PCWA-L-043

Placer County Water Agency

Power System: 24625 Harrison St. • Mail: P.O. Box 667 • Foresthill, California 95631
(530) 367-2291 (530) 885-6917 FAX (530) 367-4440

July 6, 2004

Mr. Takeshi Yamashita, Regional Engineer
FEDERAL ENERGY REGULATORY COMMISSION
901 Market Street, Suite 350
San Francisco, CA 94103

Re: FERC Project No. 2079-CA

Dear Mr. Yamashita:

Enclosed are three copies of a report dated May, 2004 by Mead & Hunt entitled, "Probable Maximum Flood Determination – Hell Hole, Interbay, and Ralston Afterbay Dams. This report is being submitted in fulfillment of the following two recommendations:

- In the Five-Year Dam Safety Inspection Report for Ralston Afterbay Dam, dated February 25, 2000, the Independent Consultant recommended that an updated PMF flood and spillway adequacy study be completed before the next 5-year dam safety inspection. Our Plan of Action, submitted to Mr. James Goris by letter dated April 14, 2000, proposed that the study be completed in time for the Independent Consultant to fully review, assess, and comment on the study's adequacy and what it may mean for the dam as part of the next 5 year dam safety inspection. This Plan of Action was accepted by Mr. Goris by letter dated April 26, 2000.

- In the Five-Year Dam Safety Inspection Report for Hell Hole Dam, dated December 11, 2001, the Independent Consultant recommended that a new flood study and spillway adequacy evaluation be completed before the next 5 year dam safety inspection. Our Plan of Action, submitted to Mr. James Goris by letter dated February 12, 2002, proposed that the study be completed in time for the Independent Consultant to fully review, assess, and comment on the study's adequacy and make recommendations for any necessary mitigation as part of the next 5 year dam safety inspection. We were notified by letter dated March 25, 2003 that you have completed a review of the December 11, 2001 dam safety inspection report and we were provided your comments.

A brief summary of the Mead & Hunt study results for these two dams is as follows:

Ralston Afterbay Dam

The Mead & Hunt PMF spill is 276,200 cfs which results in a maximum reservoir stage of 1200.4 feet. This is 11.4 feet above the road across the dam.

Hell Hole Dam

The new Probable Maximum Flood (PMF) results in a maximum spill of 85,800 cfs and a maximum reservoir elevation of 4647.1 feet, which is 2.8 feet below the lowest point on the crest. With worst case wind and wave run-up, the left and right sides (abutments) of the dam will be overtopped by about 3 feet.

Also enclosed are three copies of a CD which contains the HEC-1 model input files for the calibration events, and the observed precipitation and stream flow sequences as DSS files.

If you have any questions, please contact me at (530) 367-2291 or at sjones@pcwa.net.

Sincerely,

PLACER COUNTY WATER AGENCY

Stephen J. Jones

Stephen J. Jones
Power System Manager

cc: David A. Breninger
Richard C. Harlan
Edward J. Tiedemann

Final Report

Probable Maximum Flood Determination
Hell Hole, Interbay, and Ralston Afterbay Dams
Middle Fork American River Project

FERC Project No. 2079

Prepared for:

Placer County Water Agency

Prepared by:

MEAD HUNT

May 2004

Table of Contents

List of Tables

List of Exhibits

Exhibit

Probable Maximum Flood Determination
Hell Hole, Interbay, and Ralston Afterbay Dams
Middle Fork American River Project
FERC Project No. 2079

1. Summary

This report describes the development of the Probable Maximum Flood (PMF) inflow and outflow hydrographs at the Hell Hole, Interbay, and Ralston Afterbay Dams. These facilities are part of the Placer County Water Agency's (PCWA's) Middle Fork American River Project.

The study included the development of a watershed model for the Middle Fork basin down to Ralston Afterbay Dam; hydrologic data collection and calibration of the model to floods in 1996 and 1997; development of Probable Maximum Storm (PMS) and coincident temperature sequences as directed in the U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA) Hydrometeorological Report No. 58; and simulation of rain-on-snow PMFs for the months of November, March, and April. Local storms without snowmelt were also investigated for Ralston Afterbay and Interbay Dams, because the functioning of the radial spillway gates at these dams could be affected by a severe thunderstorm.

Table 1 summarizes peak PMF inflows and outflows at the three facilities.

Table 1
Summary of PMF Determination for
Hell Hole, Interbay, and Ralston Afterbay Dams

Facility	Minimum Dam Crest Elevation (feet NGVD)*	Month	Peak PMF Inflow (cfs)**	Peak PMF Outflow (cfs)	Peak PMF Stage at Dam (feet NGVD)
Hell Hole Dam	4649.9	November	89,600	85,800	4647.1
		March	88,600	84,500	4647.0
		April	73,600	70,300	4644.9
Interbay Dam	2538.3	November	64,700	64,700	2544.1
		March	63,900	63,900	2543.9
		April	51,500	51,500	2540.3
		Local storm (summer)	20,100	20,100	2542.9 (with radial gates closed)
Ralston Afterbay Dam	1189.0	November	276,300	276,200	1200.4

Table 1
Summary of PMF Determination for
Hell Hole, Interbay, and Ralston Afterbay Dams

Facility	Minimum Dam Crest Elevation (feet NGVD)*	Month	Peak PMF Inflow (cfs)**	Peak PMF Outflow (cfs)	Peak PMF Stage at Dam (feet NGVD)
		March	273,200	273,100	1200.0
		April	219,800	219,800	1194.0
		Local storm (summer)	82,600	82,600	1198.0 (with radial gates closed)

* *NGVD = National Geodetic Vertical Datum.*

** *cfs = cubic feet per minute.*

The PMF would not overtop Hell Hole Dam, but would overtop Interbay Dam by approximately 6 feet and Ralston Afterbay Dam by approximately 11 feet.

2. Purpose of Study

The PMF has been previously calculated for the PCWA's facilities in the Middle Fork American River basin, including French Meadows Reservoir and L.L. Anderson Dam, Hell Hole Reservoir and Dam, Interbay Dam, and Ralston Afterbay Dam. However, with the exception of new studies for L.L. Anderson Dam in 1988 and 2003, the most recent PMF study for these facilities was completed in 1982. Since the completion of that study, there have been a number of developments that could affect the determination of the PMF in the watershed. These include:

- Large floods in 1986, 1996, and 1997, with the flood of record for the lower part of the basin occurring in late 1996 and early 1997.

- The issuance in 1998 of a new NOAA hydrometeorological report, HMR 58, which provides new data and procedures for developing Probable Maximum Precipitation (PMP) sequences for California watersheds (NOAA, 1998).

- The issuance in 2001 by the U.S. Army Corps of Engineers (USACE) of a comprehensive PMF study for Folsom Dam, which included analysis of the Middle Fork basin (USACE, 2001). The USACE study demonstrated that when precipitation data from HMR 58 were used, the PMF increased substantially over previous estimates.

Hell Hole Dam is a 410-foot-high, rock-fill dam impounding a large reservoir, and if a PMF-type event were to overtop the dam and cause it to fail, it is very likely that the failure would pose a significant downstream hazard. Interbay and Ralston Afterbay Dams do not have the height, the storage capacity, or the rock-fill construction of Hell Hole Dam. However, even if the potential for downstream damage caused by dam failures is low, the PMF at these locations is of interest because of the potential damage to project facilities, either from upstream flooding or from extreme loading conditions on the structures. Therefore, the PCWA retained Mead & Hunt, Inc. to perform an updated PMF study, taking into account the recent flood events and new PMP data.

3. Description of Project Facilities

The Middle Fork American River Project is located on the western slope of the Sierra mountain range in northern California (Exhibit 1). The project comprises two major storage reservoirs (French Meadows and Hell Hole), five powerhouses, and associated tunnels, penstocks, and diversion dams. Pertinent features of the three facilities addressed in this study are summarized below.

Hell Hole Dam. Hell Hole Dam is a 410-foot-high, 1,550-foot-long, rock-fill dam located on the north fork of the Rubicon River. The 207,600-acre-foot reservoir receives inflows from the upper Rubicon River watershed and through a power plant diversion from the French Meadows Reservoir. During normal operating conditions, water is diverted from Hell Hole Reservoir through the Middle Fork Tunnel to the Lowell Stephenson power plant. A 725-kilowatt (kW) powerhouse is also located at Hell Hole Dam for the purpose of maintaining minimum streamflows in the Rubicon River. Operating reservoir levels range from 4340 to 4630 feet. This spillway is a 350-foot-long weir, having a crest elevation of 4630 feet. There are no gated spillways. The minimum elevation of the dam crest is 4649.9 feet, and the maximum elevation is approximately 4657 feet.

A spillway rating curve and a reservoir storage curve (reproduced from the 2001 independent consultant's safety inspection) are presented in Exhibit 2.

Interbay Dam. Interbay Dam is located on the Middle Fork American River just downstream of the Lowell Stephenson (Middle Fork) power plant. Water is diverted above the dam through the Ralston Tunnel to the Ralston power plant. The dam, a 70-foot-high, concrete-gravity structure, impounds a 175-acre-foot reservoir having a normal operating elevation of 2527 feet. The spillway consists of four 20-foot-wide by 20-foot-high gated bays and two ungated overflow sections. The crest elevation of the gated spillways is 2510 feet, and the crest elevation of the ungated spillways is 2529 feet. A roadway with a curb elevation of 2538.3 feet runs over the spillway gates. The spillway rating curve has been extended for this study to account for the possible interference between the bottom of the radial gates and the upper nappe of the spillway flow. This curve, shown with supporting calculations in Exhibit 3, indicates that the maximum discharge at top-of-dam elevation 2538.3 feet is 45,800 cfs. At higher elevations, the rating curve also includes the transition from free-surface to orifice flow when the roadway interferes with flow over the top of the open gates.

Ralston Afterbay Dam. Ralston Afterbay is located on the Middle Fork of the American River just downstream of the Rubicon River-Middle Fork confluence. A 400-foot tunnel conveys water from the dam's impoundment to the Oxbow power plant, which is just downstream of the dam and upstream of the mouth of the North Fork of the Middle Fork of the American River.

The 89-foot-high, concrete-gravity dam impounds approximately 2,800 acre feet of water at the maximum normal headwater elevation of 1179 feet. The spillway consists of five radial gate bays, each 40 feet wide and 30 feet high, having a spillway crest elevation of 1149 feet. At the top of dam elevation of 1189 feet, the maximum spillway capacity is 179,400 cfs. Spillway rating curves and documentation for Ralston Afterbay Dam are provided in Exhibit 4.

A. Description of Middle Fork/Rubicon River Basin

The combined drainage area of the Middle Fork American River and Rubicon River at Ralston Afterbay is 425 square miles, as measured in 2003 from 1:24000 U.S. Geological Survey (USGS) topographic maps. Of this area, 160 square miles are regulated by Hell Hole and French Meadows Reservoirs, which have a significant effect on downstream flood peaks. An additional 8 square miles in the Rubicon River basin are regulated by Loon Lake Reservoir, which is operated by the Sacramento Municipal Utility District.

The basin varies in elevation from 1180 feet at Ralston Afterbay Dam to almost 10000 feet at the Sierra divide above Hell Hole Dam. An analysis of snowpack depths performed in conjunction with the 2003 PMF study for the L.L. Anderson Dam indicated that extreme springtime snowpacks in the headwater areas approach 100 inches water equivalent. Most of the largest floods on record in the basin are winter rain-on-snow events. The flood of January 1997, which was the flood of record at Hell Hole and some lower basin locations, peaked at approximately 74,000 cfs at Ralston Afterbay Dam. This flood resulted from a basin average rainfall of 24 inches over a 9- to 10-day period. For comparison, the 100-year, 7-day precipitation for the watershed area is approximately 15 inches. (NOAA Atlas 14, Precipitation Frequency Atlas of the United States, National Weather Service, 2003).

Table 2 summarizes active stream gages in the basin and the flood of record at each.

Table 2
Active Stream Gages in Study Basin

Site Name and USGS Gage No.	Drainage Area (square miles)	Period of Record	Peak Flow of Record
Middle Fork American River Below French Meadows Reservoir (11427500)	47.9	1951 to present	21,500 cfs (January 1963 - before dam) 6,050 cfs (May 1996)
Middle Fork above Middle Fork Powerhouse (11427760)	87.8	1965 to present	13,900 cfs (January 2, 1997)
Middle Fork below Interbay Dam (1142770)	89.1	1965 to present	Not available
Middle Fork near Foresthill (11433300)	524 (includes North Fork of Middle Fork, which is not a part of this study)	1958 to present	123,000 cfs (January 1997)
Rubicon River below Rubicon Dam (11427960)	26.8	1965 to present	Not available
Rubicon River below Hell Hole Dam (11428800)	114	1991 to present	28,800 cfs (January 1997)

4. Previous Probable Maximum Flood Studies

A PMF study was completed for Hell Hole, Interbay, and Ralston Afterbay Dams in 1982 by the consulting firm Sierra Hydrotech. That study utilized PMP data from HMR No. 36, which has since been superseded by HMR 58 and 59. In that study, the basin hydrologic parameters for timing, losses, and snowpack effects were developed by calibration at two gages, the Rubicon River at Rubicon Springs and the North Fork of the American River at North Fork Dam. Although the Rubicon River is part of the study basin, the North Fork is not. The North Fork was considered to be an analogous basin to the Middle Fork, as very little information was available about historic floods within the Middle Fork basin.

Sierra Hydrotech developed PMF hydrographs for an October storm and a January or February storm for Hell Hole, Ralston Afterbay, and Interbay Dams. October was the month for which HMR 36 reported the most intense PMP; January and February were more critical in terms of potential snowmelt. All of the storms simulated were general storms as defined in HMR 36. No local storm (a short, intense storm covering a smaller area than the general PMP) was simulated in the 1982 studies. These analyses yielded an estimated PMF outflow of 69,300 cfs at Hell Hole Dam, 42,700 cfs at Interbay Dam, and 201,000 cfs at Ralston Afterbay Dam.

At about the same time (1980, revised in 1988), Pacific Gas & Electric Company hydrologists performed a PMF study for French Meadows Reservoir and L.L. Anderson Dam. This study, which utilized HMR 36, gave a peak PMF outflow of 15,500 cfs. An updated PMF study for L.L. Anderson Dam and French Meadows Reservoir was completed by Mead & Hunt in 2003, concluding that the peak PMF outflow from L.L. Anderson Dam would be 37,500 cfs. The watershed model developed for that study has been retained and is a part of the basin model used in the present study.

In addition to the incorporation of PMP data from HMR 58 and 59, the 2003 French Meadows PMF study included a model calibration to the flood of January 1997. As a result of this calibration, a uniform loss rate for rain, rain on snow, or snowmelt of 0.03-inch per hour was adopted. This value is considerably lower than that used in previous studies, but was necessary to achieve model calibration to the 1997 event. The USACE, in its 2001 PMF study for Folsom Dam, had reached a similar conclusion based on calibrations to the 1997 flood, and adopted a zero loss rate for all of its model subbasins above Ralston Afterbay Dam.

5. Watershed Model Development and Calibration

A. Model Development

The 425-square-mile watershed above Ralston Afterbay Dam was subdivided into ten subbasins for the purpose of flood simulation. These subbasins are mapped in Exhibit 5 and are summarized in Table 3.

Table 3
Subbasins in Watershed Model for Developing the PMF

Subbasin	Area (square miles)	Used to Develop PMF at:	Mean Elevation (feet NGVD)	All Season 24-hour Index PMP from HMR 58/ HMR 59 (inches)
French Meadows	47.1	Interbay, Ralston	6500	28
Duncan Canyon	42.2		5400	27.5
Upper Hell Hole	41.9	Hell Hole, Ralston	7000	26
Lower Hell Hole	70.8		5400	26
Loon Lake*	57.7	Ralston	6000	25.5
Middle Rubicon	20.2		4300	24
Lower Rubicon	45.9		4200	23
Stumpy Meadows	28.9		4500	24
Long Canyon	48.9		4600	25
Lower Middle Fork	21.9		3500	22.5

**Note: the Loon Lake dam and reservoir are included within the Loon Lake subbasin. Because of the small drainage area (8 square miles) controlled by the reservoir and a lack of calibration data above or below Loon Lake, the dam was not included as a separate model breakpoint.*

The USACE's HEC-1 watershed model was used to develop the PMF inflow and outflow hydrographs at each point of interest. For the purposes of snowmelt simulation, each of the ten subbasins in the model was divided into 1000-foot elevation intervals as shown in Table 4.

Table 4
Area-Elevation Relationship for Model Subbasins

Subbasin	Square Miles in Elevation Interval (in feet)							
	3000 and lower	3000 to 4000	4000 to 5000	5000 to 6000	6000 to 7000	7000 to 8000	8000 to 9000	9000 and higher
Lower Middle Fork	6.6	7.6	5.9	1.8				
Lower Rubicon	10.2	13.8	18.9	3.0				
Stumpy Meadows	0.9	5.1	16.4	6.4	0.1			
Long Canyon	2.2	7.3	19.6	16.1	3.7			
Duncan Canyon	0.4	2.9	11.4	17.5	9.5	0.5		
Middle Rubicon		0.8	7.5	9.2	2.6	0.1		
Loon Lake		0.2	2.1	24.8	24.2	6.1	0.3	
French Meadows				15.9	19.5	9.9	1.8	
Upper Hell Hole			2.5	5.2	16.4	15.4	2.4	
Lower Hell Hole			2.4	5.1	20.4	30.6	11.2	1.1

Pre-calibration input to the model included the area relationships shown in Table Nos. 3 and 4; recorded reservoir elevations at the beginning of each storm; storage and spillway rating curves for Hell Hole, French Meadows, Interbay, and Ralston Afterbay Dams; and preliminary values of the following:

- Clark unit hydrograph parameters, estimated from basin length and slope and comparison to calibrated values in the French Meadows study.
- Constant loss rates for bare ground and for snow-covered ground, estimated from the 2003 French Meadows study; the 1982 PMF study by Sierra Hydrotech; and the 2001 USACE study for Folsom Dam.
- A snowmelt temperature index value, relating the melt rate of snow to the temperature in degrees above freezing.

- Kinematic wave-routing parameters for translating hydrographs through the Middle Fork and Rubicon Rivers based on channel distance, slope, channel roughness, and channel configuration during flood conditions.

B. Model Calibration

The model was calibrated using precipitation, snowpack, and streamflow data from the floods of May 1996 and December 1996-January 1997. The flood of February 1986 was also investigated, but available climatological data from that event were insufficient to develop a reliable precipitation sequence. Key calibration points in the model were at Interbay, Hell Hole, and Ralston Afterbay Dams. French Meadows Reservoir was not treated as a calibration point because calibration of that watershed was completed in the 2003 PMF study for L.L. Anderson Dam.

During the December 1996-January 1997 flood, most of the basin was snow-covered at the outset of the storm. The majority of the basin retained a snow cover through the storm. In May 1996, snow was present at the highest elevations and contributed significantly to streamflows in the Hell Hole and French Meadows subbasins, but was not a significant factor at lower elevations.

U.S. Geological Survey (USGS) stream gages are located downstream of Hell Hole Dam and upstream of Interbay Dam. The following data sources were used to reconstruct the observed 1996 and 1996-97 hydrographs at each of the calibration points:

- *Hell Hole Dam*: Continuous reservoir stage record and operator's notes. Although there is a USGS gage below the dam, it measures only low flows. Reported flood flows at the gage are based on a combination of the stream gage records and spillway records.

- *Interbay Dam*: USGS upstream gage record (incomplete with estimated values for January 1997) and operator's spillway release notes.

- *Ralston Afterbay Dam*: Operator's spillway release and headwater level notes.

Precipitation, temperature, and snowpack data were obtained from the California Data Exchange Center (CDEC) as shown in Table 5. The locations of the climate stations listed are shown in Exhibit 5.

