and Costs of Alternative 8 (Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation) (\$ millions)

Item	Cost
<b>Investment Cost</b>	
Total first cost	355.4
Less cultural resources (data recovery)	(2.4)
Interest during construction	88.1
Less PED sunk cost	(12.9)
<b>Total investment cost <sup>a</sup></b>	<b>428.2</b>
<b>Annual Cost</b>	
Interest & amortization <sup>b</sup>	27.6
Operation and maintenance cost	1.9
Replacement costs for pumping plants <sup>c</sup>	0.2
<b>Total annual cost</b>	<b>29.7</b>
<b>Annual Cost Allocable to Flood Control <sup>d</sup></b>	<b>19.1</b>
<b>Annual Benefits</b>	
<i>No Advance Release</i>	
Flood damage reduction	26.5
Folsom modification project surcharge cost savings <sup>e</sup>	3.1
Advance replacement of spillway bridge <sup>f</sup>	0.2
<b>Total benefits</b>	<b>29.8</b>
<b>Net annual benefits</b>	<b>10.7</b>
<b>Benefit-to-cost ratio</b>	<b>1.6</b>
<i>Advance Release 0-100,000-190,000 Acre-Feet</i>	
Flood damage reduction	20.3
Folsom modification project surcharge cost savings <sup>e</sup>	3.1
Advance replacement of spillway bridge <sup>f</sup>	0.2
<b>Total benefits</b>	<b>23.6</b>
<b>Net annual benefits</b>	<b>4.5</b>
<b>Benefit-to-cost ratio</b>	<b>1.2</b>

<sup>a</sup> Does not include PED sunk cost

<sup>b</sup> Interest rate is 6.125% and amortization rates are 0.016% for Alternative 3 and 0.33% for Alternative 5.

<sup>c</sup> The higher water surface elevations caused by the increased releases could adversely affect the operation of many pumping and drainage facilities in the City and County of Sacramento.

<sup>d</sup> Calculated by using the Separable Cost / Remaining Benefits process

<sup>e</sup> The annual cost of the surcharge component of Folsom Modifications Project would no longer be necessary with this alternative.

<sup>f</sup> The spillway bridge would be built earlier than it would otherwise be under the No-Action Plan, resulting in cost savings.

**TABLE 8-15.** Summary Comparison of the Detention Dam Plan, No Action Plan and Project Alternatives (\$ millions)

Items	Alternative 1: No-Action	Alternative 2: 3.5-Foot Dam Raise/478-Foot Flood Pool Elevation	Alternative 3: Seven-Foot Dam Raise/482-Foot Flood Pool Elevation	Alternative 4: Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation
Relative Performance <sup>a</sup>				
Annual Exceedance Probability (1-in-X chance per year)	0.0061 (164)	0.0053 (189)	0.0047 (213)	0.0043 (233)
Long term risk of exceedance over 50-year period (%)	26	23	21	20
Reduction in Flood Risk (%)	-	13	23	30
Conditional Probability of passing 200-year storm (%)	48	57	64	69
Percent of PMF passed over spillway (%)	70	100	100	100
Features				
Folsom Dam & Reservoir				
Flood control space (1,000 ac-ft)	400/600	447/647	495/695	557/757
Maximum objective release (1,000 cfs)	115	115	115	115
Lower American River				
Stabilize/modify levees (miles)				
Raise/replace bridges				
Cost/Benefit Comparison <sup>b c</sup>				
Cost (\$ million)				
First cost	-	176.6	191.6	321.1
Annual cost allocable to flood control	-	5.2	7.8	17.5
Annual cost	-	13.7	15.1	26.7
Expected Annual Benefit (\$ million) <sup>d</sup>				
Annual benefit –flood damage reduction		9.0	15.9	20.1
Annual benefit		12.3	19.2	23.4
Net benefits				
Net flood damage reduction benefit		3.8	8.1	2.6
Net annual benefits		-1.4	4.1	-3.3
Percent reduction in flood damages		12	22	28

<sup>a</sup> Performance is based on moderate advance release as the without-project condition. See tables under individual alternatives earlier in Chapter 5 for performance based on no advance release.

<sup>b</sup> October, 2001 price levels, 50-year economic project life, and 6-1/8 percent interest rate.

<sup>c</sup> Costs and benefits for plans shown here are not directly comparable to alternatives with similar features described in the 1996 SIR. This is primarily due to changes in without project conditions and overall scope changes for each plan. The detention dam described in the SIR would provide 1-in-500 percent chance of exceedance in any year, would still provide the highest net benefits, and is still the NED plan.

