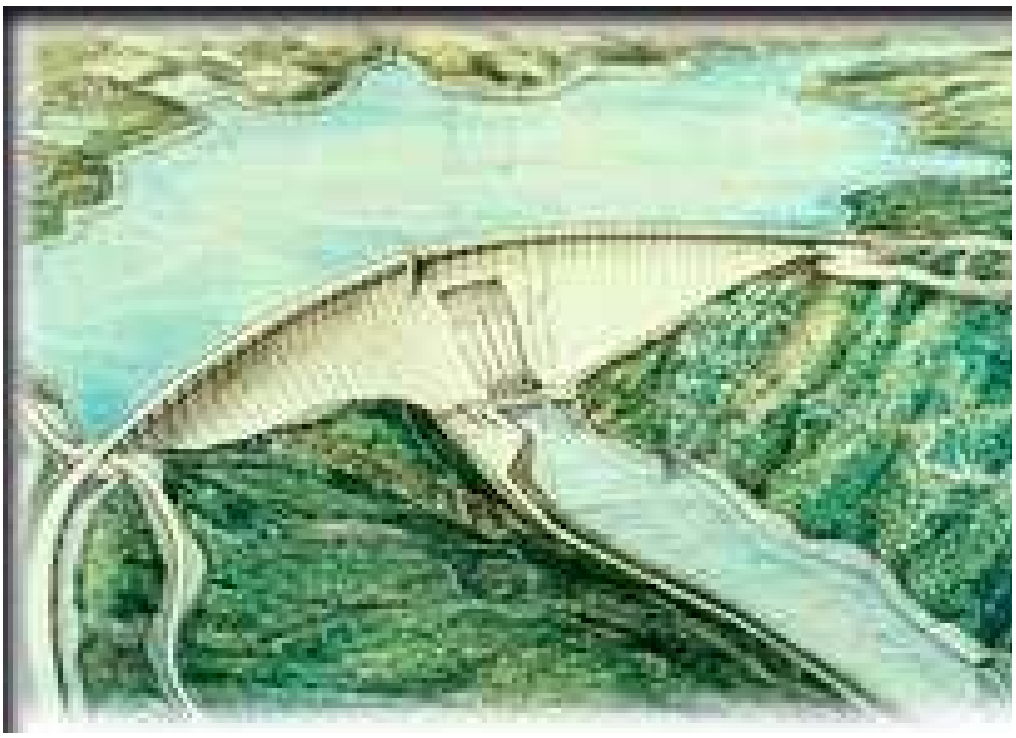
Auburn-Folsom South Unit Special Report
California



Artist Drawing Of Original Auburn Dam

Office Report

US Army Corps
of Engineers
Sacramento District

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I. Study Purpose

This office report presents an overview and the results of the Corps of Engineers study updating flood damage reduction economic benefits of the Auburn Dam portion of the Auburn Folsom - South Unit. This work will be incorporated into a benefits technical memorandum to support the Bureau's special study and report. To help readers understand, this introductory information will include historical perspective on American River projects, project description, recent activities, current assumption of without-and with-project conditions and comparison of expected vs. analytical results.

II. Introduction

A. Historical Perspective on American River Projects

Study of the American River watershed was authorized in the Flood Control Act of 1962 (Public Law 87-874) with direction from Congress given to the Corps to survey for flood control and allied purposes. These include flood control and associated projects related to channel and major drainage improvements, and flooding aggravated by, or due to, wind or tidal effects.

Flooding in 1986 due to very high American River flows changed the community perception of the flood risk posed by the river to the city of Sacramento. In response, the Corps completed a Feasibility Report for the American River Watershed Investigation in 1991 and the Supplemental Information Paper (SIR) in 1996.

The 1991 Feasibility Report and the 1996 SIR identified upstream detention near the City of Auburn on the North Fork of the American River as the National Economic Development (NED) plan. The 1991 Feasibility Report formulated a 483-foot-high roller-compacted concrete gravity dam with a capacity of 545,000 acre-feet as part of the "200-Year" Plan.