Table 5
Data Sources for Watershed Model Calibration

Gage Location	CDEC Designation	Type(s) of Data
Greek Store	GKS	Hourly precipitation, temperature, daily snow pack water equivalent
Squaw Valley	SQV	Hourly precipitation, daily temperature, daily snow pack water equivalent
Huysink	HYS	Daily precipitation, hourly temperature, daily snow pack water equivalent
Sugar Pine	SGP	Hourly precipitation, hourly temperature
Bald Mountain	BMT	Hourly precipitation, hourly temperature
Robbs Saddle	RBB	Hourly precipitation, hourly temperature, daily snow pack water equivalent
Van Vleck	UUL	Hourly precipitation, hourly temperature, daily snow pack water equivalent
Lake Lois	LOS	Daily snow pack water equivalent
Fallen Leaf Lake	LFF	Daily precipitation, daily temperature, daily snow pack water equivalent
Rubicon Peak	RP2	Daily precipitation, daily temperature, daily snow pack water equivalent
Hell Hole	HLH	Hourly precipitation, hourly temperature
Ward Creek	WC3	Daily precipitation, daily temperature, daily snow pack water equivalent

The HEC-1 watershed model was calibrated by adjusting the inputs listed as "preliminary" above: unit hydrograph parameters, loss functions, snowmelt index, and channel-routing parameters. Of these, the loss function and the snowmelt index primarily affect the volume of the flood hydrograph, while the unit hydrograph and channel-routing parameters affect only the shape of the hydrograph.

The temperature index method for computing snowmelt is based on the assumption that there is a proportional relationship between temperature above freezing and the volumetric rate of snowmelt. This approach simplifies the snowmelt computation process considerably, relative to energy-budget methods that account for snowpack density and albedo, relative humidity, and wind speed. However, by treating the index as a calibration parameter we can achieve a reasonable melt rate representation for extreme floods that does not rely upon detailed meteorological and climate data, which are generally not available. The calibration parameters were varied by trial and error until an acceptable match between the shape and volume of the observed and simulated hydrographs was achieved. Constraints on the calibration adjustments included the following:

- Parameters for each subbasin should make physical sense – by themselves and compared between subbasins – with respect to land cover, slope, and other known basin data.

- Unit hydrograph parameters should be the same for the two simulated floods. Calibrated losses were slightly higher for some of the lower subbasins for the May 1996 event, reflecting a more vegetated condition and/or drier antecedent condition than during the winter flood.

- The 1997 storm, being larger and more spatially uniform than the 1996 storm, was given more weight than the 1996 storm in evaluating the calibration. Loss rates derived from the 1997 storm were considered most relevant to a rain-on-snow PMF.

- Calibration results are shown in Exhibit Nos. 6 and 7. Where recorded data from different sources diverged, both sets of observed data are shown on the plots.

For the 1996-97 flood, a good fit was achieved at Ralston Afterbay (Exhibit 7). The simulated Hell Hole hydrograph also replicates the observed data very well, except for a shift in time of about 3 hours. However, because the rate of rise in the simulated and observed hydrographs was identical, we attribute this shift to the precipitation data (which were transferred from Greek Store) rather than to the basin timing parameters. Likewise, the simulated hydrograph at Interbay for the 1996-97 flood tracks the observed data well, given that the USGS gage apparently began to malfunction early on January 2, and the peak and average flows on this day were estimated after the event.

The final unit hydrograph and loss parameters selected for each subbasin are listed in Table 6. A melt coefficient of 0.07 (in inches of melt per degree-day over 33 degrees) was applied to melting snowpack throughout the basin.

Table 6
Basin Parameters Used to Develop PMF Hydrographs

Subbasin	Uniform Loss Rate for Snow-Covered Ground (Inches per hour)	Uniform Loss Rate for Snow-Free Ground (Inches per hour, occurs late in storm)	Clark Time of Concentration (hours)	Clark Storage Coefficient R (hours)
Lower Middle Fork	.03	0.01	8	3.8
Lower Rubicon	.03	0.01	10.8	3.8
Stumpy Meadows	.03	0.01	8.9	3.8
Long Canyon	.03	0.01	9.3	3.8
Duncan Canyon	.03	0.01	9.7	3.8
Middle Rubicon	.03	0.01	7.5	3.8
Loon Lake	.03	0.01	9.8	3.8
French Meadows	0.03	0.01	6.45	1.81
Upper Hell Hole	0.03	0.01	8.0	4.0
Lower Hell Hole	0.03	0.01	10.0	4.0

The Clark storage coefficient for the French Meadows subbasin is smaller than the coefficients assigned to other subbasins. Clark parameters for the French Meadows subbasin were adopted from a study performed in 1980 by Pacific Gas & Electric Company. The 2002 Mead & Hunt restudy, which included calibration to the flood of January 1997, revealed no reason to modify those parameters. However, in the current study, larger storage coefficients were found to give the best representation of recorded floods at the lower basin gages and at Hell Hole.

The Clark storage coefficient measures neither the volume of water entering the reservoir nor the time of the peak inflow. Instead, it describes how the runoff volume is distributed around the peak. Because reservoir storage (which is entirely separate from the storage coefficient applied to the inflow hydrograph) is so substantial in French Meadows Reservoir and Hell Hole Reservoir, the computed outflow hydrographs at the calibration points are very insensitive to the storage coefficient that is applied to the reservoir inflow hydrograph. The same insensitivity would apply to the computed PMF stage and outflow hydrographs.

The HEC-1 model input files for the calibration events, as well as the observed precipitation and streamflow sequences as DSS files, accompany this report on CD.

6. Development of Meteorological Inputs to PMF Model

A. Probable Maximum Precipitation – General Storm

The all-season PMF for all of the facilities studied would be caused by a general PMS occurring in conjunction with deep snowpack and high temperatures. Index maps in HMR 58 show that the PMP is maximized in the months of November through March for Hell Hole and Interbay; but for the watershed at Ralston Afterbay, an equally large storm could also occur in October. Although the precipitation sequence will be the same for November (or October) through March, each winter month differs in terms of temperature and available snowpack for melting. Therefore, PMF hydrographs were developed for both November, which has higher temperatures associated with the PMP but a smaller potential snowpack, and March, which has slightly lower temperatures than November but a much deeper snowpack. Finally, a simulation was also run for April, when both potential temperature and snowpack are higher than in March, but PMP is about 20 percent less. A model run for October was not made, because of the minimal snowpack that would be present over much of the basin during this month.

The spatial and temporal distributions of the storms are a matter of judgment, with some guidance being provided in HMR 58. In order to preserve the computed depth-duration relationships, it is necessary to arrange the temporal sequence in approximately a single-peaked shape. This differs from the approach taken in the 1982 Sierra Hydrotech study, which, in turn, retained the temporal rainfall distribution used in the 1980 French Meadows PMF study. That distribution roughly replicated observed storms in the area. We applied a distribution with the peak 6-hour increment occurring just before the middle of the 72-hour total storm duration, and the remaining 6-hour increments arranged in decreasing order around the peak.

For a multi-subbasin model, it is also necessary to decide how the PMP will be distributed among the subbasins. HMR 58 suggests that the spatial distribution of the PMP may be developed according to historic storms, 100-year frequency isohyets, or an idealized elliptical set of storm isohyets. Because of the significant effect of topography on storm depths, the idealized elliptical storm probably does not represent spatial distributions of extreme rainfall well for this basin. To develop a realistic spatial distribution, we compared the 100-year, 24-hour rainfall presented in NOAA Atlas 2; the recorded total storm rainfall in the 1996-97 storm; and the PMP index values given in HMR 58. The pattern of the 100-year frequency isohyets is very similar to that of the PMP index isohyets. The spatial pattern of rainfall in the 1996-97 storm was also generally consistent with the rainfall frequency maps. Based on these observations, we adopted a spatial distribution weighted according to the 100-year, 24-hour precipitation and the index PMP.

Table 7 summarizes the steps, as described in HMR 58, which were applied to develop PMP sequences for the watersheds above Ralston Afterbay, Interbay, and Hell Hole Dams. More detailed spreadsheet calculations may be found in Exhibit Nos. 8, 9, and 10. Separate calculations were performed for each dam's PMF, because if PMP is optimized for a large drainage area (such as the 425 square miles at Ralston), PMPs for smaller subareas (such as the Hell Hole or Interbay basins) do not simultaneously occur within that storm.

Table 7
Summary of PMS Development
(Note: Table, Figure, and Plate Citations Refer to HMR 58)

Step	Hell Hole	Interbay	Ralston Afterbay
1. Determine Drainage Area (square miles).	113	89	425
2. Determine 24-hour, 10-square-mile November-March Index PMP (inches) for drainage centroid from Plate 2.	26	27.7	25.5
3. Develop 10-square-mile depth-duration values (inches) up to 72 hours from Table 2.1.	1 hour = 3.6 72 hour = 45.8	1 hour = 3.9 72 hour = 48.8	1 hour = 3.6 72 hour = 44.9
4. Adjust to basin area (Table 2.3)	1 hour = 3.0 72 hour = 41.6	1 hour = 3.3 72 hour = 44.8	1 hour = 2.6 72 hour = 38.2
5. Plot and connect with a smooth curve.			
6. Separate into 1-hour increments.			
7. Arrange by 6-hour blocks as suggested in HMR 58. Maximum 6-hour depth is in hours 31-36; others arranged in decreasing order around the peak.			
8. Distribute among subbasins in proportion to 100-year precipitation and index PMP.			
9. Determine adjustment factor for April from Figure 2.3.	0.78	0.78	0.8
10. Determine April index PMP (inches).	20.3	21.6	20.4
11. Repeat Step 3 using Table 2.2 for 1-month offset.	1-hour = 2.9 72-hour = 33.9	1-hour = 3.1 72-hour = 36.1	1-hour = 2.9 72-hour = 34.1
12. Repeat Step 4 using Table 2.7 for 1-month offset.	1-hour = 2.4 72-hour = 32.4	1-hour = 2.7 72-hour = 34.9	1-hour = 2.0 72-hour = 29.7
13. Repeat steps 5-8 for April depth-duration values.			
14. Determine 1-hour, 1-square-mile local PMP (inches) from Figure 2.21	8.5	8.5	8.2
15. Determine basin average elevation and adjust local index PMP (inches).	8.5	8.4	8.2

Table 7
Summary of PMS Development
(Note: Table, Figure, and Plate Citations Refer to HMR 58)

Step	Hell Hole	Interbay	Ralston Afterbay
16. Determine 6-hour to 1-hour ratio from Figure 2.24.	1.2	1.2	1.3
17. Determine precipitation for 0.5 to 6 hours (inches).	0.5-hour = 6.7 6-hour = 10.2	0.5-hour = 6.6 6-hour = 10.1	0.5-hour = 6.5 6-hour = 10.7
18. Adjust to basin area.	0.5-hour = 2.9 6-hour = 5.7	0.5-hour = 3.1 6-hour = 6.0	0.5-hour = 1.4 6-hour = 4.1
19. Plot local storm increments.			

The development of the PMS sequence for each of the three facilities is detailed in Exhibit Nos. 8, 9, and 10.

B. Local Storm

According to HMR 58, a 6-hour local storm could occur over areas up to 500 square miles. The total rainfall in a local storm is less than in a general storm, but the intensities can be greater. Also, a local storm can occur in the summer months, when the general-storm PMP is significantly reduced due to seasonal factors. The local-type storm's temporal distribution is typically front-loaded, meaning that the most intense rainfall occurs in the first time increment. Because of the very sudden nature of the local storm and the possibility that lightning strikes occur in conjunction with it, there is a possibility that the radial gates at Ralston Afterbay and Interbay would not be fully or immediately operable during the local storm. Therefore, we simulated a local-storm PMF for these two dams assuming that the flood would pass over the top of the closed radial gates.

Temporal distributions for a local storm were computed following the procedures given in HMR 58. The areal reduction factors for drainage areas of the size being studied (89 square miles for Interbay, 113 square miles for Hell Hole, and 425 square miles for Ralston) are so substantial that the 6-hour local storm is similar to or less intense at all durations than the peak 6 hours of the general storm (Table 7). At Hell Hole, there are no critical seasonal operational conditions (such as closed spillway gates that could not be opened rapidly enough to accommodate the rising flows) that would make a local storm a potentially critical condition.

The 6-hour local storm sequences for the drainages above Interbay Dam and Ralston Afterbay Dam are shown in Exhibit Nos. 9 and 10, respectively.

C. Temperature Sequence

The temperature sequence coincident with each month's PMS was developed following the guidelines given in the Appendix to HMR 58. The development of the temperature sequence is documented in Exhibit Nos. 8, 9, and 10. The highest potential temperatures prove to be in the month of November, corresponding to the highest dew points and precipitable water. Temperature sequences for the drainage above each dam were developed for the average elevation of that drainage, and the temperature lapse rate (change in temperature with elevation) was then determined based on the freezing elevation provided in HMR 58. A temporal sequence was developed so that the maximum temperatures coincided with the maximum precipitation increments.

Table 8 summarizes the temperature range occurring during the PMS for each dam's drainage.

Table 8
Basin Average Temperature Ranges Associated with PMS
(degrees Fahrenheit, from coolest time interval to warmest interval)

Drainage Above:	November	March	April
Hell Hole	43.2 - 48.8	39.6 - 45.5	41.7 - 47.3
Interbay	42.5 - 48.3	39.0 - 44.8	41.0 - 46.3
Ralston Afterbay	44.8 - 50.5	41.8 - 47.4	43.3 - 48.6

D. Snowpack during the Probable Maximum Storm

Federal Energy Regulatory Commission (FERC) guidelines call for an assumed 100-year snowpack in place at the outset of the PMS. In the 2003 PMF study for L. L. Anderson Dam, it became apparent that at least for the elevation range of that drainage area, the 100-year snowpack is far more than can be melted by the temperature sequence coincident with the PMP. The L. L. Anderson Dam study included an analysis of monthly snowpack water equivalent frequency for February through April at climate stations ranging from 5750 feet to 7700 feet in elevation. A snowpack record long enough to develop 100-year frequency estimates was not available for the month of November or for lower elevations. However, daily snowpack data for November for the last 20 years was available at some stations, including Greek Store (5600 feet), Hysink (6600 feet), and Squaw Valley (8200 feet). For calculating the November PMF, the snowpack was assumed to be equal to the maximum recorded November snowpack at the corresponding elevation. No snowpack data at all were available for elevations below 5000 feet. To account for some snowpack at the lowest elevations, we adopted the antecedent snowpack assumptions used by the USACE in their Folsom Dam PMF study. The snowpack – elevation relationship assumed for each month is shown in Table 9. For the local storm, which would be a summer event, it was assumed that snowpack would be negligible.

Table 9
Assumed Snowpack at Outset of PMS
(Inches water equivalent)

Elevation Range (feet)	November	March	April
3000 and lower	0	0	0
3000 to 4000	.8	.8	.8
4000 to 5000	3	3	3
5000 to 6000	11	40	45
6000 to 7000	13	75	90
7000 to 8000	16	85	95
8000 to 9000	16	85	95
9000 and higher	16	85	95

7. Operation of Dams and Reservoirs during the Probable Maximum Flood

It was assumed that the water level in the two storage reservoirs in the system, French Meadows and Hell Hole, would be at the crest of the dam's spillway at the outset of the PMP. This is a worst-case assumption for winter or early spring operation, as the reservoirs are typically drawn down through the winter below the spillway crests.

For Ralston Afterbay and Interbay, the assumed starting headwater elevations were the normal operating levels of 1174 and 2527 feet, respectively. The peak outflow and stage at Ralston and Interbay are not sensitive to this assumption, because reservoir storage is very small relative to the volume of the PMF hydrograph.

The PCWA is currently in the process of developing plans for additional spillway capacity at L. L. Anderson Dam to accommodate the PMF determined in 2003. To represent the conceptual modifications to the spillway, it was assumed that L. L. Anderson Dam will pass the new PMF at the maximum pool elevation for the previously computed PMF, which is 5270.1 feet.

Although there are diversions into and out of the Hell Hole, Ralston Afterbay, and Interbay impoundments during normal operating conditions, and out-of-basin diversions by the Sacramento Municipal Utility District, these diversions were not considered for the PMF simulation. It is reasonable to assume that under such extraordinary flooding conditions powerhouse and other diversion operations would cease.

8. Probable Maximum Flood Model Results

The controlling case for all three dams proved to be a November flood, resulting from an all-season general storm and high snowmelt temperatures. PMF hydrographs for the three facilities, the three general-storm cases, and the local storm at Ralston Afterbay and Interbay are shown in Exhibit Nos. 11, 12, and 13. A separate inflow hydrograph is only shown for Hell Hole Dam (Exhibit 11) because inflow and outflow are virtually identical at Interbay and Ralston Afterbay.

Table Nos. 10, 11, and 12 summarize the PMF peak inflows, peak outflows, peak stages, and volumes.

Table 10
PMF Inflows, Outflows, and Stages at Hell Hole Dam

Month	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Stage (feet)	PMF Volume (acre-feet)	Dam Crest Elevation (feet)	Freeboard (+) or Depth of Overtopping (-) (feet)
November	89,600	85,800	4647.1	261,000	4649.9	+2.8
March	88,600	84,500	4647.0	240,000	4649.9	+2.9
April	73,600	70,300	4644.9	195,000	4649.9	+5.0

Table 11
PMF Inflows, Outflows, and Stages at Interbay Dam

Month	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Stage (feet)	PMF Volume (acre-feet)	Dam Crest Elevation (feet)	Freeboard (+) or Depth of Overtopping (-) (feet)
November	64,700	64,600	2544.1	210,000	2538.3	-5.8
March	63,900	63,900	2543.9	202,000	2538.3	-5.6
April	51,500	51,500	2540.3	157,000	2538.3	-2.0
Local Storm	20,100	20,100	2542.9 (radial gates closed)	23,900	2538.3	-4.6

MEAD & HUNT

Table 12
PMF Inflows, Outflows, and Stages at Ralston Afterbay Dam

Month	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Stage (feet)	PMF Volume (acre-feet)	Dam Crest Elevation (feet)	Freeboard (+) or Depth of Overtopping (-) (feet)
November	276,300	276,200	1200.4	876,000	1189.0	-11.4
March	273,200	273,100	1200.0	840,000	1189.0	-11.1
April	219,800	219,800	1194.0	647,000	1189.0	-5.0
Local Storm	82,600	82,600	1198.0 (radial gates closed)	87,900	1189.0	-9.0

The HEC-1 model files used to develop the PMF, as well as model output summaries, accompany this report on CD.

9. Freeboard Considerations at Hell Hole Dam

At Hell Hole Dam, the minimum freeboard is 2.8 feet at the peak of the critical PMF. This freeboard pertains to the sections of the dam nearest the abutments. Due to the camber of 7.4 feet, the PMF freeboard at the center of the dam is more than 10 feet.

Records of wind speed and direction records are available from a climate station at the dam and were used to estimate wave run-up on the dam that would be associated with a maximum observed wind condition at the dam. (Although wind speeds associated with the PMP are given in HMR 58, these are for use in energy-budget snowmelt calculations and represent winds blowing toward the west slope of the Sierras, which is the prevailing wind direction. The maximum fetch direction for wave run-up on the dam is against the prevailing wind direction.) The maximum historic November wind speed of 68 miles per hour (which occurred in November 1999) was used for the calculation. The wind direction from the northeast is consistent with the reservoir canyon direction and is also coincident with the fetch distance of 2 miles. The maximum wind speed was adjusted to reflect the assumption that the peak wind speeds coincide with the peak of the storm, which occurs about 11 hours before the peak reservoir elevation. The adjustment for a 12-hour duration was obtained from Figure A-6 of HMR 58.

Procedures outlined in the USACE Engineering Technical Letters 1110-2-305 and 1110-2-221 were used to develop estimates of wind setup and wave run-up on the dam. The wave run-up and wind setup are a function of wind speed and fetch distance, and of the upstream embankment slope, which is 1.4:1. The upstream face of the dam is riprapped. The computed maximum wave run-up and wind setup is 6 feet, or approximately 3 feet higher than the minimum dam crest elevation.

The wave run-up calculations for the PMF at Hell Hole Dam are attached as Exhibit 14.