<sup>d</sup> Expected annual benefits are future with moderate advanced release.

TABLE 8-15. Continued

Items	Alternative 5: Stepped Release to 160,000 cfs	Alternative 6: Stepped Release to 160,000 cfs and New Outlet At Folsom Dam	Alternative 7: Stepped Release to 180,000 cfs	Alternative 8: Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482 Flood Pool Elev.	Detention Dam Plan: 545,000 acre feet.
Relative Performance <sup>a</sup>					
Annual Exceedance Probability (1-in-X chance per year)	0.0058 (172)	0.0054 (185)	0.0051 (196)	0.0045 (222)	0.0019 (526)
Long term risk of exceedance over 50-year period (%)	25	24	23	20	9
Reduction in Flood Risk (%)	5	11	16	26	69
Conditional Probability of passing 200-year storm (%)	53	56	60	68	95
Percent of PMF passed over spillway (%)	70	70	70	100	100
Features					
Folsom Dam & Reservoir					
Flood control space (1,000 ac-ft)	400/600	400/600	400/600	495/695	400
Maximum objective release (1,000 cfs)	160	160	180	160	115
Lower American River					
Stabilize/modify levees (miles)	3	3	30.8	3	
Raise/replace bridges	0	0	3	0	
Cost/Benefit Comparison <sup>b c</sup>					
Cost (\$ million)					
First cost	176.7	203.9	194.6	355.4	777.0
Annual cost allocable to flood control	14.7	16.8	16.2	19.1	54.7
Annual cost	14.7	16.8	16.2	29.7	64.1
Expected Annual Benefit (\$ million) <sup>d</sup>					
Annual benefit –flood damage reduction	5.8	8.8	11.0	20.3	56.8
Annual benefit	5.8	8.8	12.2	23.6	71.0
Net benefits					
Net flood damage reduction benefit	-8.9	-8.0	-5.2	1.2	2.1
Net annual benefits	-8.9	-8.0	-4.0	-6.1	6.9
Percent reduction in flood damages	8	12	15	28	67

<sup>a</sup> Performance is based on moderate advance release as the without-project condition. See tables under individual alternatives earlier in Chapter 5 for performance based on no advance release.

<sup>b</sup> October, 2001 price levels, 50-year economic project life, and 6-1/8 percent interest rate.

<sup>c</sup> Costs and benefits for plans shown here are not directly comparable to alternatives with similar features described in the 1996 SIR. This is primarily due to changes in without project conditions and overall scope changes for each plan. The detention dam described in the SIR would provide 1-in-500 percent chance of exceedance in any year, would still provide the highest net benefits, and is still the NED plan.

<sup>d</sup> Expected annual benefits are future with moderate advanced release.

The low benefits compared to costs of Alternative 8 indicate that combining Folsom Dam enlargement with downstream levees modification does not generate any synergistic benefit or efficiency. It is not apparent that other combinations could work or are worth pursuing.

All alternatives were analyzed using no advance release and moderate advance release scenarios. Alternative 4 also was tested against a without-project condition of Upper Bound Advance Release to show the economic effect of the highest conceivable advance release scenario.

All the stepped release alternatives include extensive hydraulic mitigation in improvements to the downstream levee system to accommodate the substantial increase in floodflows.

As shown in Table 8-15, Alternatives 2, 3 and 4 are the only alternatives with positive net benefits. In addition, dam safety improvements are included in these alternatives that would correct the existing safety inadequacies.

### **8.8.2 Project Evaluation**

Table 8-16 is a summary comparison of the plans' consistency with the established Corps planning criteria of (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. These criteria and evaluation of the project alternatives by established criteria are described below.

#### **Completeness**

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of the planned objectives. A complete alternative (1) meets the objectives, (2) needs no further actions for complete fulfillment of the project, (3) is consistent and reliable, (4) is capable of being physically implemented, and (5) mitigates unavoidable adverse environmental effects, as appropriate.

All alternatives are fully formulated and complete. No further actions would be required to meet environmental regulations and implement the project. All alternatives would be fully beneficial without depending on further actions or conditions outside the plan.

#### **Effectiveness**

Effectiveness is the extent to which an alternative resolves the identified problems and achieves the specified objective(s). The effectiveness of the alternatives is defined by the reduction in flood damages, and the realization of the community objective of a very low risk of flooding appropriate for a city the size of Sacramento.