Subsequent to completion of the 1991 Feasibility Report, Congress provided guidance relating to the American River in Section 9159 of the Department of Defense Appropriations Act of 1993 (Public Law 102-396). This Act directed that additional studies be conducted to identify a project for increased flood protection along the American River. In response to congressional direction, the Corps and its local sponsors, the Reclamation Broad and Sacramento Area Flood Control Agency (SAFCA), prepared the 1996 SIR to provide additional information. The SIR presented three final candidate plans:

- Folsom Modification Plan - a version of the plan was authorized and included in the Final Limited Reevaluation Report, November 2003 American River Watershed, California, Folsom Dam Modification Project.
- Folsom Stepped Release Plan - versions of this plan were included in the Long-Term Study, February 2002, but have since been dropped from consideration, and

- 894,000 ac-ft Detention Dam Plan - this plan was the National Economic Development Plan (NED), it terminates the variable space reoperation to the fixed 400,000 ac-ft flood control space; however, the plan did not gain local consensus or congressional support.

The 1996 SIR identified three comprehensive plans to reduce long-term flood damage in the urbanized area of metropolitan Sacramento. The Corps recommended a 894,000 ac-ft detention dam, terminate the variable space reoperation of Folsom dam returning to the fixed 400,000 ac-ft flood control space, construct slurry walls in the lower American River levees, and raise and strengthen about 12 miles of levees on Sacramento River adjacent to the Natomas Basin. Due to the magnitude of the opposition to the proposed use of upstream flood storage detention, Congress chose not to authorize construction of a dam, but instead authorized features common to each of the three comprehensive plans as an interim measure to increase the level of community safety from flooding. Congress authorized the American River Common Features Project under WRDA 1996.

The Common Features Project includes approximately 24 miles of slurry wall in the levees along the lower American River, approximately 12 miles of levee modifications along the east bank of Sacramento River downstream from the Natomas Cross Canal, 3-telemeter stream flow gauges upstream from the Folsom Reservoir and modifications to the flood warning system along the lower American River. WRDA of 1999 (Section 366) authorized added improvements to the Common Features project. New features included approximately 3.8 miles of additional levee modification along the lower American River and 10 miles on Natomas Cross Canal. The improvements included Mayhew, Howe Avenue Bridge, and additional work in Natomas and the Lower American River.

In March 2002, the Corps completed the Second Addendum to the 1996 SIR (Common Features) to support the Project Cooperation Agreement (PCA) Amendment for implementation of the lower American River as authorized under WRDA 1999. The cost estimate for the American River Common Features Project exceeded the amount authorized by Section 902 of WRDA 1999 (Public Law 106-53). Revised project features, designs, and costs were prepared and included in the Second Addendum to the SIR and EA/IS. Overall, the outputs for the features authorized by WRDA 1996 and WRDA 1999 remained unchanged.

The Folsom Modifications Project was authorized by Section 101 of WRDA 1999 (Public Law 106-53). The project would increase the Folsom dam's early release capacity to match downstream channel capacity, thereby using the reservoir's flood control space more efficiently. The originally conceived measure is to increase release capacity by enlarging the eight existing outlets, and adding two new outlets. Due to cost escalation, the Corps is currently studying alternative measures to increase release capacity. These include modification of fewer outlets and an auxiliary spillway with submerged tainter gates.

In February 2002, the Corps also completed the American River Long-Term Study. The Corps recommended a seven-foot dam raise with a 482-foot flood pool elevation. Based on the Chief's report that came out of the Long Term Study, Congress in 2003 authorized the Folsom Dam Raise ("mini-Raise") project. This includes a dam raise of 7 feet and increasing the flood control storage space. The project also includes a bridge over the American River near Folsom Dam, improvements to L.L. Anderson Dam which is a non-Federal Dam, and ecosystem restoration.

The Corps is also studying the feasibility of early, weather forecast-based releases that could further increase the efficiency of Folsom Dam. No forecast-based operation plan has been recommended to date.

The Bureau, through its Corrective Action Study, has identified dam safety problems at Folsom Dam. The problems include the inability of the dam to safely pass the probable maximum flood (PMF). Correcting Folsom Dam safety deficiencies is a high priority with the Bureau. The agency is pursuing dam safety improvements through its existing dam safety program.

The Corps currently is working closely with the Bureau, flood control sponsors (State of California and Sacramento Area Flood Control Agency (SAFCA)) and other partners to develop a coordinated plan that combines the facilities of the Folsom Dam Modifications Project, the Folsom Dam Raise Project, and the Reclamation's Safety of Dams Program into a joint Federal plan.

A Project Alternative Solutions Study (PASS) was initiated in September 2005 with the purpose of developing a flood damage reduction and dam safety hydrologic risk reduction plan and cost estimate for the Folsom facility. The study was conducted in two phases, known as PASS I and PASS II. Pass I considered five alternatives. Conceptual comparative cost estimates were prepared for each of the PASS I alternatives. The PASS I study culminated in the publication of a PASS I Final Report, dated October 31, 2005. PASS II commenced in November 2005. An integrated Federal plan (IFP) was developed that includes an auxiliary spillway with four submerged tainter gates and the seven-foot dam raise. PASS II is currently developing designs and cost estimates for this plan.