10. Probable Maximum Flood Stages at Placer County Water Agency Powerhouses

The peak PMF stages at Ralston Afterbay Dam and at Interbay Dam were used to estimate the PMF flood stage at the Ralston Powerhouse and at the Lowell Stephenson Powerhouse, which is located about 2,000 feet upstream of Interbay Dam. For each of these locations, a steady-state HEC-RAS step backwater model, running from the dam upstream to the powerhouse, was developed from reservoir topography maps supplied by the PCWA. These topographic maps were prepared by S&E Engineering of Nevada City, California, and were based on aerial photographs taken in August 2000. For the Interbay – Lowell Stephenson Powerhouse reach, the topographic survey data were limited in detail and so were supplemented by valley width measurements from the Greek Store 7.5-minute USGS quadrangle map.

In addition, the peak PMF outflow from Ralston Afterbay was applied to a HEC-RAS model of the Middle Fork between the Oxbow Powerhouse and the confluence with the North Fork of the Middle Fork of the American River. For this model, there was no known discharge-elevation relationship at the downstream boundary. Neither PMF discharges nor topography for the reach below the North Fork confluence are known. Therefore, the downstream boundary condition was assumed to be a normal-flow section just upstream of the confluence. However, in all three river segments studied, critical flow or near-critical flow conditions were found to exist in the modeled reaches. This is a reasonable analytical result, considering the very high magnitude of the flows and the narrowness of the river valleys. Thus, neglecting possible backwater effects from the river downstream of the North Fork-Middle Fork confluence is unlikely to significantly affect the computed stage at the Oxbow Powerhouse.

Model calibration data were available from the 1997 flood at the Ralston Powerhouse. This flood produced a peak stage of 1199.2 feet at the powerhouse. The HEC-RAS model reproduced this stage within one-half foot. Calibration data were not available for the other two river reaches.

The computed-PMF peak stages and flows at each powerhouse are listed in Table 13. The 1-foot reporting precision reflects the uncertainty in modeling hydraulics of very large floods. Factors that could affect the flood stage at the powerhouse, but which could not be included in the analytical model, include the possibility of debris blockage, channel scour, or redeposition of gravel or cobbles during the flood.

Table 13

PMF Stages at Placer County Water Agency Powerhouses

Powerhouse	PMF Discharge (cfs)	Powerhouse Top Deck Elevation (feet)	Peak PMF Stage (feet NGVD)
Middle Fork	64,700	2562	2555
Ralston	208,000 (above Middle Fork-Rubicon confluence)	1211	1221
Oxbow	276,200	1143	1136

The HEC-RAS input files used to develop these elevations are submitted with this report on CD.

11. Conclusions

The general-storm PMF, as recalculated for this study, would overtop both the Ralston Afterbay Dam and Interbay Dam and their access roads, and would overtop the Ralston powerhouse. The PMF would not overtop Hell Hole Dam, although critical wind conditions could cause waves to overtop the lower sections of the dam's crest. A local-storm PMF could also overtop Ralston Afterbay and Interbay Dams if the radial gates became inoperable during that event. However, the local-storm PMF is well within the capacity of the fully opened spillways at both Ralston and Interbay.

We recommend that PCWA evaluate the findings reported in this study with respect to their implications for the safety of its facilities.

References

Mead & Hunt, Inc., *Probable Maximum Flood Study, L.L. Anderson Dam (French Meadows Reservoir)*, Madison, WI; 2003.

NOAA Atlas 14, Precipitation Frequency Atlas of the United States, National Weather Service, Silver Spring, MD; 2003; frequency data accessed at http://hdsc.nws.noaa.gov

NOAA Atlas 2, *Rainfall Frequency for the Western United States*, National Weather Service, Silver Spring, MD, 1973.

Pacific Gas & Electric Company, *Flood Hydrology: French Meadows Reservoir (L.L. Anderson Dam)*; San Francisco, CA; July 1980, revised December 1988.

Sierra Hydrotech Engineering Consultants, *Probable Maximum Flood Study for Hell Hole, Interbay, and Ralston Afterbay*." Placerville, CA; October 1982.

U.S. Army Corps of Engineers, Sacramento District, *American River Basin, California, Folsom Dam and Lake Revised PMF Study*, 2003.

U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA), 1998; *Hydrometeorological Report No 58: Probable Maximum Precipitation for California – Calculation Procedures.*

Exhibit 1. Middle Fork Project Map

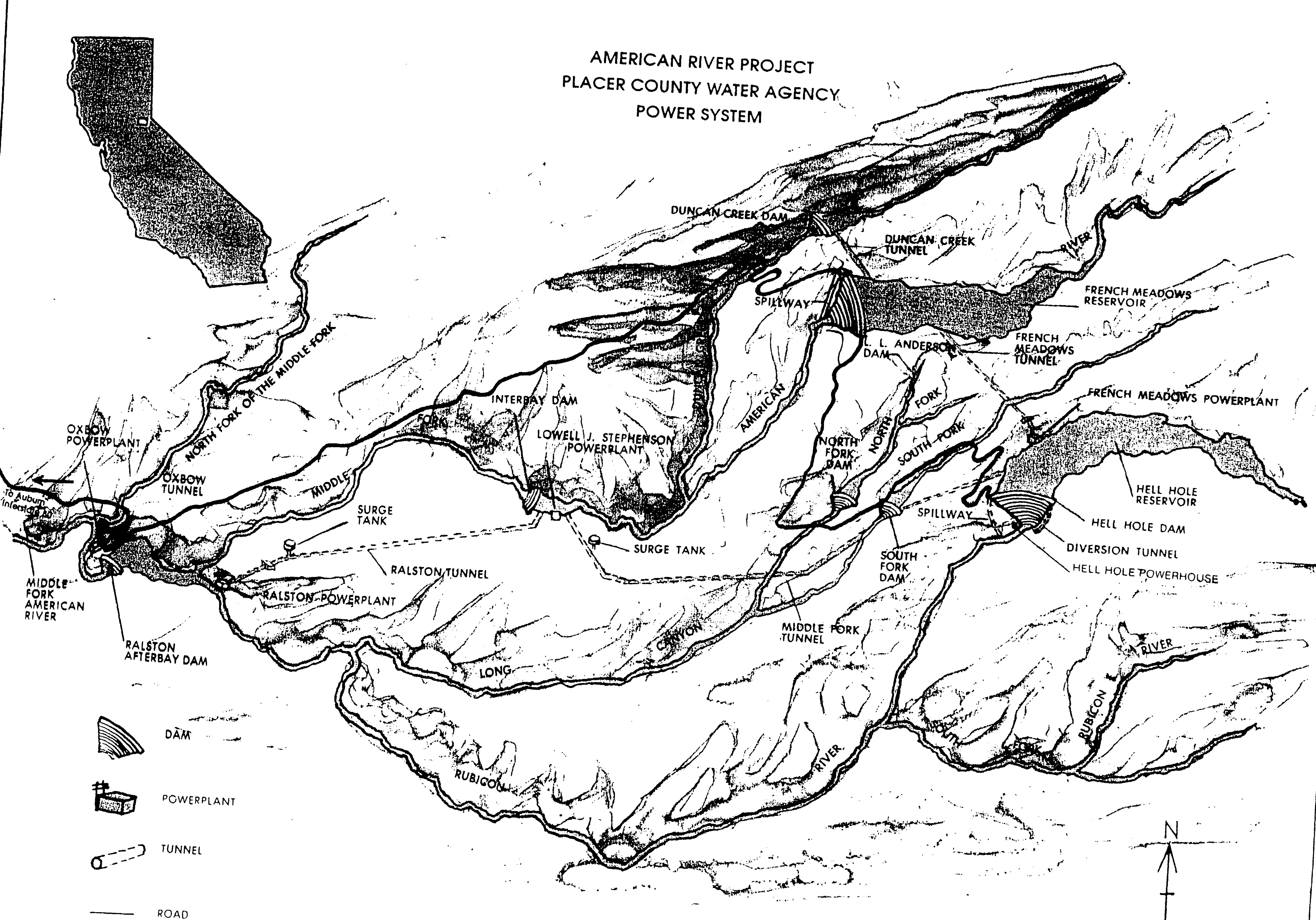


Exhibit 1
Middle Fork American River Development
(reproduced from Placer County Water Agency brochure)

Exhibit 2. Spillway and Reservoir Curves for Hell Hole Dam

EXHIBIT 2

HELL HOLE RESERVOIR

SPILLWAY DISCHARGE AND RESERVOIR STORAGE CURVES

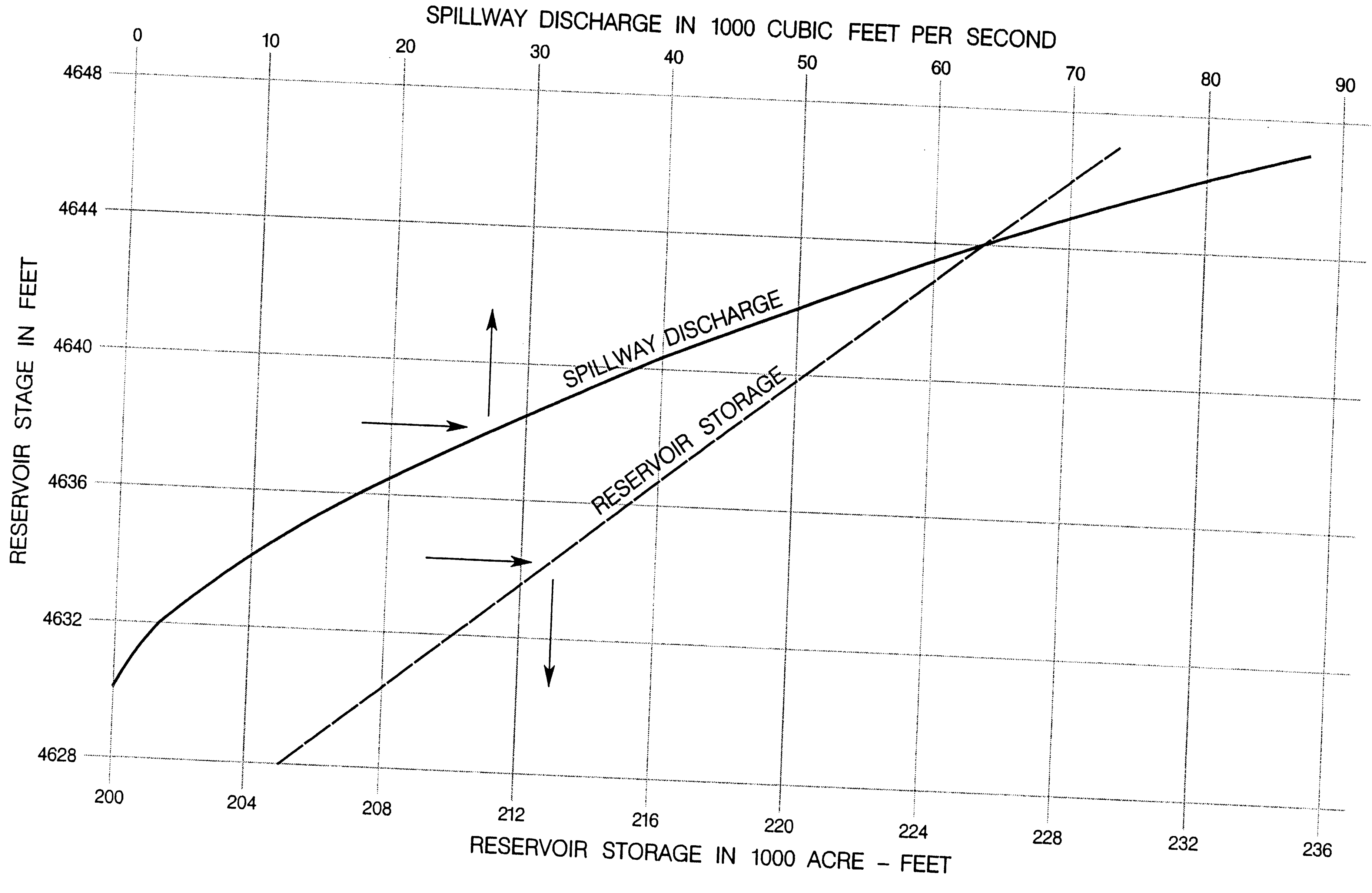


Exhibit 3. Spillway Rating Curve Calculations for Interbay Dam

INTERBAY DAM SPILLWAY RATING CURVE

TAINTER GATE

DESIGN HEAD	23	feet	WEIR BOTTOM	2464	feet(ngvd)		GATE	UNCONTRL SPILLWAY	DAM
CREST ELEVATION	2510	feet(ngvd)	WEIR HEIGHT	46	feet	CREST ELEVATION[5]	999999	2529	2539.34 feet(ngvd)
CREST LENGTH	80	feet	U/S FACE SLOPE	0		LENGTH OF WEIR	80	80	172 feet
GATE OPENING	19	feet	P/H	2.00		DISCHARGE COEFF	3.1	3.1	3.1 feet
ABUTMENT RADIUS	999999	feet	C_0[1]	3.95		CREST SLOPE %		0	0
NUMBER OF BAYS	4		U/S FACE SLOPE CORREC.	1					

Gate Open Beta 1, 79.5 — Dis. Coeff 0.68 — 1.05 — Top of Gate 2533.6

Gate Open Beta 2, 80 — Dis. Coeff 0.69 — 2.05 — Top of Gate 2534

RESERVOIR ELEVATION feet (NGVD)	HEAD OVER CREST feet	HEAD OVER GATE feet	Ha/H	Ka[1]	Kp[1]	EFFECTIVE CREST LENGTH feet	He/Hd	C/Cd[2]	Cweir	WEIR FLOW cfs	Cd 19.5 ORIFICE FLOW cfs	GATE FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	FLOW OVER UNCONTROL cfs	FLOW OVER DAM/BRIDG cfs	TOTAL FLOW cfs
2510.00	0.00	0.00	0.00	0.000	0.050	80.00	0.00	0.800	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
2510.50	0.50	0.00	0.00	0.000	0.050	79.85	0.02	0.800	3.16	88.21	0.00	88.21	0.00	0.00	0.00	0.00	88
2511.00	1.00	0.00	0.00	0.000	0.050	79.70	0.04	0.797	3.15	251.03	0.00	251.03	0.00	0.00	0.00	0.00	251
2511.50	1.50	0.00	0.00	0.000	0.050	79.55	0.07	0.806	3.18	465.32	0.00	465.32	0.00	0.00	0.00	0.00	465
2512.00	2.00	0.00	0.00	0.000	0.050	79.40	0.09	0.815	3.22	722.78	0.00	722.78	0.00	0.00	0.00	0.00	723
2512.50	2.50	0.00	0.00	0.000	0.050	79.25	0.11	0.823	3.25	1018.96	0.00	1018.96	0.00	0.00	0.00	0.00	1019
2513.00	3.00	0.00	0.00	0.000	0.050	79.10	0.13	0.835	3.30	1356.28	0.00	1356.28	0.00	0.00	0.00	0.00	1356
2513.50	3.50	0.00	0.00	0.000	0.050	78.95	0.15	0.841	3.32	1716.45	0.00	1716.45	0.00	0.00	0.00	0.00	1716
2514.00	4.00	0.00	0.00	0.000	0.053	78.74	0.17	0.846	3.34	2105.87	0.00	2105.87	0.00	0.00	0.00	0.00	2106
2514.50	4.50	0.00	0.00	0.000	0.050	78.64	0.20	0.852	3.37	2526.84	0.00	2526.84	0.00	0.00	0.00	0.00	2527
2515.00	5.00	0.00	0.00	0.000	0.048	78.55	0.22	0.858	3.39	2976.34	0.00	2976.34	0.00	0.00	0.00	0.00	2976
2515.50	5.50	0.00	0.00	0.000	0.046	78.46	0.24	0.864	3.41	3453.76	0.00	3453.76	0.00	0.00	0.00	0.00	3454
2516.00	6.00	0.00	0.00	0.000	0.044	78.42	0.26	0.872	3.45	3970.54	0.00	3970.54	0.00	0.00	0.00	0.00	3971
2516.50	6.50	0.00	0.00	0.000	0.042	78.37	0.28	0.877	3.46	4496.68	0.00	4496.68	0.00	0.00	0.00	0.00	4497
2517.00	7.00	0.00	0.00	0.000	0.040	78.34	0.30	0.881	3.48	5048.12	0.00	5048.12	0.00	0.00	0.00	0.00	5048
2517.50	7.50	0.00	0.00	0.000	0.037	78.32	0.33	0.885	3.50	5624.67	0.00	5624.67	0.00	0.00	0.00	0.00	5625
2518.00	8.00	0.00	0.00	0.000	0.030	78.56	0.35	0.880	3.51	6246.13	0.00	6246.13	0.00	0.00	0.00	0.00	6246
2518.50	8.50	0.00	0.00	0.000	0.030	78.47	0.37	0.884	3.53	6866.33	0.00	6866.33	0.00	0.00	0.00	0.00	6866
2519.00	9.00	0.00	0.00	0.000	0.030	78.38	0.39	0.888	3.56	7508.77	0.00	7508.77	0.00	0.00	0.00	0.00	7509
2519.50	9.50	0.00	0.00	0.000	0.030	78.29	0.41	0.905	3.58	8195.62	0.00	8195.62	0.00	0.00	0.00	0.00	8196
2520.00	10.00	0.00	0.00	0.000	0.030	78.20	0.43	0.908	3.59	8877.32	0.00	8877.32	0.00	0.00	0.00	0.00	8877
2520.50	10.50	0.00	0.00	0.000	0.030	78.11	0.46	0.913	3.60	9579.50	0.00	9579.50	0.00	0.00	0.00	0.00	9579
2521.00	11.00	0.00	0.00	0.000	0.030	78.02	0.48	0.916	3.62	10301.88	0.00	10301.88	0.00	0.00	0.00	0.00	10302
2521.50	11.50	0.00	0.00	0.000	0.032	77.83	0.50	0.920	3.63	11029.58	0.00	11029.58	0.00	0.00	0.00	0.00	11030
2522.00	12.00	0.00	0.00	0.000	0.031	77.76	0.52	0.924	3.65	11793.52	0.00	11793.52	0.00	0.00	0.00	0.00	11794
2522.50	12.50	0.00	0.00	0.000	0.031	77.69	0.54	0.927	3.66	12577.64	0.00	12577.64	0.00	0.00	0.00	0.00	12578
2523.00	13.00	0.00	0.00	0.000	0.031	77.62	0.57	0.931	3.68	13381.83	0.00	13381.83	0.00	0.00	0.00	0.00	13382
2523.50	13.50	0.00	0.00	0.000	0.030	77.55	0.58	0.936	3.69	14205.98	0.00	14205.98	0.00	0.00	0.00	0.00	14206
2524.00	14.00	0.00	0.00	0.000	0.030	77.49	0.61	0.939	3.71	15049.99	0.00	15049.99	0.00	0.00	0.00	0.00	15050
2524.50	14.50	0.00	0.00	0.000	0.030	77.43	0.63	0.942	3.72	15913.79	0.00	15913.79	0.00	0.00	0.00	0.00	15914
2525.00	15.00	0.00	0.00	0.000	0.029	77.37	0.65	0.946	3.74	16797.32	0.00	16797.32	0.00	0.00	0.00	0.00	16797
2525.50	15.50	0.00	0.00	0.000	0.033	76.90	0.67	0.950	3.75	17806.56	0.00	17806.56	0.00	0.00	0.00	0.00	17807
2526.00	16.00	0.00	0.00	0.000	0.032	76.91	0.70	0.954	3.77	18538.85	0.00	18538.85	0.00	0.00	0.00	0.00	18539
2526.50	16.50	0.00	0.00	0.000	0.031	76.92	0.72	0.945	3.73	19236.08	0.00	19236.08	0.00	0.00	0.00	0.00	19236
2527.00	17.00	0.00	0.00	0.000	0.030	76.94	0.74	0.950	3.75	20245.10	0.00	20245.10	0.00	0.00	0.00	0.00	20245
2527.50	17.50	0.00	0.00	0.000	0.029	76.96	0.76	0.956	3.78	21280.41	0.00	21280.41	0.00	0.00	0.00	0.00	21280
2528.00	18.00	0.00	0.00	0.000	0.028	76.99	0.78	0.962	3.80	22342.34	0.00	22342.34	0.00	0.00	0.00	0.00	22342
2528.50	18.50	0.00	0.00	0.000	0.027	77.03	0.80	0.968	3.82	23431.26	0.00	23431.26	0.00	0.00	0.00	0.00	23431
2529.00	19.00	0.00	0.00	0.000	0.027	76.87	0.83	0.974	3.86	24484.37	0.00	24484.37	0.00	0.00	0.00	0.00	24484
2529.50	19.50	0.50	0.00	0.000	0.026	76.94	0.85	0.980	3.87	25630.77	0.00	25630.77	0.00	0.00	65.71	0.00	25705
2530.00	20.00	1.00	0.00	0.000	0.025	77.02	0.87	0.983	3.88	26738.13	0.00	26738.13	0.00	0.00	185.88	0.00	26924
2530.50	20.50	1.50	0.00	0.000	0.024	77.11	0.89	0.986	3.89	27859.96	0.00	27859.96	0.00	0.00	340.85	0.00	28201
2531.00	21.00	2.00	0.00	0.000	0.022	77.20	0.91	0.989	3.90	29005.61	0.00	29005.61	0.00	0.00	524.33	0.00	29530
2531.50	21.50	2.50	0.00	0.000	0.021	77.30	0.93	0.991	3.92	30175.44	0.00	30175.44	0.00	0.00	732.17	0.00	30908
2532.00	22.00	3.00	0.00	0.000	0.020	77.41	0.96	0.994	3.93	31369.84	0.00	31369.84	0.00	0.00	961.65	0.00	32331
2532.50	22.50	3.50	0.00	0.000	0.018	77.53	0.98	0.997	3.94	32589.21	0.00	32589.21	0.00	0.00	1210.81	0.00	33800
2533.00	23.00	4.00	0.00	0.000	0.015	77.93	1.00	1.000	3.95	33954.19	0.00	33954.19	0.00	0.00	1478.08	0.00	35432
2533.50	23.50	4.50	0.00	0.000	0.014	78.04	1.02	1.003	3.96	35217.88	0.00	35217.88	0.00	0.00	1762.23	0.00	36980
2534.00	24.00	5.00	0.00	0.000	0.013	78.15	1.04	1.006	3.97	36506.49	0.00	36506.49	0.00	0.00	2062.21	0.00	38569
2534.50	24.50	5.50	0.00	0.000	0.012	78.27	1.07	1.008	3.98	37820.36	35394.52	35394.52	0.00	0.00	2377.16	0.00	37772
2535.00	25.00	6.00	0.00	0.000	0.000	80.00	1.09	1.012	4.00	39957.96	35979.58	35979.58	0.00	0.00	2706.29	0.00	38686
2535.50	25.50	6.50	0.00	0.000	0.000	80.00	1.11	1.014	4.01	41280.61	36555.30	36555.30	0.00	0.00	3048.97	0.00	39604
2536.00	26.00	7.00	0.00	0.000	0.000	80.00	1.13	1.017	4.02	42622.11	37122.09	37122.09	0.00	0.00	3404.58	0.00	40527
2536.50	26.50	7.50	0.00	0.000	0.000	80.00	1.15	1.020	4.03	43982.44	37680.34	37680.34	0.00	0.00	3772.61	0.00	41453
2537.00	27.00	8.00	0.00	0.000	0.000	80.00	1.17	1.023	4.04	45338.02	38230.45	38230.45	0.00	0.00	4152.58	0.00	42383
2537.50	27.50	8.50	0.00	0.000	0.005	79.14	1.20	1.025	4.05	46210.62	38772.75	38772.75	0.00	0.00	4544.07	0.00	43317
2538.00	28.00	9.00	0.00	0.000	0.004	79.31	1.22	1.027	4.06	47688.89	39307.58	39307.58	0.00	0.00	4946.67	0.00	44254
2538.50	28.50	9.50	0.00	0.000	0.003	79.48	1.24	1.030	4.07	49194.45	39835.22	39835.22	0.00	0.00	5360.03	35.20	45230
2539.00	29.00	10.00	0.00	0.000	0.002	79.66	1.26	1.032	4.08	50727.76	40355.96	40355.96	0.00	0.00	5783.81	288.06	46428
2539.50	29.50	10.50	0.00	0.000	0.001	79.85	1.28	1.035	4.09	52289.25	40870.07	40870.07	0.00	0.00	6217.70	669.03	47757
2540.00	30.00	11.00	0.00	0.000	0.000	80.00	1.30	1.037	4.10	53853.07	41377.79	41377.79	0.00	0.00	6661.41	1143.82	49183
2540.50	30.50	11.50	0.00	0.000	-0.001	80.00	1.33	1.040	4.11	55333.56	41879.36	41879.36	0.00	0.00	7114.67	1696.58	50691
2541.00	31.00	12.00	0.00	0.000	-0.002	80.00	1.35	1.042	4.12	56831.52	42374.99	42374.99	0.00	0.00	7577.24	2317.55	52270
2541.50	31.50	12.50	0.00	0.000	-0.003	80.00	1.37	1.044	4.13	58346.95	42864.89	42864.89	0.00	0.00	8048.86	2999.91	53914
2542.00	32.00	13.00	0.00	0.000	-0.005	80.00	1.39	1.047	4.13	59879.83	43349.26	43349.26	0.00	0.00	8529.33	3738.56	55617
2542.50	32.50	13.50	0.00	0.000	-0.006	80.00	1.41	1.049	4.14	61430.15	43828.27	43828.27	0.00	0.00	9018.42	4529.52	57376
2543.00	33.00	14.00	0.00	0.000	-0.007	80.00	1.43	1.052	4.15	62997.91	44302.10	44302.10	0.00	0.00	9515.93	5369.51	59188
2543.50	33.50	14.50	0.00	0.000	-0.008	80.00	1.46	1.054	4.16	64583.09	44770.92	44770.92	0.00	0.00	10021.68	6255.84	61048
2544.00	34.00	15.00	0.00	0.000	-0.009	80.00	1.48	1.056	4.17	66185.68	45234.88	45234.88	0.00	0.00	10535.48	7186.18	62957