Effectiveness may be measured in reduction in the annual probability of exceedance as well as other risk and uncertainty output, provided by the project. Alternatives 3, 4, and 8 are highly effective alternatives, as they would significantly reduce flood damages and meet or

exceed the community objective of a very low risk of flooding. Alternatives 2, 5, 6, and 7 are less effective at providing increased flood protection.

### **Efficiency**

Efficiency is the extent to which an alternative is the most cost-effective means of alleviating the identified problems while realizing the specified objectives consistent with protecting the Nation's environment. One measure of efficient is monetary costs versus benefits. Efficiency is shown as net economic benefits and is the extent to which the economic benefits exceed costs.

Of the alternatives, Alternatives 3 and 4 most efficiently solve flood control problems.

### **Acceptability**

Acceptability is the workability and viability of an alternative to other Federal agencies, affected State and local agencies, and public entities, given existing laws, regulations, and public policies. Two primary dimensions to acceptability are implementability and satisfaction. Implementability relates to whether the alternative is feasible from technical, environmental, economic, financial, political, legal, institutional, and social perspectives. Support by a local sponsor, other agencies, and the public is of prime importance in this category. The satisfaction was based on input from the staff of The Reclamation Board, Sacramento Area Flood Control Agency (SAFCA), and the Bureau and a public assessment vote that residents recently passed. This assessment involved an increase in their SAFCA assessments to pay for flood control and restoration projects, including the Folsom Dam Modification Project.

No known environmental effects are extensive, controversial, or unlawful. All effects are mitigated as much as is practicable. The action complies with the Federal and State Endangered Species Acts (ESA).

### **8.8.3 Derivation of Federally Supportable Plan**

The alternatives evaluated in this report were derived based on the language in Section 566 of the Water Resources Development Act (WRDA) of 1999. This language specifically directs the study to assess flood control through "increasing surcharge flood control storage at the Folsom Dam and Reservoir" in subsection (a) and through "levee modification" in subsection (b). Thus, all Folsom Dam enlargement alternatives are compared to identify the enlargement alternative that best meets planning objectives and has the highest net benefits (benefits minus costs). This is identified as the Federally-supportable Folsom enlargement plan. Similarly, all stepped release plans are compared to identify the Federally-supportable downstream levee plan. The Federally-supportable Folsom enlargement plan may be used as a basis for establishing the Federal share of the cost of a locally preferred plan involving the enlargement of Folsom Dam. Similarly, the Federally-supportable downstream levee plan may be used as the basis for establishing the Federal share of the cost of a locally preferred plan involving stepped release improvements.

**TABLE 8-16.** Summary Comparison of Plans

Plan	Plan Formulation Criteria				Relative Ranking
	Completeness	Effectiveness	Efficiency	Acceptability	
Folsom Dam Enlargement	<p>Technically feasible, all alternatives provide decrease in flood risk without further actions. Folsom Dam operations are not affected</p> <p>Significant environmental effects are avoided or mitigated.</p> <p>No significant adverse impacts on downstream conditions.</p> <p>All sized alternatives resolve Folsom Dam safety.</p>	<p>Provides low to high decrease in flood risk. Larger sized dam raises are more effective. Alternatives 2 would require additional action to reduce flood risk to community goal of 1 in 200 protection. Alternative 3 &amp; 4 exceed this goal.</p>	<p>Efficiency generally increases with size of dam enlargement. Alternative 2 is small, but has positive net benefits. Alternative 3 is the most efficient. Alternative 4 has moderate net benefits. The high cost of stability features reduces the net benefits.</p>	<p>All enlargement alternatives are viable and implementable given existing laws &amp; policy.</p> <p>Local satisfaction and sponsor support will be assessed during the public review of the draft document.</p>	
Alt. 2: 3.5-Foot Dam Raise/478-Foot Flood Pool Elevation	High	Moderate	Moderate	Acceptable	Moderate
Alt. 3: Seven-Foot Dam Raise/482-Foot Flood Pool Elevation	High	High (exceeds community goal of 1 in 200 annual flood risk)	High	Acceptable	High
Alt. 4: Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation	High	High (exceeds community goal of 1 in 200 annual flood risk)	Moderate	Acceptable	High
Downstream Levee Modifications	<p>Technically feasible, all alternatives provide decrease in flood risk without further actions. More of a reliance on levees than enlargement alternatives.</p> <p>Requires extensive hydraulic mitigation features. Levee work difficult to implement due to narrow construction window.</p>	<p>Provides low to moderate decrease in flood risk. No alternative reduce flood risk to community goal of 1 in 200 protection.</p>	<p>Negative net economic benefits, no alternative is economical. Large residual flood damages.</p>	<p>All downstream levee alternatives are viable and implementable given existing laws &amp; policy.</p> <p>Local satisfaction and sponsor support unlikely due to no Federal interest.</p>	
Alt. 5: Stepped Release to 160,000 cfs	Moderate/Low	Low	Inefficient	Acceptable	Very Low
Alt. 6: Stepped Release to 160,000 cfs and New Outlet at Folsom Dam	Moderate/Low	Low	Inefficient	Acceptable	Very Low
Alt. 7: Stepped Release to 180,000 cfs	Moderate/Low	Moderate	Marginal	Acceptable	Low
Combination Alt. 8: Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation	<p>Technically feasible, all alternatives provide decrease in flood risk without further actions.</p> <p>Levee work difficult to implement due to narrow construction window.</p>	<p>Provides a major decrease in flood risk, second only to Alternative 4.</p>	<p>Marginal with or without advance release. With advance release is inefficient. Positive net economic benefits, but stepped release not economic as 2<sup>nd</sup> increment</p>	<p>Alternative is viable and implementable</p> <p>Sponsor support unlikely due to no Federal interest.</p>	
	Moderate/High	High	Low	Acceptable	Low