PASS I and II provide design and cost engineering information that will focus further planning works. The Corps and the Bureau will use their respective decision processes to recommend and seek funds to construct a common Folsom Modifications/Folsom Dam Raise/Dam Safety plan. This plan has not been identified, but the plan may include the IFP, which is an effective solution to dam safety and flood damage reduction.

B. Project Description

The Auburn-Folsom South Unit includes Auburn Dam, Reservoir and Powerplant, located about 40 miles northeast of Sacramento on the North Fork

and Middle Fork of the American River; Sugar Pine Dam and Reservoir and conveyance to serve the Foresthill Divide area, County Line Dam and Reservoir and conveyance to serve the Malby area southeast of Folsom; and the Folsom South Canal to serve a gross area of 500,000 acres in portions of Sacramento and San Joaquin counties.

In 1965, Auburn Dam was authorized with a total capacity of 2.5 million acre-feet (ac-ft) to include 250,000 ac-ft for flood control. The project would provide water, power and flood control.

C. Recent Activities

In Section 209 of the 2005 Energy and Water Appropriation Act (PL 109-103), the Secretary of the Interior is authorized to complete a special report to update the analysis of costs and associated benefits of the Auburn-Folsom South Unit, Central Valley Project.

The primary purpose of the Bureau's report is to update the costs and associated benefits of the Auburn-Folsom South Unit as authorized under Federal reclamation laws and the Act of September 2, 1965, Public Law 89–161. Their special report will:

- identify those project features that are still relevant;
- identify changes in benefit values from previous analyses and update to current levels;
- identify design standard changes from the 1978 Reclamation design which require updated project engineering;
- assess risks and uncertainties associated with the 1978 Reclamation design; and
- update design and reconnaissance-level cost estimate for features identified under paragraph.

Corps involvement in this study is authorized under Section 7 of the 1944 Flood Control Act. In ER1110-2-241, The ER states that: "During the planning and design phases, the project owner should consult with the Corps of Engineers regarding the quantity and value of space to reserve in the reservoir for flood control and/or navigation purpose…"

III. Alternative Without and With Project Conditions

For information purposes, three without project conditions were developed and compared to with project conditions with an Auburn Dam. The without-and with-project conditions are described below.

A. Without Project Conditions

- ***Without Project A*** – This scenario assumes completion of the Common Features Project and continuing the Folsom Reoperation Plan.

Reoperation consists of a variable flood control space from 400,000 to 670,000 acre-feet. The flood control space is dependent on the availability of storage at upstream unfilled water supply reservoirs. Folsom would be operated with a larger flood space if upstream reservoirs are full. Reoperation is accomplished through an interim agreement between the Bureau and SAFCA, and it is very beneficial in terms of reduction in flood damages. The cost of reoperation is the loss of water supply for hydropower, municipal & industrial, irrigation, and fish and wildlife purposes.

The Common Features Project includes levee stability, underseepage and raising on the lower American River, the west bank of the Sacramento River between the American River and the Natomas Cross Canal, and levee improvement on both sides of the Natomas Cross Canal. These levee improvements reduce the risk of flooding to Sacramento, including the Natomas area. Most of the lower American River levee work is completed. The Sacramento River and Natomas Cross Canal work will require reauthorization in order to complete.

- ***Without Project B*** – Same as Without Project A, but without reoperation, thus the flood space is fixed at 400,000 acre- feet. Although Reoperation is currently beneficial, it is not known if it will continue to be so, or if it will continue to be implementable. Reoperation is based on a temporary agreement. Its continuation is dependent upon it continuing to be beneficial and have mitigable impacts to downstream fish and wildlife. As there is a possibility that the Reoperation agreement would not continue indefinitely, this scenario was adopted as an alternative without project condition.

- ***Without Project C*** – This scenario assumes the completion of the Folsom Modifications Project and Folsom Dam Mini-Raise. The Folsom Modifications Project would consist of an auxiliary spillway beyond the right abutment of Folsom Dam, with submerged gates. The Folsom Dam Raise Project would consist of a 7-foot physical raise with the top of the flood pool at 482 feet above MSL elevation. Variable flood space reoperation would be in place but modified to 400,000-600,000 acre-feet.