RESERVOIR ELEVATION feet (NGVD)	HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW[9] OVER GATE cfs	TOTAL FLOW cfs
2510.00	0.00	0.00	0.00	0.00	0.00	0.00	0
2510.50	0.00	88.21	0.00	88.21	0.00	0.00	88
2511.00	0.00	251.03	0.00	251.03	0.00	0.00	251
2511.50	0.50	465.32	458.39	458.39	0.00	0.00	458
2512.00	1.00	722.78	561.41	561.41	0.00	0.00	561
2512.50	1.50	1018.96	648.26	648.26	0.00	0.00	648
2513.00	2.00	1356.28	724.77	724.77	0.00	0.00	725
2513.50	2.50	1716.45	783.95	783.95	0.00	0.00	784
2514.00	3.00	2105.87	857.56	857.56	0.00	0.00	858
2514.50	3.50	2526.84	916.77	916.77	0.00	0.00	917
2515.00	4.00	2976.34	972.38	972.38	0.00	0.00	972
2515.50	4.50	3453.76	1024.98	1024.98	0.00	0.00	1025
2516.00	5.00	3970.54	1075.01	1075.01	0.00	0.00	1075
2516.50	5.50	4496.68	1122.81	1122.81	0.00	0.00	1123
2517.00	6.00	5048.12	1168.66	1168.66	0.00	0.00	1169
2517.50	6.50	5624.67	1212.77	1212.77	0.00	0.00	1213
2518.00	7.00	6246.13	1255.34	1255.34	0.00	0.00	1255
2518.50	7.50	6866.33	1296.51	1296.51	0.00	0.00	1297
2519.00	8.00	7508.77	1336.41	1336.41	0.00	0.00	1336
2519.50	8.50	8195.62	1375.16	1375.16	0.00	0.00	1375
2520.00	9.00	8877.32	1412.84	1412.84	0.00	0.00	1413
2520.50	9.50	9579.50	1449.54	1449.54	0.00	0.00	1450
2521.00	10.00	10301.88	1485.34	1485.34	0.00	0.00	1485
2521.50	10.50	11029.58	1520.29	1520.29	0.00	0.00	1520
2522.00	11.00	11793.52	1554.46	1554.46	0.00	0.00	1554
2522.50	11.50	12577.64	1587.89	1587.89	0.00	0.00	1588
2523.00	12.00	13381.83	1620.64	1620.64	0.00	0.00	1621
2523.50	12.50	14205.98	1652.73	1652.73	0.00	0.00	1653
2524.00	13.00	15049.99	1684.22	1684.22	0.00	0.00	1684
2524.50	13.50	15913.79	1715.12	1715.12	0.00	0.00	1715
2525.00	14.00	16797.32	1745.48	1745.48	0.00	0.00	1745
2525.50	14.50	17806.56	1775.32	1775.32	0.00	0.00	1775
2526.00	15.00	18538.85	1804.67	1804.67	0.00	0.00	1805
2526.50	15.50	19236.08	1833.54	1833.54	0.00	0.00	1834
2527.00	16.00	20245.10	1861.97	1861.97	0.00	0.00	1862
2527.50	16.50	21280.41	1889.97	1889.97	0.00	0.00	1890
2528.00	17.00	22342.34	1917.57	1917.57	0.00	0.00	1918
2528.50	17.50	23431.26	1944.77	1944.77	0.00	0.00	1945
2529.00	18.00	24484.37	1971.58	1971.58	0.00	0.00	1972
2529.50	18.50	25630.77	1998.06	1998.06	0.00	0.00	2064
2530.00	19.00	26738.13	2024.18	2024.18	0.00	0.00	2210
2530.50	19.50	27859.96	2049.96	2049.96	0.00	0.00	2391
2531.00	20.00	29005.61	2075.43	2075.43	0.00	0.00	2600
2531.50	20.50	30175.44	2100.58	2100.58	0.00	0.00	2833
2532.00	21.00	31369.84	2125.46	2125.46	0.00	0.00	3087
2532.50	21.50	32589.21	2150.02	2150.02	0.00	0.00	3361
2533.00	22.00	33954.19	2174.31	2174.31	0.00	0.00	3652
2533.50	22.50	35217.88	2198.34	2198.34	0.00	0.00	3961
2534.00	23.00	36506.49	2222.11	2222.11	0.40	82.74	4367
2534.50	23.50	37820.36	2245.62	2245.62	0.90	211.75	4835
2535.00	24.00	39957.96	2268.89	2268.89	1.40	410.81	5386
2535.50	24.50	41280.61	2291.93	2291.93	1.90	649.50	5990
2536.00	25.00	42622.11	2314.73	2314.73	2.40	922.08	6641
2536.50	25.50	43982.44	2337.32	2337.32	2.90	1224.75	7335
2537.00	26.00	45338.02	2360.69	2360.69	3.40	1554.78	8067
2537.50	26.50	46210.62	2381.84	2381.84	3.90	1910.07	8836
2538.00	27.00	47688.89	2403.80	2403.80	4.40	2258.40	9609
2538.50	27.50	49194.45	2425.56	2425.56	4.90	2418.39	10239
2539.00	28.00	50727.76	2447.11	2447.11	5.40	2568.23	11087
2539.50	28.50	52289.25	2468.48	2468.48	5.90	2709.68	12065
2540.00	29.00	53853.07	2489.67	2489.67	6.40	2844.01	13139
2540.50	29.50	55333.56	2510.68	2510.68	6.90	2972.22	14294
2541.00	30.00	56831.52	2531.52	2531.52	7.40	3096.08	15521
2541.50	30.50	58346.95	2552.18	2552.18	7.90	3213.21	16814
2542.00	31.00	59879.83	2572.68	2572.68	8.40	3327.13	18168
2542.50	31.50	61430.15	2593.02	2593.02	8.90	3437.25	19578
2543.00	32.00	62997.91	2613.20	2613.20	9.40	3543.93	21043
2543.50	32.50	64583.09	2633.23	2633.23	9.90	3647.49	22558
2544.00	33.00	66185.68	2653.10	2653.10	10.40	3748.17	24123

RESERVOIR ELEVATION feet (NGVD)	HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW[9] OVER GATE cfs	TOTAL FLOW cfs
2510.00	0.00	0.00	0.00	0.00	0.00	0.00	0
2510.50	0.00	88.21	0.00	88.21	0.00	0.00	88
2511.00	0.00	251.03	0.00	251.03	0.00	0.00	251
2511.50	0.00	465.32	0.00	465.32	0.00	0.00	465
2512.00	0.00	722.78	0.00	722.78	0.00	0.00	723
2512.50	0.50	1018.96	0.00	1018.96	0.00	0.00	1019
2513.00	1.00	1356.28	1284.25	1284.25	0.00	0.00	1284
2513.50	1.50	1716.45	1435.84	1435.84	0.00	0.00	1436
2514.00	2.00	2105.87	1572.88	1572.88	0.00	0.00	1573
2514.50	2.50	2526.84	1698.91	1698.91	0.00	0.00	1699
2515.00	3.00	2976.34	1816.21	1816.21	0.00	0.00	1816
2515.50	3.50	3453.76	1926.38	1926.38	0.00	0.00	1926
2516.00	4.00	3970.54	2030.58	2030.58	0.00	0.00	2031
2516.50	4.50	4496.68	2129.69	2129.69	0.00	0.00	2130
2517.00	5.00	5048.12	2224.39	2224.39	0.00	0.00	2224
2517.50	5.50	5624.67	2315.22	2315.22	0.00	0.00	2315
2518.00	6.00	6246.13	2402.62	2402.62	0.00	0.00	2403
2518.50	6.50	6866.33	2486.95	2486.95	0.00	0.00	2487
2519.00	7.00	7508.77	2568.51	2568.51	0.00	0.00	2569
2519.50	7.50	8195.62	2647.56	2647.56	0.00	0.00	2648
2520.00	8.00	8877.32	2724.31	2724.31	0.00	0.00	2724
2520.50	8.50	9579.50	2798.97	2798.97	0.00	0.00	2799
2521.00	9.00	10301.88	2871.68	2871.68	0.00	0.00	2872
2521.50	9.50	11029.58	2942.80	2942.80	0.00	0.00	2943
2522.00	10.00	11793.52	3011.84	3011.84	0.00	0.00	3012
2522.50	10.50	12577.64	3079.53	3079.53	0.00	0.00	3080
2523.00	11.00	13381.83	3145.77	3145.77	0.00	0.00	3146
2523.50	11.50	14205.98	3210.83	3210.83	0.00	0.00	3211
2524.00	12.00	15049.99	3274.22	3274.22	0.00	0.00	3274
2524.50	12.50	15913.79	3336.59	3336.59	0.00	0.00	3337
2525.00	13.00	16797.32	3397.82	3397.82	0.00	0.00	3398
2525.50	13.50	17806.56	3457.98	3457.98	0.00	0.00	3458
2526.00	14.00	18538.85	3517.07	3517.07	0.00	0.00	3517
2526.50	14.50	19236.08	3575.21	3575.21	0.00	0.00	3575
2527.00	15.00	20245.10	3632.42	3632.42	0.00	0.00	3632
2527.50	15.50	21280.41	3688.74	3688.74	0.00	0.00	3689
2528.00	16.00	22342.34	3744.21	3744.21	0.00	0.00	3744
2528.50	16.50	23431.26	3798.87	3798.87	0.00	0.00	3799
2529.00	17.00	24484.37	3852.76	3852.76	0.00	0.00	3853
2529.50	17.50	25630.77	3905.91	3905.91	0.00	0.00	3972
2530.00	18.00	26738.13	3958.34	3958.34	0.00	0.00	4144
2530.50	18.50	27859.96	4010.08	4010.08	0.00	0.00	4351
2531.00	19.00	29005.61	4061.17	4061.17	0.00	0.00	4586
2531.50	19.50	30175.44	4111.62	4111.62	0.00	0.00	4844
2532.00	20.00	31369.84	4161.46	4161.46	0.00	0.00	5123
2532.50	20.50	32589.21	4210.71	4210.71	0.00	0.00	5422
2533.00	21.00	33954.19	4259.39	4259.39	0.00	0.00	5737
2533.50	21.50	35217.88	4307.52	4307.52	0.00	0.00	6070
2534.00	22.00	36506.49	4355.12	4355.12	0.00	0.00	6417
2534.50	22.50	37820.36	4402.20	4402.20	0.50	87.68	6867
2535.00	23.00	39957.96	4448.79	4448.79	1.00	248.00	7403
2535.50	23.50	41280.61	4494.89	4494.89	1.50	455.61	7999
2536.00	24.00	42622.11	4540.52	4540.52	2.00	701.45	8647
2536.50	24.50	43982.44	4585.70	4585.70	2.50	980.31	9339
2537.00	25.00	45338.02	4630.44	4630.44	3.00	1288.65	10072
2537.50	25.50	46210.62	4674.75	4674.75	3.50	1591.93	10811
2538.00	26.00	47688.89	4718.65	4718.65	4.00	1732.17	11397
2538.50	26.50	49194.45	4762.14	4762.14	4.50	1861.70	12019
2539.00	27.00	50727.76	4805.24	4805.24	5.00	1992.67	12870
2539.50	27.50	52289.25	4847.95	4847.95	5.50	2096.81	13831
2540.00	28.00	53853.07	4890.29	4890.29	6.00	2204.82	14900
2540.50	28.50	55333.56	4932.27	4932.27	6.50	2307.54	16051
2541.00	29.00	56831.52	4973.89	4973.89	7.00	2406.04	17275
2541.50	29.50	58346.95	5015.17	5015.17	7.50	2500.65	18565
2542.00	30.00	59879.83	5056.11	5056.11	8.00	2591.79	19916
2542.50	30.50	61430.15	5096.72	5096.72	8.50	2678.82	21324
2543.00	31.00	62997.91	5137.02	5137.02	9.00	2765.04	22787
2543.50	31.50	64583.09	5176.99	5176.99	9.50	2847.71	24302
2544.00	32.00	66185.68	5216.86	5216.86	10.00	2928.03	25896

NOTES:

[1] Obtained from "Design of Small Dams", Bureau of Reclamation
[2] Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 6-1
[3] Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 3-4
[4] Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 3-1
[5] Computed using Equation 6-1, "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers
[6] For transition between the weir flow to orifice flow see "Hydraulic Design of Spillway", 1965, U.S. Army Corps of Engineers
[7] Gate opening in feet, minimum distance from gate lip to crest boundary, "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Equation 6-1
[8] The maximum gate elevation is higher than the low chord of the bridge causing negligible flow between the low chord and gate. The top of gate elevation was assumed very hig
[9] Flow is minimum of weir and orifice flow