**TABLE 8-17.** Derivation for the Federally-Supportable Folsom Enlargement Plan

	<b>No Advance Release</b>	<b>Moderate Advance Release<sup>a</sup></b>
<b>Alternative 1: No Action</b>		
Average annual benefit	NA	NA
Total annual cost	NA	NA
Net benefit		
<b>Alternative 2: 3.5-Foot Dam Raise/478-Foot Flood Pool Elevation</b>		
Average annual benefit	12.5	12.3
Annual cost allocable to flood control	5.2	5.2
Net benefit	7.3	7.1
<b>Alternative 3: Seven-Foot Dam Raise/482-Foot Flood Pool Elevation</b>		
Average annual benefit	20.8	19.2
Annual cost allocable to flood control	7.8	7.8
Net benefit	13.0	11.4
<b>Alternative 4: Twelve-Foot Dam Raise/487-Foot Flood Pool Elevation</b>		
Average annual benefit	28.0	23.4
Annual cost allocable to flood control	17.5	17.5
Net benefit	10.5	5.9
<b>Alternative 8: Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation)</b>		
Average annual benefit	29.8	23.6
Annual cost allocable to flood control	19.1	19.1
Net benefit	10.7	4.5

<sup>a</sup> Without-project advance release scenario adopted by this study and on which recommendations will be made.

NA = not applicable.

Table 8-17 displays the derivation for the Federally-supportable Folsom enlargement plan. Net benefits are shown for each alternative for each advance release scenario. Alternative 3 has the highest net benefits and would be the Federally-supportable plan. As shown in Table 8-18, none of the downstream levee alternatives has positive net benefits (benefits greater than total annual costs); thus, none of these alternatives are considered economically feasible and therefore will not be further evaluated in this study. Because there is no downstream levee plan with positive net benefits, the study identifies no Federally-supportable downstream levee plan.

**TABLE 8-18.** Derivation for the Federally-Supportable Downstream Levee Modification Plan

	No Advance Release	Moderate Advance Release <sup>a</sup>
<b>Alternative 1: No Action</b>		
Average annual benefit	NA	NA
Total annual cost	NA	NA
Net benefit		
<b>Alternative 5: Stepped Release to 160,000 cfs</b>		
Average annual benefit	8.2	5.8
Total annual cost	14.7	14.7
Net benefit	(6.5)	(8.9)
<b>Alternative 6: Stepped Release to 160,000 cfs and New Outlet at Folsom Dam</b>		
Average annual benefit	11.9	8.8
Total annual cost	16.8	16.8
Net benefit	(4.9)	(8.0)
<b>Alternative 7: Stepped Release to 180,000 cfs</b>		
Average annual benefit	15.9	12.2
Total annual cost	16.2	16.2
Net benefit	(0.3)	(4.0)
<b>Alternative 8: Stepped Release to 160,000 cfs and Seven-Foot Dam Raise/482-Foot Flood Pool Elevation</b>		
Average annual benefit	29.8	23.6
Total annual cost	29.7	29.7
Net benefit	0.1	(6.1)

<sup>a</sup> Without-project advance release scenario adopted by this study and on which recommendations will be made.