B. With Project Conditions

- ***With Project D*** – This with project condition consists of Auburn Dam in place. Operation of Auburn is in concert with Folsom allocating fixed flood storage space of 450,000 acre-feet and 200,000 acre-feet respectively. This scenario also assumes Folsom Modification Project and Folsom Dam Mini-Raise are not constructed prior to the Auburn Dam.

- ***With Project E*** – Same as D, but includes the Folsom Modification Project and Folsom Dam Mini-Raise as described under Without-Project C.

IV. Economic Analysis

A. Risk-Based Results

The HEC-FDA program was used to simulate both without-and with-project conditions. Stage-frequency curves, stage damage curve (both with uncertainty) relationships were entered into the Monte Carlo simulation. The outputs of the HEC-FDA model are Expected Annual Damages (EAD) for the without and with-project conditions. Three potential alternatives are being evaluated. Expected annual damages (EAD) were calculated for both without-and with-project conditions on different assumptions are listed in Table 1.

The damages are based on flood plains and damageable property inventory developed by the Corps for the American River Watershed feasibility study and subsequent studies described above. Since the 1990's, the flood plains have been adapted to new hydrology of the subsequent studies, but have never been formally updated. The Corps is in the first stages of revising the flood plains to support the Folsom Modifications and Dam Raise Projects. The new flood plains will take advantage of better hydrology and technical models. Also for Folsom Modifications and Dam Raise, the Corps is assessing other flood related economic benefit categories that may now be significant due to lessons learned from Hurricane Katrina. These include emergency response and relocation costs that arise from catastrophic flooding of large urban areas.

The stage-damage relationships used in the with-project condition Monte Carlo simulations are essentially the same as the without-project condition. The with-project condition changes that were made to the hydrology and hydraulics models are reflected in the with-project condition discharge-frequency and stage-frequency relationships. Changes were also made to include different project features to simulate the conditions.

Auburn Dam, if operated for flood damage reduction as described in the 1963 study without either modification to flood control pool elevation or modification to the design, will provide significantly less flood protection than described in earlier studies. Using the defined flood control pool elevation of 1083.4 feet MSL without redefining spillway operations and coordinating operation with Folsom, may cause the Auburn Dam to overtop. Therefore, two scenarios for with project conditions are being considered, both having potential impacts either on other benefit categories, dam safety, or increased project costs.

- First scenario - Allowed operations to drop the reservoir below the flood control elevation of 1,083.4 feet to keep the dam from overtopping for all modeled events. In effect, this scenario is utilizing more than the 250,000 acre feet of additional space for flood control purposes, than originally described in the authorization. Preliminary results are shown in Table 1 and 3.

- Second scenario - Restricting the releases from dropping the reservoir below the flood control elevation and allowing flows for rare events to exceed capacity. Without design modifications, these flows would overtop Auburn Dam and impact Folsom Dam and possibility other downstream development. This scenario would keep the flood control pool within the storage and would not have any negative impacts on the other benefit categories. Additional construction costs may be required to modify Auburn Dam so these flows could be passed safely. Preliminary results are shown in Table 2 and 3.

Table 1 – First Scenario
Expected Annual Damages
Without and With Project Condition Damages in $Million
October 2006 Price Levels
(With Project D & E are based on operation allowed below flood control elevation for dam safety)

Conditions	Annual Exceedance Probability	Expected Annual Damages (in $ Million)
Without Project A	0.0080	111.2
Without Project B	0.0085	117.8
Without Project C	0.0045	66.0
With Project D	0.0026	42.8
With Project E	0.0020	36.0

Table 2 – Second Scenario
Expected Annual Damages
Without and With Project Condition Damages in $Million
October 2006 Price Levels
(With Project D & E are based on operation restricted to top of flood control elevation)

Conditions	Annual Exceedance Probability	Expected Annual Damages (in $ Million)
Without Project A	0.0080	111.2
Without Project B	0.0085	117.8
Without Project C	0.0045	66.0
With Project D	0.0051	64.5
With Project E	0.0045	56.4

Table 3
Expected Annual Damages and Benefits
Without and With Project Conditions Damages in $Million
October 2006 Price Levels

With Project Conditions Based on *Operations Below* Flood Control Elevation[1]				
		Expected Annual Damage		
Alternatives	Features Completed	Without Project	With Project	Benefits – Damage Reduced
1	Without A – With D	111.2	42.8	68.4
2	Without B – With D	117.8	42.8	75.0
3	Without C – With E	66.0	36.0	30.0
With Project Conditions Based on *Restricting Operation* to Flood Control Pool[2]				
Alternatives	Features Completed	Without Project	With Project	Benefits – Damage Reduced
1	Without A – With D	111.2	64.5	46.7
2	Without B – With D	117.8	64.5	53.3
3	Without C – With E	66.0	56.4	9.6

1 This operation would reduce storage available for water supply, hydropower and lower total project benefits.
2 This operation would not impact other benefit categories but would impact on project costs.