INTERBAY DAM SPILLWAY RATING CURVE

Gate Open Bats 5 85 · Dis. Coeff ' 0.685 · G_o' 5 · Top of Gate 2535.1

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW* OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	89.21	0.00	89.21	0.00	0.00	89
0.00	251.03	0.00	251.03	0.00	0.00	251
0.00	485.32	0.00	485.32	0.00	0.00	485
0.00	722.78	0.00	722.78	0.00	0.00	723
0.00	1018.96	0.00	1018.96	0.00	0.00	1019
0.00	1355.28	0.00	1355.28	0.00	0.00	1356
0.00	1716.45	0.00	1716.45	0.00	0.00	1716
0.00	2105.87	0.00	2105.87	0.00	0.00	2106
0.00	2526.84	0.00	2526.84	0.00	0.00	2527
0.00	2976.34	0.00	2976.34	0.00	0.00	2976
0.50	3453.76	0.00	3453.76	0.00	0.00	3454
1.00	3870.54	0.00	3870.54	0.00	0.00	3871
1.50	4496.68	4461.88	4461.88	0.00	0.00	4462
2.00	5048.12	4732.54	4732.54	0.00	0.00	4733
2.50	5624.67	4988.53	4988.53	0.00	0.00	4989
3.00	6246.13	5232.02	5232.02	0.00	0.00	5232
3.50	6886.33	5464.86	5464.86	0.00	0.00	5465
4.00	7508.77	5687.80	5687.80	0.00	0.00	5688
4.50	8195.62	5902.51	5902.51	0.00	0.00	5903
5.00	8877.32	6109.88	6109.88	0.00	0.00	6110
5.50	9579.50	6310.06	6310.06	0.00	0.00	6310
6.00	10301.89	6504.25	6504.25	0.00	0.00	6504
6.50	11029.58	6692.82	6692.82	0.00	0.00	6693
7.00	11793.52	6876.22	6876.22	0.00	0.00	6876
7.50	12577.64	7054.85	7054.85	0.00	0.00	7056
8.00	13381.83	7229.07	7229.07	0.00	0.00	7229
8.50	14205.98	7398.19	7398.19	0.00	0.00	7398
9.00	15049.98	7566.48	7566.48	0.00	0.00	7566
9.50	15913.79	7728.20	7728.20	0.00	0.00	7728
10.00	16797.32	7887.56	7887.56	0.00	0.00	7888
10.50	17606.56	8043.77	8043.77	0.00	0.00	8044
11.00	18538.85	8196.99	8196.99	0.00	0.00	8197
11.50	19236.08	8347.41	8347.41	0.00	0.00	8347
12.00	20245.10	8495.16	8495.16	0.00	0.00	8495
12.50	21280.41	8640.39	8640.39	0.00	0.00	8640
13.00	22342.34	8783.22	8783.22	0.00	0.00	8783
13.50	23431.26	8923.76	8923.76	0.00	0.00	8924
14.00	24484.37	9062.12	9062.12	0.00	0.00	9062
14.50	25630.77	9198.40	9198.40	0.00	0.00	9264
15.00	26738.13	9332.00	9332.00	0.00	0.00	9518
15.50	27869.86	9465.07	9465.07	0.00	0.00	9806
16.00	29005.61	9595.63	9595.63	0.00	0.00	10120
16.50	30175.44	9724.44	9724.44	0.00	0.00	10457
17.00	31380.84	9851.56	9851.56	0.00	0.00	10813
17.50	32589.21	9977.06	9977.06	0.00	0.00	11188
18.00	33854.19	10101.01	10101.01	0.00	0.00	11579
18.50	35217.89	10223.45	10223.45	0.00	0.00	11986
19.00	36506.49	10344.44	10344.44	0.00	0.00	12407
19.50	37820.36	10464.03	10464.03	0.00	0.00	12841
20.00	38957.86	10582.27	10582.27	0.00	0.00	13289
20.50	41280.61	10699.21	10699.21	0.40	62.74	13811
21.00	42622.11	10814.88	10814.88	0.90	211.75	14431
21.50	43982.44	10929.33	10929.33	1.40	280.98	14983
22.00	45338.02	11042.50	11042.50	1.90	334.63	15530
22.50	46210.62	11154.70	11154.70	2.40	380.76	16080
23.00	47686.89	11265.88	11265.88	2.90	421.87	16634
23.50	49194.45	11375.80	11375.80	3.40	459.30	17230
24.00	50727.76	11484.46	11484.46	3.90	493.90	18050
24.50	52289.25	11592.30	11592.30	4.40	526.23	19005
25.00	53853.07	11699.14	11699.14	4.90	556.68	20061
25.50	55333.56	11805.02	11805.02	5.40	585.56	21202
26.00	56831.52	11909.96	11909.96	5.90	613.07	22418
26.50	58346.95	12013.98	12013.98	6.40	639.40	23702
27.00	59879.83	12117.10	12117.10	6.90	664.68	25050
27.50	61430.15	12219.36	12219.36	7.40	689.04	26456
28.00	62997.91	12320.76	12320.76	7.90	712.57	27919
28.50	64583.09	12421.34	12421.34	8.40	735.34	29434
29.00	66185.88	12521.12	12521.12	8.90	757.43	31000

Gate Open Bats 10 89 · Dis. Coeff ' 0.725 · G_o' 10 · Top of Gate* 99999

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	89.21	0.00	89.21	0.00	0.00	89
0.00	251.03	0.00	251.03	0.00	0.00	251
0.00	485.32	0.00	485.32	0.00	0.00	485
0.00	722.78	0.00	722.78	0.00	0.00	723
0.00	1018.96	0.00	1018.96	0.00	0.00	1019
0.00	1355.28	0.00	1355.28	0.00	0.00	1355
0.00	1716.45	0.00	1716.45	0.00	0.00	1716
0.00	2105.87	0.00	2105.87	0.00	0.00	2106
0.00	2526.84	0.00	2526.84	0.00	0.00	2527
0.00	2976.34	0.00	2976.34	0.00	0.00	2976
0.00	3453.76	0.00	3453.76	0.00	0.00	3454
0.00	3870.54	0.00	3870.54	0.00	0.00	3871
0.00	4496.68	0.00	4496.68	0.00	0.00	4497
0.00	5048.12	0.00	5048.12	0.00	0.00	5048
0.00	5624.67	0.00	5624.67	0.00	0.00	5625
0.00	6246.13	0.00	6246.13	0.00	0.00	6246
0.00	6886.33	0.00	6886.33	0.00	0.00	6886
0.00	7508.77	0.00	7508.77	0.00	0.00	7509
0.00	8195.62	0.00	8195.62	0.00	0.00	8196
0.00	8877.32	0.00	8877.32	0.00	0.00	8877
0.50	9579.50	0.00	9579.50	0.00	0.00	9579
1.00	10301.89	0.00	10301.89	0.00	0.00	10302
1.50	11029.58	0.00	11029.58	0.00	0.00	11030
2.00	11793.52	0.00	11793.52	0.00	0.00	11794
2.50	12577.64	0.00	12577.64	0.00	0.00	12578
3.00	13381.83	13164.85	13164.85	0.00	0.00	13165
3.50	14205.98	13570.02	13570.02	0.00	0.00	13570
4.00	15049.98	13963.43	13963.43	0.00	0.00	13963
4.50	15913.79	14346.06	14346.06	0.00	0.00	14346
5.00	16797.32	14718.75	14718.75	0.00	0.00	14719
5.50	17606.56	15082.23	15082.23	0.00	0.00	15082
6.00	18538.85	15437.16	15437.16	0.00	0.00	15437
6.50	19236.08	15784.10	15784.10	0.00	0.00	15784
7.00	20246.10	16123.58	16123.58	0.00	0.00	16124
7.50	21280.41	16456.06	16456.06	0.00	0.00	16456
8.00	22342.34	16781.96	16781.96	0.00	0.00	16782
8.50	23431.26	17101.64	17101.64	0.00	0.00	17102
9.00	24484.37	17415.46	17415.46	0.00	0.00	17415
9.50	25630.77	17723.72	17723.72	0.00	0.00	17788
10.00	26738.13	18026.71	18026.71	0.00	0.00	18212
10.50	27869.86	18324.70	18324.70	0.00	0.00	18666
11.00	29005.61	18617.91	18617.91	0.00	0.00	19142
11.50	30175.44	18906.58	18906.58	0.00	0.00	19636
12.00	31380.84	19190.90	19190.90	0.00	0.00	20153
12.50	32589.21	19471.08	19471.08	0.00	0.00	20682
13.00	33854.19	19747.28	19747.28	0.00	0.00	21225
13.50	35217.89	20019.66	20019.66	0.00	0.00	21782
14.00	36506.49	20288.40	20288.40	0.00	0.00	22351
14.50	37820.36	20553.62	20553.62	0.00	0.00	22931
15.00	38957.86	20815.46	20815.46	0.00	0.00	23522
15.50	41280.61	21074.04	21074.04	0.00	0.00	24123
16.00	42622.11	21329.50	21329.50	0.00	0.00	24734
16.50	43982.44	21581.92	21581.92	0.00	0.00	25355
17.00	45338.02	21831.43	21831.43	0.00	0.00	25984
17.50	46210.62	22078.12	22078.12	0.00	0.00	26622
18.00	47686.89	22322.09	22322.09	0.00	0.00	27268
18.50	49194.45	22563.42	22563.42	0.00	0.00	27958
19.00	50727.76	22802.19	22802.19	0.00	0.00	28874
19.50	52289.25	23038.49	23038.49	0.00	0.00	29925
20.00	53853.07	23272.39	23272.39	0.00	0.00	31078
20.50	55333.56	23503.96	23503.96	0.00	0.00	32315
21.00	56831.52	23733.27	23733.27	0.00	0.00	33628
21.50	58346.95	23960.39	23960.39	0.00	0.00	35009
22.00	59879.83	24185.37	24185.37	0.00	0.00	36453
22.50	61430.15	24408.29	24408.29	0.00	0.00	37966
23.00	62997.91	24629.18	24629.18	0.00	0.00	39615
23.50	64583.09	24848.11	24848.11	0.00	0.00	41128
24.00	66185.88	25065.13	25065.13	0.00	0.00	42787

Gate Open Bats 15 111 · Dis. Coeff ' 0.73 · G_o' 15.1 · Top of Gate* 99999

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	89.21	0.00	89.21	0.00	0.00	89
0.00	251.03	0.00	251.03	0.00	0.00	251
0.00	485.32	0.00	485.32	0.00	0.00	485
0.00	722.78	0.00	722.78	0.00	0.00	723
0.00	1018.96	0.00	1018.96	0.00	0.00	1019
0.00	1355.28	0.00	1355.28	0.00	0.00	1356
0.00	1716.45	0.00	1716.45	0.00	0.00	1716
0.00	2105.87	0.00	2105.87	0.00	0.00	2106
0.00	2526.84	0.00	2526.84	0.00	0.00	2527
0.00	2976.34	0.00	2976.34	0.00	0.00	2976
0.00	3453.76	0.00	3453.76	0.00	0.00	3454
0.00	3870.54	0.00	3870.54	0.00	0.00	3871
0.00	4496.68	0.00	4496.68	0.00	0.00	4497
0.00	5048.12	0.00	5048.12	0.00	0.00	5048
0.00	5624.67	0.00	5624.67	0.00	0.00	5625
0.00	6246.13	0.00	6246.13	0.00	0.00	6246
0.00	6886.33	0.00	6886.33	0.00	0.00	6886
0.00	7508.77	0.00	7508.77	0.00	0.00	7509
0.00	8195.62	0.00	8195.62	0.00	0.00	8196
0.00	8877.32	0.00	8877.32	0.00	0.00	8877
0.00	9579.50	0.00	9579.50	0.00	0.00	9579
0.00	10301.89	0.00	10301.89	0.00	0.00	10302
0.00	11029.58	0.00	11029.58	0.00	0.00	11030
0.00	11793.52	0.00	11793.52	0.00	0.00	11794
0.00	12577.64	0.00	12577.64	0.00	0.00	12578
0.00	13381.83	0.00	13381.83	0.00	0.00	13382
0.00	14205.98	0.00	14205.98	0.00	0.00	14206
0.00	15049.98	0.00	15049.98	0.00	0.00	15050
0.00	15913.79	0.00	15913.79	0.00	0.00	15914
0.00	16797.32	0.00	16797.32	0.00	0.00	16797
0.50	17606.56	0.00	17606.56	0.00	0.00	17607
1.00	18538.85	0.00	18538.85	0.00	0.00	18538
1.50	19236.08	0.00	19236.08	0.00	0.00	19236
2.00	20246.10	0.00	20246.10	0.00	0.00	20246
2.50	21280.41	0.00	21280.41	0.00	0.00	21280
3.00	22342.34	0.00	22342.34	0.00	0.00	22342
3.50	23431.26	0.00	23431.26	0.00	0.00	23431
4.00	24484.37	23998.36	23998.36	0.00	0.00	23998
4.50	25630.77	24514.92	24514.92	0.00	0.00	24580
5.00	26738.13	25020.02	25020.02	0.00	0.00	25206
5.50	27869.86	25515.52	25515.52	0.00	0.00	25866
6.00	29005.61	26001.57	26001.57	0.00	0.00	26526
6.50	30175.44	26478.71	26478.71	0.00	0.00	27211
7.00	31380.84	26947.39	26947.39	0.00	0.00	27909
7.50	32589.21	27408.06	27408.06	0.00	0.00	28619
8.00	33854.19	27861.12	27861.12	0.00	0.00	29336
8.50	35217.89	28306.93	28306.93	0.00	0.00	30089
9.00	36506.49	28745.82	28745.82	0.00	0.00	30808
9.50	37820.36	29178.11	29178.11	0.00	0.00	31595
10.00	38957.86	29604.08	29604.08	0.00	0.00	32310
10.50	41280.61	30024.03	30024.03	0.00	0.00	33073
11.00	42622.11	30438.17	30438.17	0.00	0.00	33843
11.50	43982.44	30846.76	30846.76	0.00	0.00	34619
12.00	45338.02	31250.00	31250.00	0.00	0.00	35403
12.50	46210.62	31648.11	31648.11	0.00	0.00	36192
13.00	47686.89	32041.27	32041.27	0.00	0.00	36986
13.50	49194.45	32429.66	32429.66	0.00	0.00	37825
14.00	50727.76	32813.45	32813.45	0.00	0.00	38665
14.50	52289.25	33192.81	33192.81	0.00	0.00	40080
15.00	53853.07	33567.89	33567.89	0.00	0.00	41373
15.50	55333.56	33938.81	33938.81	0.00	0.00	42750
16.00	56831.52	34305.73	34305.73	0.00	0.00	44201
16.50	58346.95	34668.76	34668.76	0.00	0.00	45718
17.00	59879.83	35028.03	35028.03	0.00	0.00	47296
17.50	61430.15	35383.66	35383.66	0.00	0.00	48932
18.00	62997.91	35735.74	35735.74	0.00	0.00	50621
18.50	64583.09	36084.38	36084.38	0.00	0.00	52362
19.00	66185.88	36429.71	36429.71	0.00	0.00	54151

Gate Closed

GATE	
CREST ELEVATION	2533
LENGTH OF WEIR	80
DISCHARGE COEFF	3.1

2533

HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	86
0.00	0.00	186
0.00	0.00	341
0.00	0.00	524
0.00	0.00	732
0.00	0.00	962
0.00	0.00	1211
0.00	0.00	1478
0.50	87.68	1850
1.00	248.08	2316
1.50	455.81	2835
2.00	701.46	3408
2.50	980.31	4029
3.00	1288.65	4683
3.50	1623.80	5386
4.00	1984.50	6137
4.50	2367.38	6911
5.00	2772.72	7719
5.50	3198.86	8560
6.00	3487.77	9594
6.50	3668.72	10555
7.00	3840.99	11646
7.50	4005.74	12817
8.00	4163.89	14059
8.50	4316.19	15365
9.00	4463.24	16731
9.50	4605.56	18153
10.00	4743.58	19629
10.50	4877.67	21155
11.00	5008.14	27730

Exhibit 3
Sheet 2 of 3

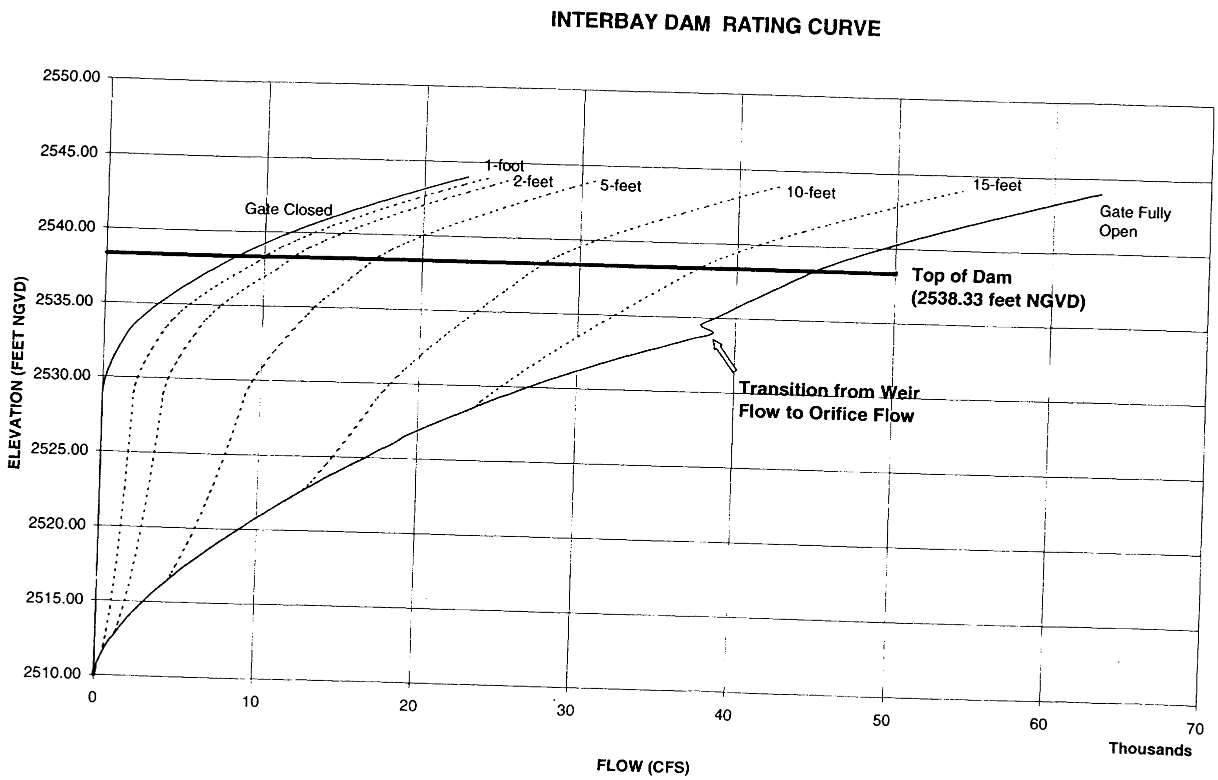


EXHIBIT 3
Sheet 3 of 3

Exhibit 4. Spillway Rating Curve Calculations for Ralston Afterbay Dam

Ralston Afterbay Dam Rating Curve

TAINTER GATE

DESIGN HEAD	34	feet	WEIR BOTTOM	1109	feet(ngvd)		GATE	DAM	PIERS	
CREST ELEVATION	1149	feet(ngvd)	WEIR HEIGHT	40	feet	CREST ELEVATION	1193.9	1189	1192	feet(ngvd)
CREST LENGTH	200	feet	U/S FACE SLOPE	0		LENGTH OF WEIR	200	360	32	feet
GATE OPENING	29.6	feet	P/H_o	1.176470588		DISCHARGE COEFF.	3.1	3.1		
ABUTMENT RADIUS	4	feet	C_o[1]	3.9		CREST SLOPE %				
NUMBER OF BAYS	5		U/S FACE SLOPE CORREC.	1	G_o'		1193.9			

Case 1: Gate Open 1, Beta 71, Dis. Coeff.[2] 0.68, G_o[7] 1.5, Top of Gate 1180.4

Case 2: Gate Open 2, Beta 66, Dis. Coeff.[2] 0.68, G_o[7] 2.5, Top of Gate 1181.2

RESERVOIR ELEVATION feet (NGVD)	HEAD OVER CREST feet	HEAD OVER GATE feet	He/R	Ka[3]	Kp[4]	EFFECTIVE CREST LENGTH feet	H_e/H_o	C/C_o[1]	C_{wam}
1149.00	0.00	0.00	0.00	0.000	0.080	200.00	0.00	0.800	3.12
1150.00	1.00	0.00	0.25	0.006	0.080	199.35	0.03	0.800	3.12
1151.00	2.00	0.00	0.50	0.011	0.080	198.68	0.06	0.804	3.13
1152.00	3.00	0.00	0.75	0.017	0.080	197.98	0.09	0.815	3.18
1153.00	4.00	0.00	1.00	0.023	0.080	197.26	0.12	0.827	3.23
1154.00	5.00	0.00	1.25	0.028	0.080	196.52	0.15	0.839	3.27
1155.00	6.00	0.00	1.50	0.034	0.080	195.76	0.18	0.847	3.30
1156.00	7.00	0.00	1.75	0.039	0.079	195.02	0.21	0.855	3.33
1157.00	8.00	0.00	2.00	0.045	0.075	194.50	0.24	0.863	3.36
1158.00	9.00	0.00	2.25	0.048	0.070	194.06	0.26	0.871	3.40
1159.00	10.00	0.00	2.50	0.053	0.066	193.68	0.29	0.878	3.43
1160.00	11.00	0.00	2.75	0.056	0.061	193.35	0.32	0.885	3.45
1161.00	12.00	0.00	3.00	0.060	0.057	193.08	0.35	0.891	3.47
1162.00	13.00	0.00	3.25	0.064	0.053	192.87	0.38	0.896	3.50
1163.00	14.00	0.00	3.50	0.068	0.049	192.67	0.41	0.902	3.52
1164.00	15.00	0.00	3.75	0.071	0.045	192.48	0.44	0.908	3.54
1165.00	16.00	0.00	4.00	0.075	0.041	192.33	0.47	0.914	3.57
1166.00	17.00	0.00	4.25	0.077	0.038	192.29	0.50	0.920	3.59
1167.00	18.00	0.00	4.50	0.079	0.034	192.29	0.53	0.925	3.61
1168.00	19.00	0.00	4.75	0.081	0.030	192.35	0.56	0.930	3.63
1169.00	20.00	0.00	5.00	0.083	0.026	192.46	0.59	0.935	3.65
1170.00	21.00	0.00	5.25	0.084	0.024	192.44	0.62	0.940	3.67
1171.00	22.00	0.00	5.50	0.086	0.022	192.32	0.65	0.945	3.69
1172.00	23.00	0.00	5.75	0.088	0.020	192.23	0.68	0.950	3.71
1173.00	24.00	0.00	6.00	0.090	0.018	192.15	0.71	0.955	3.73
1174.00	25.00	0.00	6.25	0.091	0.017	192.13	0.74	0.960	3.75
1175.00	26.00	0.00	6.50	0.093	0.015	192.13	0.76	0.965	3.76
1176.00	27.00	0.00	6.75	0.094	0.013	192.16	0.79	0.970	3.78
1177.00	28.00	0.00	7.00	0.095	0.011	192.21	0.82	0.975	3.80
1178.00	29.00	0.00	7.25	0.096	0.009	192.29	0.85	0.980	3.82
1179.00	30.00	0.40	7.50	0.098	0.007	192.39	0.88	0.984	3.84
1180.00	31.00	1.40	7.75	0.099	0.006	192.51	0.91	0.988	3.85
1181.00	32.00	2.40	8.00	0.100	0.004	192.66	0.94	0.992	3.87
1182.00	33.00	3.40	8.25	0.100	0.002	192.91	0.97	0.996	3.88
1183.00	34.00	4.40	8.50	0.100	0.000	193.20	1.00	1.000	3.90
1184.00	35.00	5.40	8.75	0.100	0.000	193.07	1.03	1.004	3.92
1185.00	36.00	6.40	9.00	0.100	0.000	192.94	1.06	1.008	3.93
1186.00	37.00	7.40	9.25	0.100	-0.001	192.82	1.09	1.012	3.95
1187.00	38.00	8.40	9.50	0.100	-0.001	192.70	1.12	1.016	3.96
1188.00	39.00	9.40	9.75	0.100	-0.001	192.58	1.15	1.020	3.98
1189.00	40.00	10.40	10.00	0.100	-0.001	192.47	1.18	1.023	3.99
1190.00	41.00	11.40	10.25	0.100	-0.002	192.36	1.21	1.026	4.00
1191.00	42.00	12.40	10.50	0.100	-0.002	192.26	1.24	1.029	4.01
1192.00	43.00	13.40	10.75	0.100	-0.002	192.16	1.26	1.033	4.03
1193.00	44.00	14.40	11.00	0.100	-0.002	192.06	1.29	1.036	4.04
1194.00	45.00	15.40	11.25	0.100	-0.003	191.97	1.32	1.039	4.05
1195.00	46.00	16.40	11.50	0.100	-0.003	191.88	1.35	1.043	4.07
1196.00	47.00	17.40	11.75	0.100	-0.003	191.80	1.38	1.046	4.08
1197.00	48.00	18.40	12.00	0.100	-0.003	191.72	1.41	1.049	4.09
1198.00	49.00	19.40	12.25	0.100	-0.004	191.64	1.44	1.052	4.10
1199.00	50.00	20.40	12.50	0.100	-0.004	191.57	1.47	1.056	4.12
1200.00	51.00	21.40	12.75	0.100	-0.004	191.50	1.50	1.059	4.13
1201.00	52.00	22.40	13.00	0.100	-0.004	191.44	1.53	1.062	4.14
1202.00	53.00	23.40	13.25	0.100	-0.005	191.37	1.56	1.065	4.16
1203.00	54.00	24.40	13.50	0.100	-0.005	191.32	1.59	1.069	4.17
1204.00	55.00	25.40	13.75	0.100	-0.005	191.26	1.62	1.072	4.18

RESERVOIR ELEVATION feet (NGVD)	WEIR FLOW cfs	30.5 ORIFICE[5,6] FLOW cfs	GATE FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	FLOW OVER DAM cfs	FLOW OVER PIERS cfs	TOTAL FLOW cfs
1149.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1150.00	621.97	0.00	621.97	0.00	0.00	0.00	0.00	622
1151.00	1760.98	0.00	1760.98	0.00	0.00	0.00	0.00	1761
1152.00	3270.99	0.00	3270.99	0.00	0.00	0.00	0.00	3271
1153.00	5090.14	0.00	5090.14	0.00	0.00	0.00	0.00	5090
1154.00	7191.13	0.00	7191.13	0.00	0.00	0.00	0.00	7191
1155.00	9504.25	0.00	9504.25	0.00	0.00	0.00	0.00	9504
1156.00	12042.12	0.00	12042.12	0.00	0.00	0.00	0.00	12042
1157.00	14808.09	0.00	14808.09	0.00	0.00	0.00	0.00	14808
1158.00	17790.17	0.00	17790.17	0.00	0.00	0.00	0.00	17790
1159.00	20982.44	0.00	20982.44	0.00	0.00	0.00	0.00	20982
1160.00	24339.05	0.00	24339.05	0.00	0.00	0.00	0.00	24339
1161.00	27877.64	0.00	27877.64	0.00	0.00	0.00	0.00	27878
1162.00	31606.33	0.00	31606.33	0.00	0.00	0.00	0.00	31606
1163.00	35518.76	0.00	35518.76	0.00	0.00	0.00	0.00	35519
1164.00	39608.26	0.00	39608.26	0.00	0.00	0.00	0.00	39608
1165.00	43882.60	0.00	43882.60	0.00	0.00	0.00	0.00	43883
1166.00	48358.64	0.00	48358.64	0.00	0.00	0.00	0.00	48359
1167.00	52978.72	0.00	52978.72	0.00	0.00	0.00	0.00	52979
1168.00	57785.41	0.00	57785.41	0.00	0.00	0.00	0.00	57785
1169.00	62781.38	0.00	62781.38	0.00	0.00	0.00	0.00	62781
1170.00	67904.39	0.00	67904.39	0.00	0.00	0.00	0.00	67904
1171.00	73157.26	0.00	73157.26	0.00	0.00	0.00	0.00	73157
1172.00	78579.01	0.00	78579.01	0.00	0.00	0.00	0.00	78579
1173.00	84170.57	0.00	84170.57	0.00	0.00	0.00	0.00	84171
1174.00	89947.70	0.00	89947.70	0.00	0.00	0.00	0.00	89948
1175.00	95900.29	0.00	95900.29	0.00	0.00	0.00	0.00	95900
1176.00	102030.20	0.00	102030.20	0.00	0.00	0.00	0.00	102030
1177.00	108339.48	0.00	108339.48	0.00	0.00	0.00	0.00	108339
1178.00	114817.26	0.00	114817.26	0.00	0.00	0.00	0.00	114817
1179.00	121353.39	0.00	121353.39	0.00	0.00	0.00	0.00	121353
1180.00	128062.06	0.00	128062.06	0.00	0.00	0.00	0.00	128062
1181.00	134945.63	0.00	134945.63	0.00	0.00	0.00	0.00	134946
1182.00	142067.39	0.00	142067.39	0.00	0.00	0.00	0.00	142067
1183.00	149379.19	0.00	149379.19	0.00	0.00	0.00	0.00	149379
1184.00	156523.00	0.00	156523.00	0.00	0.00	0.00	0.00	156523
1185.00	163808.42	0.00	163808.42	0.00	0.00	0.00	0.00	163808
1186.00	171235.38	0.00	171235.38	0.00	0.00	0.00	0.00	171235
1187.00	178803.86	172123.28	172123.28	0.00	0.00	0.00	0.00	172123
1188.00	186525.84	175793.70	175793.70	0.00	0.00	0.00	0.00	175794
1189.00	194253.85	179389.04	179389.04	0.00	0.00	0.00	0.00	179389
1190.00	202114.39	182913.72	182913.72	0.00	0.00	1116.00	0.00	184030
1191.00	210107.48	186371.75	186371.75	0.00	0.00	3156.52	0.00	189528
1192.00	218233.17	189766.78	189766.78	0.00	0.00	5798.91	0.00	195566
1193.00	226491.54	193102.13	193102.13	0.00	0.00	8928.00	106.56	202137
1194.00	234882.73	196380.83	196380.83	0.10	19.61	12477.26	234.24	209112
1195.00	243406.89	199605.69	199605.69	1.10	715.29	16401.78	383.04	217106
1196.00	252064.25	202779.27	202779.27	2.10	1886.78	20668.61	552.96	225888
1197.00	260855.03	205903.95	205903.95	3.10	3384.03	25252.20	744.00	235284
1198.00	269779.52	208981.90	208981.90	4.10	5147.16	30132.00	1457.94	245719
1199.00	278838.02	212015.18	212015.18	5.10	7140.80	35291.02	1837.21	256284
1200.00	288030.87	215005.67	215005.67	6.10	9340.85	40714.89	2244.64	267306
1201.00	297358.46	217955.13	217955.13	7.10	11729.49	46391.25	2678.40	278754
1202.00	306821.17	220865.21	220865.21	8.10	14292.86	52308.34	3136.98	290604
1203.00	316419.45	223737.44	223737.44	9.10	17019.77	58458.66	3619.10	302836
1204.00	326153.75	226573.26	226573.26	10.10	19900.85	64833.74	4123.67	315432

RESERVOIR ELEVATION feet (NGVD)	Gate Open 1: HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs	Gate Open 2: HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
1149.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0
1150.00	0.00	621.97	0.00	621.97	0.00	0.00	622	0.00	621.97	0.00	621.97	0.00	0.00	622
1151.00	1.00	1760.98	2005.02	2005.02	0.00	0.00	2005	0.00	1760.98	0.00	1760.98	0.00	0.00	1761
1152.00	2.00	3270.99	2588.47	2588.47	0.00	0.00	2588	1.00	3270.99	3858.66	3858.66	0.00	0.00	3859
1153.00	3.00	5090.14	3062.72	3062.72	0.00	0.00	3063	2.00	5090.14	4725.88	4725.88	0.00	0.00	4726
1154.00	4.00	7191.13	3472.80	3472.80	0.00	0.00	3473	3.00	7191.13	5456.97	5456.97	0.00	0.00	5457
1155.00	5.00	9504.25	3839.32	3839.32	0.00	0.00	3839	4.00	9504.25	6101.08	6101.08	0.00	0.00	6101
1156.00	6.00	12042.12	4173.78	4173.78	0.00	0.00	4174	5.00	12042.12	6683.40	6683.40	0.00	0.00	6683
1157.00	7.00	14808.09	4483.36	4483.36	0.00	0.00	4483	6.00	14808.09	7218.90	7218.90	0.00	0.00	7219
1158.00	8.00	17790.17	4772.90	4772.90	0.00	0.00	4773	7.00	17790.17	7717.33	7717.33	0.00	0.00	7717
1159.00	9.00	20982.44	5045.86	5045.86	0.00	0.00	5046	8.00	20982.44	8185.46	8185.46	0.00	0.00	8185
1160.00	10.00	24339.05	5304.78	5304.78	0.00	0.00	5305	9.00	24339.05	8628.23	8628.23	0.00	0.00	8628
1161.00	11.00	27877.64	5551.65	5551.65	0.00	0.00	5552	10.00	27877.64	9049.37	9049.37	0.00	0.00	9049
1162.00	12.00	31606.33	5787.99	5787.99	0.00	0.00	5788	11.00	31606.33	9451.76	9451.76	0.00	0.00	9452
1163.00	13.00	35518.76	6015.06	6015.06	0.00	0.00	6015	12.00	35518.76	9837.70	9837.70	0.00	0.00	9838
1164.00	14.00	39608.26	6233.86	6233.86	0.00	0.00	6234	13.00	39608.26	10209.06	10209.06	0.00	0.00	10209
1165.00	15.00	43882.60	6445.24	6445.24	0.00	0.00	6445	14.00	43882.60	10567.38	10567.38	0.00	0.00	10567
1166.00	16.00	48358.64	6649.90	6649.90	0.00	0.00	6650	15.00	48358.64	10913.95	10913.95	0.00	0.00	10914
1167.00	17.00	52978.72	6848.45	6848.45	0.00	0.00	6848	16.00	52978.72	11249.84	11249.84	0.00	0.00	11250
1168.00	18.00	57785.41	7041.40	7041.40	0.00	0.00	7041	17.00	57785.41	11575.99	11575.99	0.00	0.00	11576
1169.00	19.00	62781.38	7229.20	7229.20	0.00	0.00	7229	18.00	62781.38	11893.20	11893.20	0.00	0.00	11893
1170.00	20.00	67904.39	7412.25	7412.25	0.00	0.00	7412	19.00	67904.39	12202.16	12202.16	0.00	0.00	12202
1171.00	21.00	73157.26	7590.88	7590.88	0.00	0.00	7591	20.00	73157.26	12503.50	12503.50	0.00	0.00	12503
1172.00	22.00	78579.01	7765.41	7765.41	0.00	0.00	7765	21.00	78579.01	12797.74	12797.74	0.00	0.00	12798
1173.00	23.00	84170.57	7936.10	7936.10	0.00	0.00	7936	22.00	84170.57	13085.36	13085.36	0.00	0.00	13085
1174.00	24.00	89947.70	8103.19	8103.19	0.00	0.00	8103	23.00	89947.70	13366.80	13366.80	0.00	0.00	13367
1175.00	25.00	95900.29	8266.91	8266.91	0.00	0.00	8267	24.00	95900.29	13642.43	13642.43	0.00	0.00	13642
1176.00	26.00	102030.20	8427.45	8427.45	0.00	0.00	8427	25.00	102030.20	13912.61	13912.61	0.00	0.00	13913
1177.00	27.00	108339.48	8584.98	8584.98	0.00	0.00	8585	26.00	108339.48	14177.63	14177.63	0.00	0.00	14178
1178.00	28.00	114817.26	8739.68	8739.68	0.00	0.00	8740	27.00	114817.26	14437.79	14437.79	0.00	0.00	14438
1179.00	29.00	121353.39	8891.69	8891.69	0.00	0.00	8892	28.00	121353.39	14693.35	14693.35	0.00	0.00	14693
1180.00	30.00	128062.06	9041.14	9041.14	0.00	0.00	9041	29.00	128062.06	14944.54	14944.54	0.00	0.00	14945
1181.00	31.00	134945.63	9188.16	9188.16	0.60	288.15	9476	30.00	134945.63	15191.57	15191.57	0.00	0.00	15192
1182.00	32.00	142067.39	9332.86	9332.86	1.60	1254.79	10588	31.00	142067.39	15434.65	15434.65	0.80	443.64	15878
1183.00	33.00	149379.19	9475.36	9475.36	2.60	2599.27	12075	32.00	149379.19	15673.96	15673.96	1.80	1497.27	17171
1184.00	34.00	156523.00	9615.74	9615.74	3.60	4234.92	13851	33.00	156523.00	15909.68	15909.68	2.80	2904.88	18815
1185.00	35.00	163808.42	9754.10	9754.10	4.60	6116.86	15871	34.00	163808.42	16141.95	16141.95	3.80	4592.69	20735
1186.00	36.00	171235.38	9890.53	9890.53	5.60	8216.25	18107	35.00	171235.38	16370.92	16370.92	4.80	6520.09	22891
1187.00	37.00	178803.86	10025.10	10025.10	6.60	10512.54	20538	36.00	178803.86	16596.74	16596.74	5.80	8660.31	25257
1188.00	38.00	186525.84	10157.89	10157.89	7.60	12990.09	23148	37.00	186525.84	16819.52	16819.52	6.80	10993.98	27814
1189.00	39.00	194253.85	10288.96	10288.96	8.60	15636.49	25925	38.00	194253.85	17039.39	17039.39	7.80	12406.44	29446
1190.00	40.00	202114.39	10418.39	10418.39	9.60	17885.38	29420	39.00	202114.39	17256.47	17256.47	8.80	13891.14	32364
1191.00	41.00	210107.48	10546.23	10546.23	10.60	20123.92	33827	40.00	210107.48	17470.84	17470.84	9.80	16023.43	36651
1192.00	42.00	218233.17	10672.53	10672.53	11.60	22632.97	39104	41.00	218233.17	17682.62	17682.62	10.80	18336.14	41818
1193.00	43.00	226491.54	10797.36	10797.36	12.60	25358.65	45191	42.00	226491.54	17891.88	17891.88	11.80	20874.05	47800
1194.00	44.00	234882.73	10920.77	10920.77	13.60	28271.62	51904	43.00	234882.73	18098.73	18098.73	12.80	23606.82	54417
1195.00	45.00	243406.89	11042.79	11042.79	14.60	31352.91	59181	44.00	243406.89	18303.25	18303.25	13.80	26514.62	61803
1196.00	46.00	252064.25	11163.48	11163.48	15.60	34580.00	66974	45.00	252064.25	18505.50	18505.50	14.80	29583.21	69310
1197.00	47.00	260855.03	11282.88	11282.88	16.60	37969.57	75249	46.00	260855.03	18705.56	18705.56	15.80	32801.73	77503
1198.00	48.00	269779.52	11401.03	11401.03	17.60	41486.45	84477	47.00	269779.52	18903.51	18903.51	16.80	36161.47	86655
1199.00	49.00	278838.02	11517.96	11517.96	18.60	45132.88	93779	48.00	278838.02	19099.41	19099.41	17.80	39655.29	95883
1200.00	50.00	288030.87	11633.72	11633.72	19.60	48903.20	103496	49.00	288030.87	19293.31	19293.31	18.80	43277.12	105530
1201.00	51.00	297358.46	11748.35	11748.35	20.60	52792.50	113610	50.00	297358.46	19485.29	19485.29	19.80	47021.76	115577
1202.00	52.00	306821.17	11861.86	11861.86	21.60	56796.51	124105	51.00	306821.17	19675.40	19675.40	20.80	50884.65	126006
1203.00	53.00	316419.45	11974.30	11974.30	22.60	60911.45	134965	52.00	316419.45	19863.68	19863.68	21.80	54861.76	136804
1204.00	54.00	326153.75	12085.69	12085.69	23.60	65133.92	146177	53.00	326153.75	20050.20	20050.20	22.80	58949.47	147957

NOTES:

1 Obtained from "Design of Small Dams", Bureau of Reclamation

2 Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 6-

3 Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 3-

4 Obtained from "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Plate 3-

5 Computed using Equation 6-1, "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers

6 For transition between the weir flow to orifice flow see "Hydraulic Design of Spillway", 1965, U.S. Army Corps of Engineers

7 Gate opening in feet, minimum distance from gate lip to crest boundary, "Hydraulic Design of Spillways", 1990, U.S. Army Corps of Engineers, Equation 6-1