B. Project Performance

In addition to EAD, HEC-FDA provides project performance statistics for describing flood risk for both without-and with-project conditions. These include annual exceedance probability, long-term risk and conditional non-exceedance probability by event as the following.

- Expected Annual Target Stage Exceedance Probability- the annual probability of having a damaging flood event or the risk of flooding in a given year.
- Long-Term Risk: the probability of exceeding levee stage/having a levee failure over a 10-year, 25-year and 50-year time period.
- Conditional Non-Exceedance Probability by Events: the chance of containing the specific 0.10, 0.04, 0.02, 0.01, 0.004, and 0.002 exceedance probability within the target stage (with geotechnical failure) should that event occur.

These performance values are provided from the Economics Appendix to this office report. These project performance results are listed in Table 4 and 5.

Table 4
Project Performance Statistics – Annual Exceedance Probability and Long Term Risk

Condition	Annual Exceedance Probability	Chance of Flooding in a Given Year	Long Term Risk		
			Over 10 Years	Over 30 Years	Over 50 Years
Without A	0.0080	1 in 125	7.7%	21.4%	33.1%
Without B	0.0085	1 in 118	8.2%	22.6%	34.7%
Without C	0.0045	1 in 222	4.4%	12.7%	20.3%
With Project Conditions Based on *Operations Below* Flood Control Elevation[1]					
With D	0.0026	1 in 385	2.5%	7.4%	12%
With E	0.0020	1 in 500	2.0%	5.9%	9.7%
With Project Conditions Based on *Restricting Operation* to Flood Control Pool[2]					
With D	0.0051	1 in 196	5.0%	14.3%	22.7%
With E	0.0045	1 in 222	4.4%	12.7%	20.2%

1 This operation would reduce storage available for water supply, hydropower and lower total project benefits.
2 This operation would not impact other benefit categories but would impact on project costs.

Table 5
Project Performance Statistics – Conditional Non-Exceedance Probability

Condition	Conditional Non-Exceedance Probability by Events				
	4% (1 in 25)	2% (1 in 50)	1% (1 in 100)	0.4% (1 in 250)	0.2% (1 in 500)
Without A	100%	98.1%	73.4%	16.6%	2.1%
Without B	100%	97.3%	69.6%	14.0%	1,7%
Without C	100%	99.8%	93.6%	49.3%	15.1%
With Project Conditions Based on *Operations Below* Flood Control Elevation[1]					
With D	100%	100%	98.3%	71.6%	32.6%
With E	100%	100%	98.7%	75.1%	36.4%
With Project Conditions Based on 99.7*Restricting Operation* to Flood Control Pool[2]					
With D	100%	99.7%	92.1%	43.8%	11.8%
With E	100%	99.9%	95.0%	52.6%	16.6%

1 This operation would reduce storage available for water supply, hydropower and lower total project benefits.
2 This operation would not impact other benefit categories but would impact on project costs.

V. Summary of Results

The primary objective of this office report is to document the engineering and economic reevaluation results on flood damage reduction economic benefits and reduction in flood risk. The report provides no recommendations.

Three possible without-project conditions, two project conditions; and three alternatives were being evaluated and presented in this office report. Expected annual damages (EAD) were calculated and presented for both without-and with-project conditions on different assumptions. Benefits are simply the differences between without project and with project EAD. The project performance statistics which include annual exceedance probability, long-term risk and conditional non-exceedance probability by event for describing flood risk

for both without-and with-project conditions also are presented in this office report.

However, at the time of this report, the baseline economics from the American River Folsom Modification Report and Long Term Study, upon which data in this preliminary benefits update was derived, is still under review and refinement. Operations between Folsom and Auburn for the authorized 650,000 acre-feet flood control space have not been optimized. Current projects, (added since the 1965 Authorization) hydrology and other conditions have significantly changed and would impact the effectiveness of the operations modeled in this report. Thus, the with- and without-project damages reported herein are very cursory. The economic benefits would change significantly with optimization of the reservoir space and operations.