Ralston Afterbay Dam Rating Curve

Gate Closed

	GATE
CREST ELEVATION	1179
LENGTH OF WEIR	200
DISCHARGE COEFF	3.1

Gate Open Beta: 5 | 74 — Dis. Coeff.[6] 0.68 — G_s[7] 5.2 — Top of Gate 1183.5

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	621.97	0.00	621.97	0.00	0.00	622
0.00	1760.98	0.00	1760.98	0.00	0.00	1761
0.00	3270.99	0.00	3270.99	0.00	0.00	3271
0.00	5090.14	0.00	5090.14	0.00	0.00	5090
0.00	7191.13	0.00	7191.13	0.00	0.00	7191
1.00	9504.25	0.00	9504.25	0.00	0.00	9504
2.00	12042.12	12039.03	12039.03	0.00	0.00	12039
3.00	14808.09	13309.65	13309.65	0.00	0.00	13310
4.00	17790.17	14469.11	14469.11	0.00	0.00	14469
5.00	20982.44	15542.32	15542.32	0.00	0.00	15542
6.00	24339.05	16546.06	16546.06	0.00	0.00	16546
7.00	27877.64	17492.30	17492.30	0.00	0.00	17492
8.00	31606.33	18389.92	18389.92	0.00	0.00	18390
9.00	35518.76	19245.72	19245.72	0.00	0.00	19246
10.00	39608.26	20065.05	20065.05	0.00	0.00	20065
11.00	43882.80	20852.21	20852.21	0.00	0.00	20852
12.00	48358.64	21610.72	21610.72	0.00	0.00	21611
13.00	52978.72	22343.49	22343.49	0.00	0.00	22343
14.00	57785.41	23052.98	23052.98	0.00	0.00	23053
15.00	62781.38	23741.28	23741.28	0.00	0.00	23741
16.00	67904.39	24410.18	24410.18	0.00	0.00	24410
17.00	73157.26	25061.24	25061.24	0.00	0.00	25061
18.00	78579.01	25695.80	25695.80	0.00	0.00	25696
19.00	84170.57	26315.06	26315.06	0.00	0.00	26315
20.00	89947.70	26920.09	26920.09	0.00	0.00	26920
21.00	95600.29	27511.81	27511.81	0.00	0.00	27512
22.00	102030.20	28091.07	28091.07	0.00	0.00	28091
23.00	108339.48	28658.62	28658.62	0.00	0.00	28659
24.00	114817.26	29215.15	29215.15	0.00	0.00	29215
25.00	121353.39	29761.27	29761.27	0.00	0.00	29761
26.00	128062.06	30297.56	30297.56	0.00	0.00	30298
27.00	134945.63	30824.51	30824.51	0.00	0.00	30825
28.00	142067.39	31342.61	31342.61	0.00	0.00	31343
29.00	149379.19	31852.28	31852.28	0.00	0.00	31852
30.00	156523.00	32353.92	32353.92	0.50	219.20	32573
31.00	163808.42	32847.90	32847.90	1.50	1139.01	33987
32.00	171235.38	33334.56	33334.56	2.50	1857.85	35192
33.00	178803.86	33814.22	33814.22	3.50	2258.13	36073
34.00	186525.84	34287.17	34287.17	4.50	2598.86	36886
35.00	194253.85	34753.68	34753.68	5.50	2898.92	37653
36.00	202114.39	35214.02	35214.02	6.50	3790.66	40121
37.00	210107.48	35668.41	35668.41	7.50	5174.48	43999
38.00	218233.17	36117.09	36117.09	8.50	6875.55	48792
39.00	226491.54	36560.26	36560.26	9.50	8833.01	54428
40.00	234882.73	36998.12	36998.12	10.50	11012.14	60722
41.00	243406.88	37430.86	37430.86	11.50	13389.71	67605
42.00	252064.25	37858.66	37858.66	12.50	15948.74	75029
43.00	260855.03	38281.67	38281.67	13.50	18676.10	82954
44.00	269779.52	38700.06	38700.06	14.50	21561.23	91851
45.00	278838.02	39113.98	39113.98	15.50	24595.41	100838
46.00	288030.87	39523.56	39523.56	16.50	27771.25	110254
47.00	297358.46	39928.94	39928.94	17.50	31082.38	120081
48.00	306821.17	40330.25	40330.25	18.50	34523.27	130300
49.00	316419.45	40727.60	40727.60	19.50	38088.99	140895
50.00	326153.75	41121.11	41121.11	20.50	41775.18	151854

Gate Open Beta: 10 | 84 — Dis. Coeff.[6] 0.695 — G_s[7] 10 — Top of Gate 1186.8

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	621.97	0.00	621.97	0.00	0.00	622
0.00	1760.98	0.00	1760.98	0.00	0.00	1761
0.00	3270.99	0.00	3270.99	0.00	0.00	3271
0.00	5090.14	0.00	5090.14	0.00	0.00	5090
0.00	7191.13	0.00	7191.13	0.00	0.00	7191
0.00	9504.25	0.00	9504.25	0.00	0.00	9504
0.00	12042.12	0.00	12042.12	0.00	0.00	12042
0.00	14808.09	0.00	14808.09	0.00	0.00	14808
0.00	17790.17	0.00	17790.17	0.00	0.00	17790
0.00	20982.44	0.00	20982.44	0.00	0.00	20982
1.00	24339.05	0.00	24339.05	0.00	0.00	24339
2.00	27877.64	0.00	27877.64	0.00	0.00	27878
3.00	31606.33	31550.24	31550.24	0.00	0.00	31550
4.00	35518.76	33464.09	33464.09	0.00	0.00	33464
5.00	39608.26	35274.25	35274.25	0.00	0.00	35274
6.00	43882.80	36995.94	36995.94	0.00	0.00	36996
7.00	48358.64	38641.00	38641.00	0.00	0.00	38641
8.00	52978.72	40218.83	40218.83	0.00	0.00	40219
9.00	57785.41	41737.05	41737.05	0.00	0.00	41737
10.00	62781.38	43201.95	43201.95	0.00	0.00	43202
11.00	67904.39	44618.78	44618.78	0.00	0.00	44619
12.00	73157.26	45991.99	45991.99	0.00	0.00	45992
13.00	78579.01	47325.37	47325.37	0.00	0.00	47325
14.00	84170.57	48622.19	48622.19	0.00	0.00	48622
15.00	89947.70	49885.32	49885.32	0.00	0.00	49885
16.00	95600.29	51117.24	51117.24	0.00	0.00	51117
17.00	102030.20	52320.16	52320.16	0.00	0.00	52320
18.00	108339.48	53486.04	53486.04	0.00	0.00	53486
19.00	114817.26	54646.63	54646.63	0.00	0.00	54647
20.00	121353.39	55773.48	55773.48	0.00	0.00	55773
21.00	128062.06	56878.01	56878.01	0.00	0.00	56878
22.00	134945.63	57961.50	57961.50	0.00	0.00	57961
23.00	142067.39	59025.10	59025.10	0.00	0.00	59025
24.00	149379.19	60069.88	60069.88	0.00	0.00	60070
25.00	156523.00	61096.79	61096.79	0.00	0.00	61097
26.00	163808.42	62106.72	62106.72	0.00	0.00	62107
27.00	171235.38	63100.49	63100.49	0.00	0.00	63100
28.00	178803.86	64078.85	64078.85	0.20	0.00	64079
29.00	186525.84	65042.50	65042.50	1.20	0.00	65042
30.00	194253.85	65992.07	65992.07	2.20	0.00	65992
31.00	202114.39	66928.18	66928.18	3.20	620.00	68664
32.00	210107.48	67851.37	67851.37	4.20	1753.62	72762
33.00	218233.17	68762.16	68762.16	5.20	3221.61	77783
34.00	226491.54	69661.05	69661.05	6.20	4960.00	83656
35.00	234882.73	70548.49	70548.49	7.20	6931.81	90192
36.00	243406.88	71424.90	71424.90	8.20	9112.10	97322
37.00	252064.25	72290.69	72290.69	9.20	11482.56	104995
38.00	260855.03	73146.23	73146.23	10.20	14029.00	113171
39.00	269779.52	73991.88	73991.88	11.20	16740.00	122322
40.00	278838.02	74827.97	74827.97	12.20	19606.12	131562
41.00	288030.87	75654.83	75654.83	13.20	22619.38	141234
42.00	297358.46	76472.74	76472.74	14.20	25772.82	151315
43.00	306821.17	77282.00	77282.00	15.20	29080.74	161810
44.00	316419.45	78082.87	78082.87	16.20	32477.58	172639
45.00	326153.75	78875.61	78875.61	17.20	36018.75	183862

Gate Open Beta: 15 | 89 — Dis. Coeff.[6] 0.702 — G_s[7] 15.1 — Top of Gate 1189.6

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	621.97	0.00	621.97	0.00	0.00	622
0.00	1760.98	0.00	1760.98	0.00	0.00	1761
0.00	3270.99	0.00	3270.99	0.00	0.00	3271
0.00	5090.14	0.00	5090.14	0.00	0.00	5090
0.00	7191.13	0.00	7191.13	0.00	0.00	7191
0.00	9504.25	0.00	9504.25	0.00	0.00	9504
0.00	12042.12	0.00	12042.12	0.00	0.00	12042
0.00	14808.09	0.00	14808.09	0.00	0.00	14808
0.00	17790.17	0.00	17790.17	0.00	0.00	17790
0.00	20982.44	0.00	20982.44	0.00	0.00	20982
0.00	24339.05	0.00	24339.05	0.00	0.00	24339
0.00	27877.64	0.00	27877.64	0.00	0.00	27878
0.00	31606.33	0.00	31606.33	0.00	0.00	31606
0.00	35518.76	0.00	35518.76	0.00	0.00	35519
0.00	39608.26	0.00	39608.26	0.00	0.00	39608
1.00	43882.80	0.00	43882.80	0.00	0.00	43883
2.00	48358.64	0.00	48358.64	0.00	0.00	48359
3.00	52978.72	0.00	52978.72	0.00	0.00	52979
4.00	57785.41	57894.70	57894.70	0.00	0.00	57895
5.00	62781.38	60150.88	60150.88	0.00	0.00	60151
6.00	67904.39	62510.63	62510.63	0.00	0.00	62511
7.00	73157.26	64784.48	64784.48	0.00	0.00	64784
8.00	78579.01	66981.19	66981.19	0.00	0.00	66981
9.00	84170.57	69108.10	69108.10	0.00	0.00	69108
10.00	89947.70	71171.48	71171.48	0.00	0.00	71171
11.00	95600.29	73176.71	73176.71	0.00	0.00	73177
12.00	102030.20	75128.43	75128.43	0.00	0.00	75128
13.00	108339.48	77030.71	77030.71	0.00	0.00	77031
14.00	114817.26	78887.14	78887.14	0.00	0.00	78887
15.00	121353.39	80700.88	80700.88	0.00	0.00	80701
16.00	128062.06	82474.73	82474.73	0.00	0.00	82475
17.00	134945.63	84211.23	84211.23	0.00	0.00	84211
18.00	142067.39	85912.64	85912.64	0.00	0.00	85913
19.00	149379.19	87581.01	87581.01	0.00	0.00	87581
20.00	156523.00	89218.18	89218.18	0.00	0.00	89218
21.00	163808.42	90825.84	90825.84	0.00	0.00	90826
22.00	171235.38	92405.54	92405.54	0.00	0.00	92406
23.00	178803.86	93958.68	93958.68	0.00	0.00	93959
24.00	186525.84	95486.56	95486.56	0.00	0.00	95487
25.00	194253.85	96990.36	96990.36	0.00	0.00	96990
26.00	202114.39	98471.24	98471.24	0.40	156.85	99744
27.00	210107.48	99930.15	99930.15	1.40	1027.03	104114
28.00	218233.17	101368.07	101368.07	2.40	2305.20	109472
29.00	226491.54	102785.87	102785.87	3.40	3866.96	115707
30.00	234882.73	104184.38	104184.38	4.40	5722.30	122618
31.00	243406.88	105564.37	105564.37	5.40	7780.05	130129
32.00	252064.25	106926.55	106926.55	6.40	10036.33	138186
33.00	260855.03	108271.59	108271.59	7.40	12480.71	146748
34.00	269779.52	109600.12	109600.12	8.40	15094.22	156284
35.00	278838.02	110912.74	110912.74	9.40	17868.31	165909
36.00	288030.87	112210.01	112210.01	10.40	20794.18	175963
37.00	297358.46	113492.46	113492.46	11.40	23864.31	186426
38.00	306821.17	114760.57	114760.57	12.40	27072.24	197279
39.00	316419.45	116014.82	116014.82	13.40	30412.27	208505
40.00	326153.75	117255.65	117255.65	14.40	33879.36	220092

Gate Open Beta: 20 | 98 — Dis. Coeff.[6] 0.725 — G_s[7] 20.2 — Top of Gate 1191.7

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	621.97	0.00	621.97	0.00	0.00	622
0.00	1760.98	0.00	1760.98	0.00	0.00	1761
0.00	3270.99	0.00	3270.99	0.00	0.00	3271
0.00	5090.14	0.00	5090.14	0.00	0.00	5090
0.00	7191.13	0.00	7191.13	0.00	0.00	7191
0.00	9504.25	0.00	9504.25	0.00	0.00	9504
0.00	12042.12	0.00	12042.12	0.00	0.00	12042
0.00	14808.09	0.00	14808.09	0.00	0.00	14808
0.00	17790.17	0.00	17790.17	0.00	0.00	17790
0.00	20982.44	0.00	20982.44	0.00	0.00	20982
0.00	24339.05	0.00	24339.05	0.00	0.00	24339
0.00	27877.64	0.00	27877.64	0.00	0.00	27878
0.00	31606.33	0.00	31606.33	0.00	0.00	31606
0.00	35518.76	0.00	35518.76	0.00	0.00	35519
0.00	39608.26	0.00	39608.26	0.00	0.00	39608
0.00	43882.80	0.00	43882.80	0.00	0.00	43883
0.00	48358.64	0.00	48358.64	0.00	0.00	48359
0.00	52978.72	0.00	52978.72	0.00	0.00	52979
0.00	57785.41	0.00	57785.41	0.00	0.00	57785
0.00	62781.38	0.00	62781.38	0.00	0.00	62781
1.00	67904.39	0.00	67904.39	0.00	0.00	67904
2.00	73157.26	0.00	73157.26	0.00	0.00	73157
3.00	78579.01	0.00	78579.01	0.00	0.00	78579
4.00	84170.57	0.00	84170.57	0.00	0.00	84171
5.00	89947.70	0.00	89947.70	0.00	0.00	89948
6.00	95600.29	94020.44	94020.44	0.00	0.00	94020
7.00	102030.20	96814.06	96814.06	0.00	0.00	96814
8.00	108339.48	99723.74	99723.74	0.00	0.00	99724
9.00	114817.26	102456.40	102456.40	0.00	0.00	102456
10.00	121353.39	105118.05	105118.05	0.00	0.00	105118
11.00	128062.06	107713.95	107713.95	0.00	0.00	107714
12.00	134945.63	110248.74	110248.74	0.00	0.00	110249
13.00	142067.39	112726.55	112726.55	0.00	0.00	112727
14.00	149379.19	115151.08	115151.08	0.00	0.00	115151
15.00	156523.00	117525.55	117525.55	0.00	0.00	117526
16.00	163808.42	119853.02	119853.02	0.00	0.00	119853
17.00	171235.38	122136.14	122136.14	0.00	0.00	122136
18.00	178803.86	124377.36	124377.36	0.00	0.00	124377
19.00	186525.84	126578.90	126578.90	0.00	0.00	126579
20.00	194253.85	128742.79	128742.79	0.00	0.00	128743
21.00	202114.39	130870.92	130870.92	0.00	0.00	131987
22.00	210107.48	132964.99	132964.99	0.00	0.00	136122
23.00	218233.17	135026.56	135026.56	0.30	101.88	140927
24.00	226491.54	137057.17	137057.17	1.30	918.98	147011
25.00	234882.73	139058.11	139058.11	2.30	2182.64	153932
26.00	243406.88	141030.67	141030.67	3.30	3716.74	161532
27.00	252064.25	142976.01	142976.01	4.30	5526.34	169726
28.00	260855.03	144895.24	144895.24	5.30	7564.94	178456
29.00	269779.52	146789.37	146789.37	6.30	9800.98	188183
30.00	278838.02	148659.37	148659.37	7.30	12226.58	198016
31.00	288030.87	150506.15	150506.15	8.30	14825.48	208291
32.00	297358.46	152330.53	152330.53	9.30	17583.94	218984
33.00	306821.17	154133.32	154133.32	10.30	20494.98	230075
34.00	316419.45	155915.27	155915.27	11.30	23551.00	241545
35.00	326153.75	157677.08	157677.08	12.30	26745.42	253380

Gate Open Beta: 25 | 102 — Dis. Coeff.[6] 0.73 — G_s[7] 25.6 — Top of Gate 1193.2

HEAD OVER GATE feet	GATE FLOW WEIR cfs	GATE FLOW ORIFICE cfs	GATE FLOW FLOW cfs	HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0.00	0.00	0.00	0.00	0
0.00	621.97	0.00	621.97	0.00	0.00	622
0.00	1760.98	0.00	1760.98	0.00	0.00	1761
0.00	3270.99	0.00	3270.99	0.00	0.00	3271
0.00	5090.14	0.00	5090.14	0.00	0.00	5090
0.00	7191.13	0.00	7191.13	0.00	0.00	7191
0.00	9504.25	0.00	9504.25	0.00	0.00	9504
0.00	12042.12	0.00	12042.12	0.00	0.00	12042
0.00	14808.09	0.00	14808.09	0.00	0.00	14808
0.00	17790.17	0.00	17790.17	0.00	0.00	17790
0.00	20982.44	0.00	20982.44	0.00	0.00	20982
0.00	24339.05	0.00	24339.05	0.00	0.00	24339
0.00	27877.64	0.00	27877.64	0.00	0.00	27878
0.00	31606.33	0.00	31606.33	0.00	0.00	31606
0.00	35518.76	0.00	35518.76	0.00	0.00	35519
0.00	39608.26	0.00	39608.26	0.00	0.00	39608
0.00	43882.80	0.00	43882.80	0.00	0.00	43883
0.00	48358.64	0.00	48358.64	0.00	0.00	48359
0.00	52978.72	0.00	52978.72	0.00	0.00	52979
0.00	57785.41	0.00	57785.41	0.00	0.00	57785
0.00	62781.38	0.00	62781.38	0.00	0.00	62781
0.00	67904.39	0.00	67904.39	0.00	0.00	67904
0.00	73157.26	0.00	73157.26	0.00	0.00	73157
0.00	78579.01	0.00	78579.01	0.00	0.00	78579
0.00	84170.57	0.00	84170.57	0.00	0.00	84171
0.00	89947.70	0.00	89947.70	0.00	0.00	89948
1.00	95600.29	0.00	95600.29	0.00	0.00	95600
2.00	102030.20	0.00	102030.20	0.00	0.00	102030
3.00	108339.48	0.00	108339.48	0.00	0.00	108339
4.00	114817.26	0.00	114817.26	0.00	0.00	114817
5.00	121353.39	0.00	121353.39	0.00	0.00	121353
6.00	128062.06	0.00	128062.06	0.00	0.00	128062
7.00	134945.63	132450.33	132450.33	0.00	0.00	132450
8.00	142067.39	135804.04	135804.04	0.00	0.00	135804
9.00	149379.19	139076.89	139076.89	0.00	0.00	139077
10.00	156523.00	142274.48	142274.48	0.00	0.00	142274
11.00	163808.42	145401.77	145401.77	0.00	0.00	145402
12.00	171235.38	148463.19	148463.19	0.00	0.00	148463
13.00	178803.86	151462.75	151462.75	0.00	0.00	151463
14.00	186525.84	154404.05	154404.05	0.00	0.00	154404
15.00	194253.85	157290.36	157290.36	0.00	0.00	157290
16.00	202114.39	160124.65	160124.65	0.00	0.00	161241
17.00	210107.48	162909.63	162909.63	0.00	0.00	166066
18.00	218233.17	165647.80	165647.80	0.00	0.00	171447
19.00	226491.54	168341.44	168341.44	0.00	0.00	177376
20.00	234882.73	170992.85	170992.85	0.80	443.64	184146
21.00	243406.88	173603.37	173603.37	1.80	1497.27	191885
22.00	252064.25	176175.41	176175.41	2.80	2904.88	200302
23.00	260855.03	178710.44	178710.44	3.80	4582.68	209289
24.00	269779.52	181210.01	181210.01	4.80	6520.09	219320
25.00	278838.02	183675.57	183675.57	5.80	8660.31	229464
26.00	288030.87	186108.46	186108.46	6.80	10993.98	240061
27.00	297358.46	188509.96	188509.96	7.80	13508.21	251086
28.00	306821.17	190881.25	190881.25	8.80	16185.11	262513
29.00	316419.45	193223.44	193223.44	9.80	19020.89	274323
30.00	326153.75	195537.57	195537.57	10.80	22005.30	286500

Gate Closed — 1179

HEAD OVER TOP OF GATE feet	FLOW OVER GATE cfs	TOTAL FLOW cfs
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
0.00	0.00	0
1.00	620.00	620
2.00	1753.62	1754
3.00	3221.61	3222
4.00	4960.00	4960
5.00	6931.81	6932
6.00	9112.10	9112
7.00	11482.56	11483
8.00	14029.00	14029
9.00	16740.00	16740
10.00	19606.12	19606
11.00	23239.38	24355
12.00	27526.54	30683
13.00	30512.40	36311
14.00	33552.28	42587
15.00	36767.84	49479
16.00	40141.29	56926
17.00	43660.13	64882
18.00	47314.90	73311
19.00	51098.14	82688
20.00	55003.76	92132
21.00	59026.62	101986
22.00	63162.32	112232
23.00	67407.01	122853
24.00	71757.28	133836
25.00	76210.06	145167

Exhibit 4
Sheet 2 of 3

RALSTON AFTERBAY DAM RATING CURVE

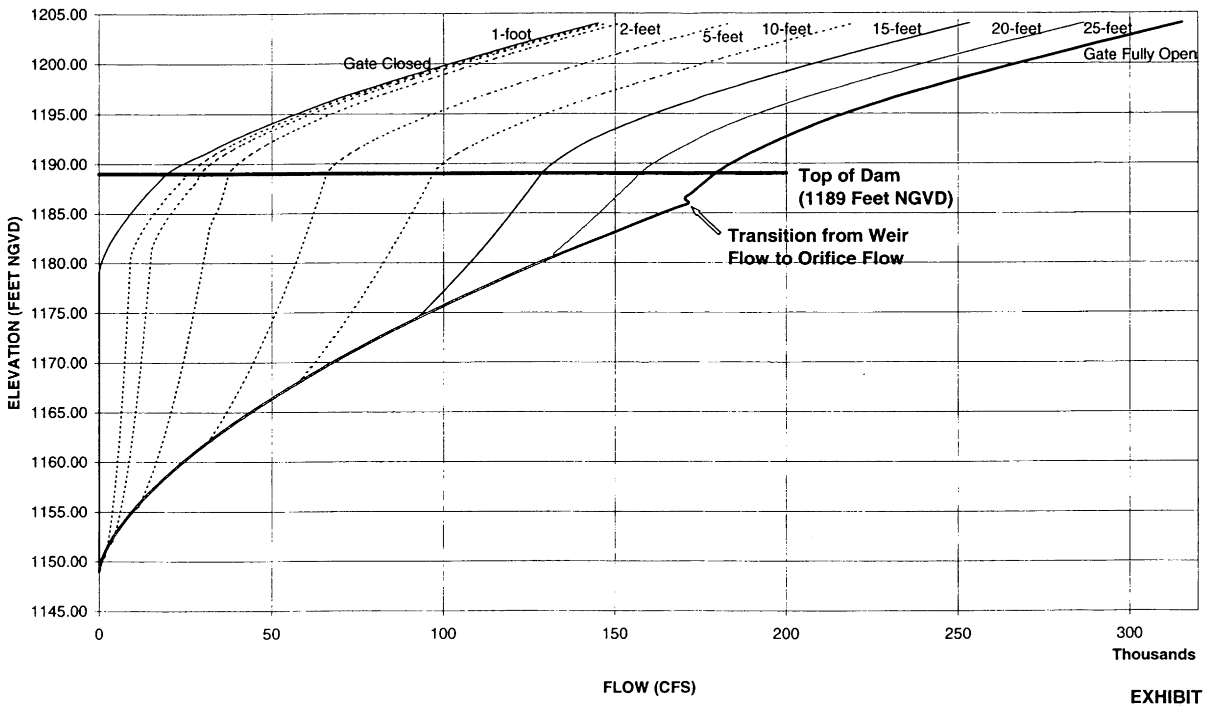
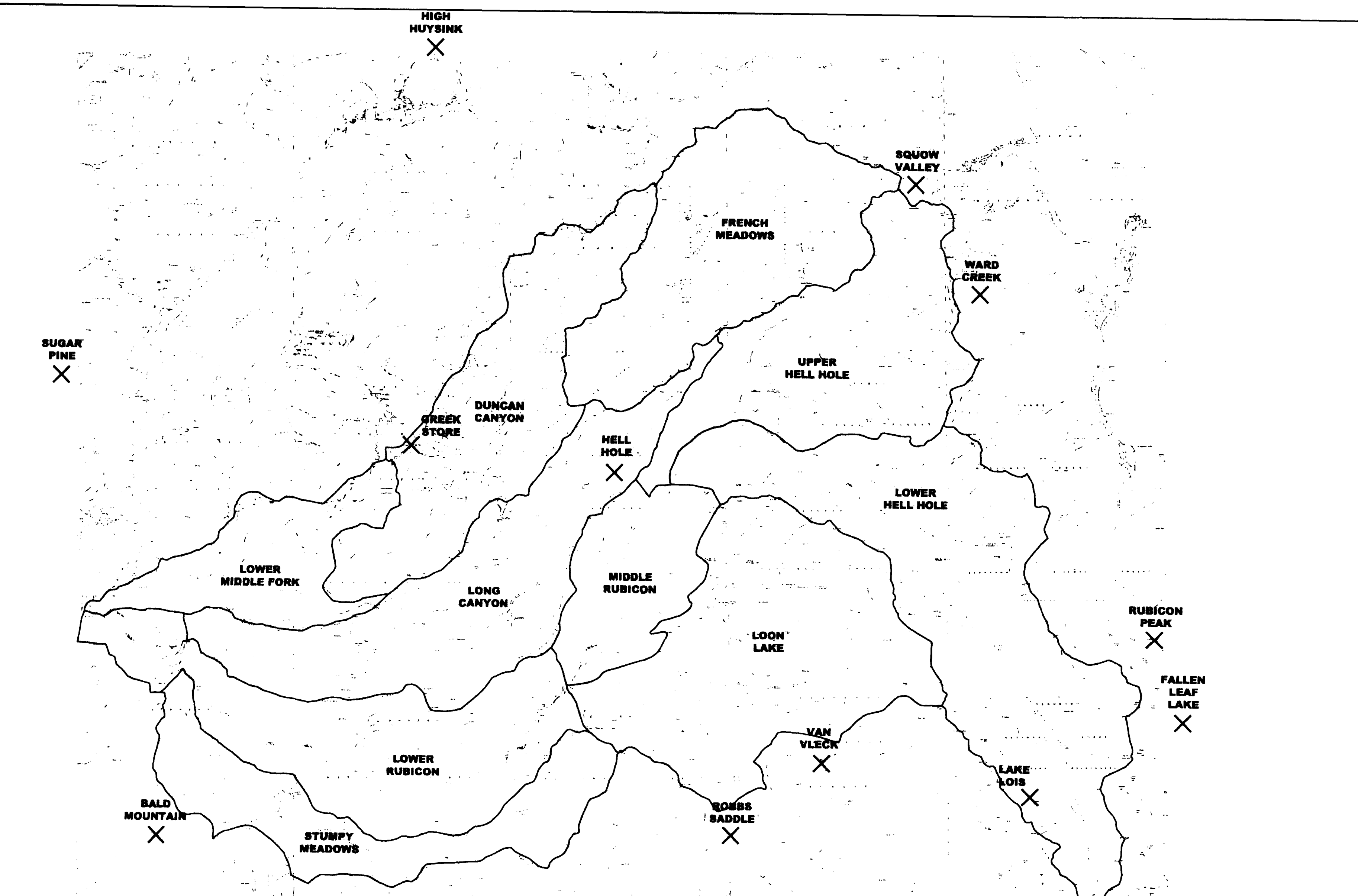


EXHIBIT 4
Sheet 3 of 3



SUBBASIN BOUNDARIES AND GAGE LOCATIONS

NOT TO SCALE

EXHIBIT 5

Exhibit 6. Calibration Results – 1996 Flood

Exhibit 6A: HEC-1 Model Calibration
Spillway Flow at Hell Hole Dam
May, 1996

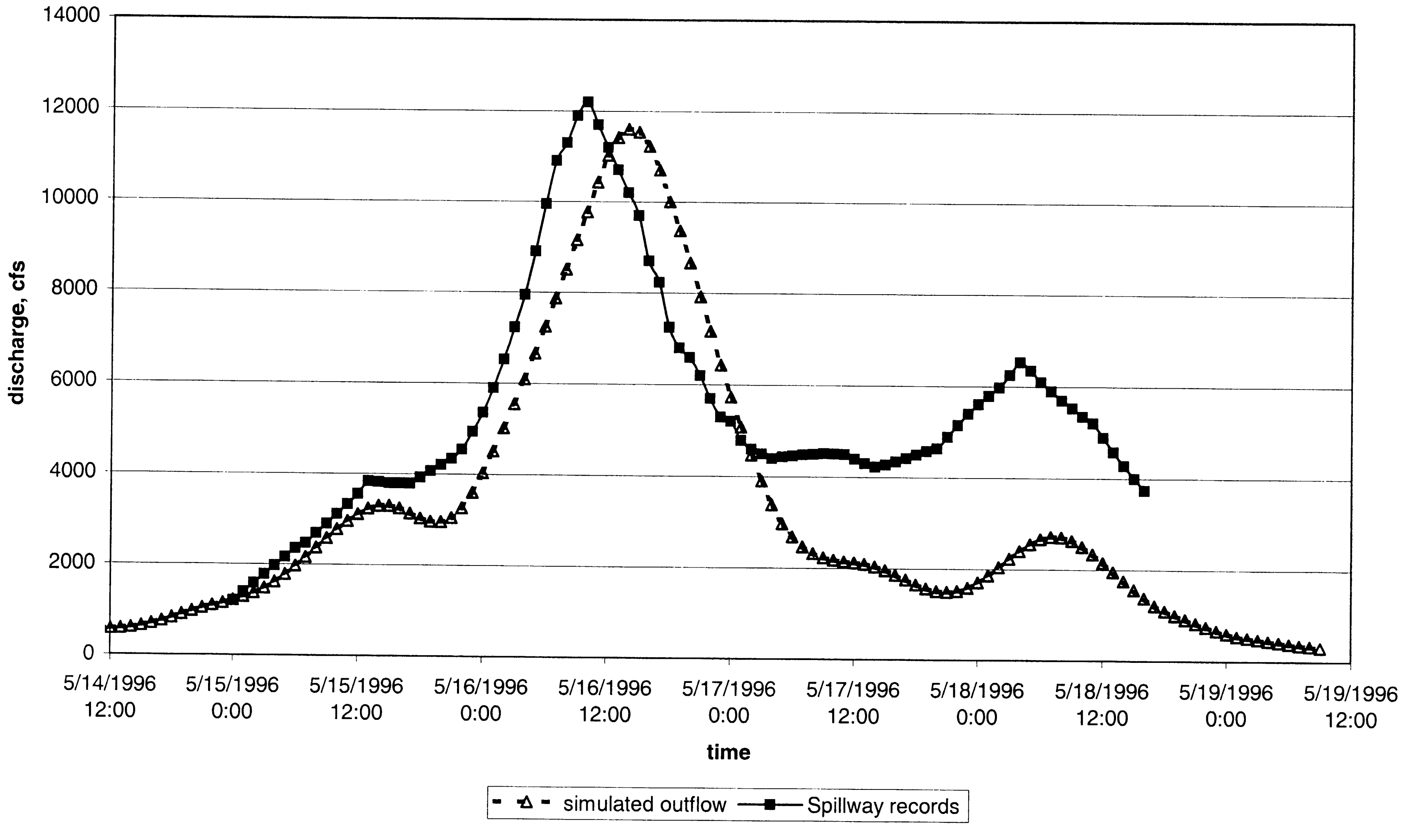


Exhibit 6B: HEC-1 Model Calibration
Flow at Interbay Dam
May, 1996

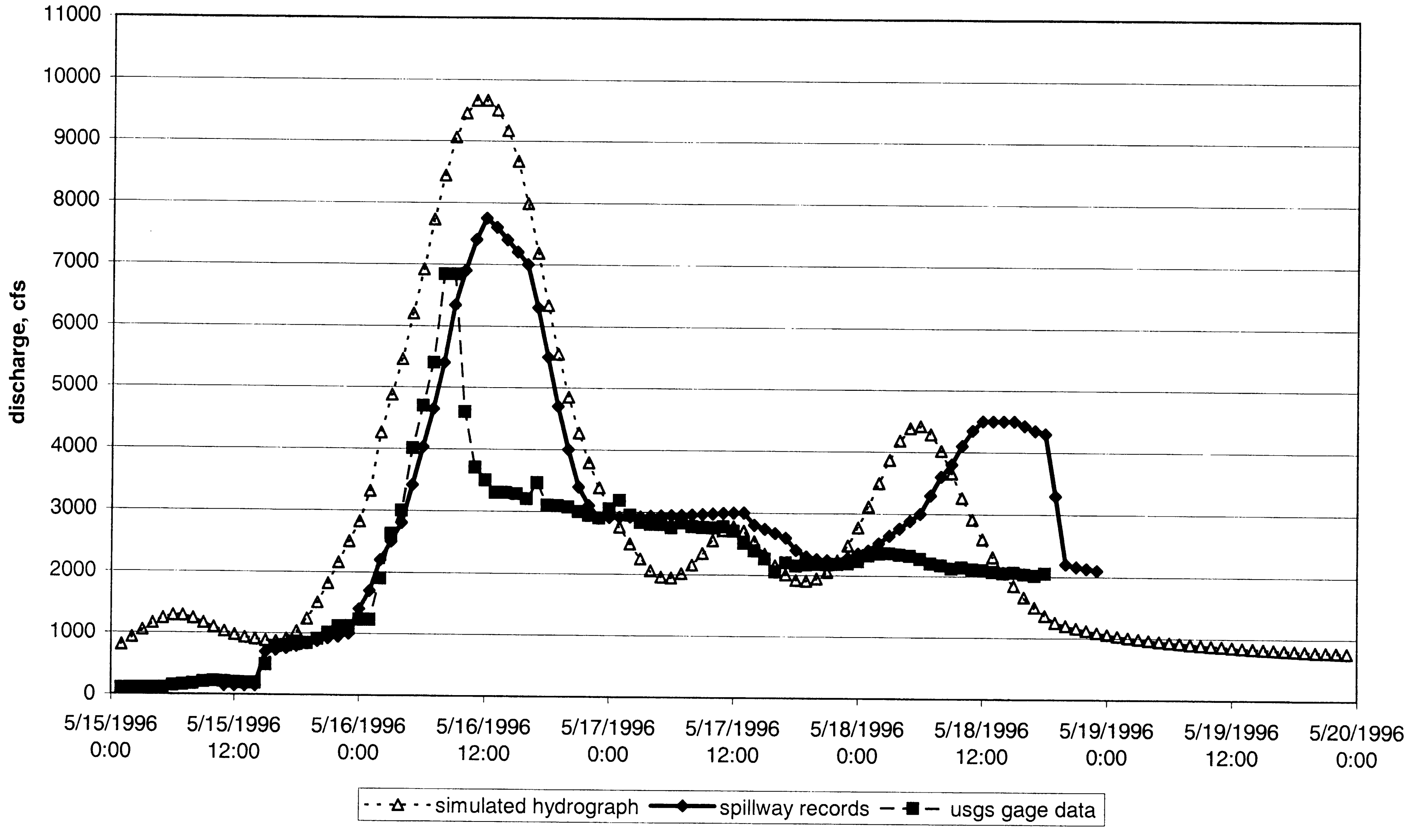


Exhibit 6C: HEC-1 Model Calibration
Flow at Ralston Afterbay Dam
May, 1996

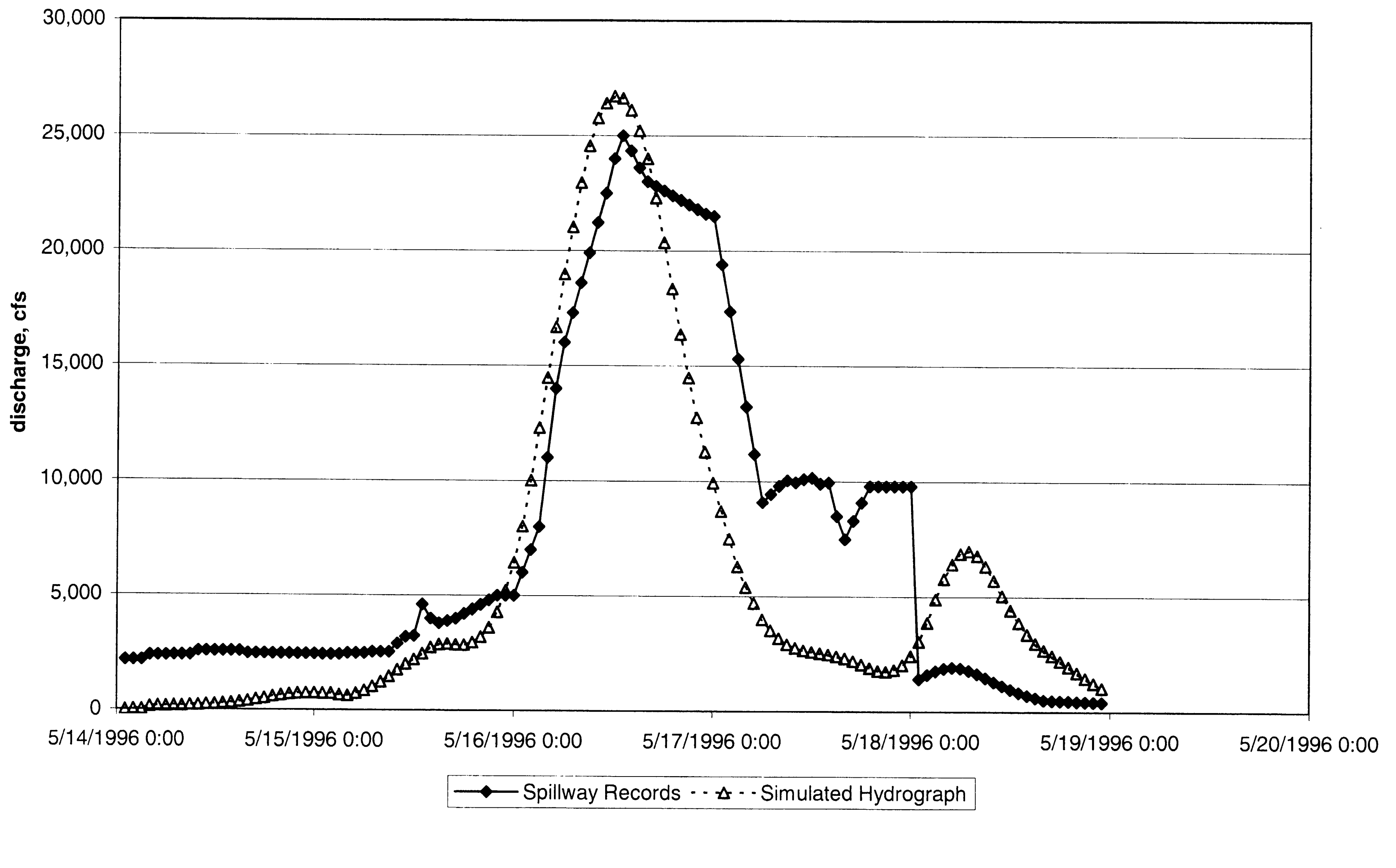


Exhibit 7. Calibration Results – 1996-97 Flood

Exhibit 7A: HEC-1 Model Calibration
Spillway Flow at Hell Hole Dam
December 1996-January 1997

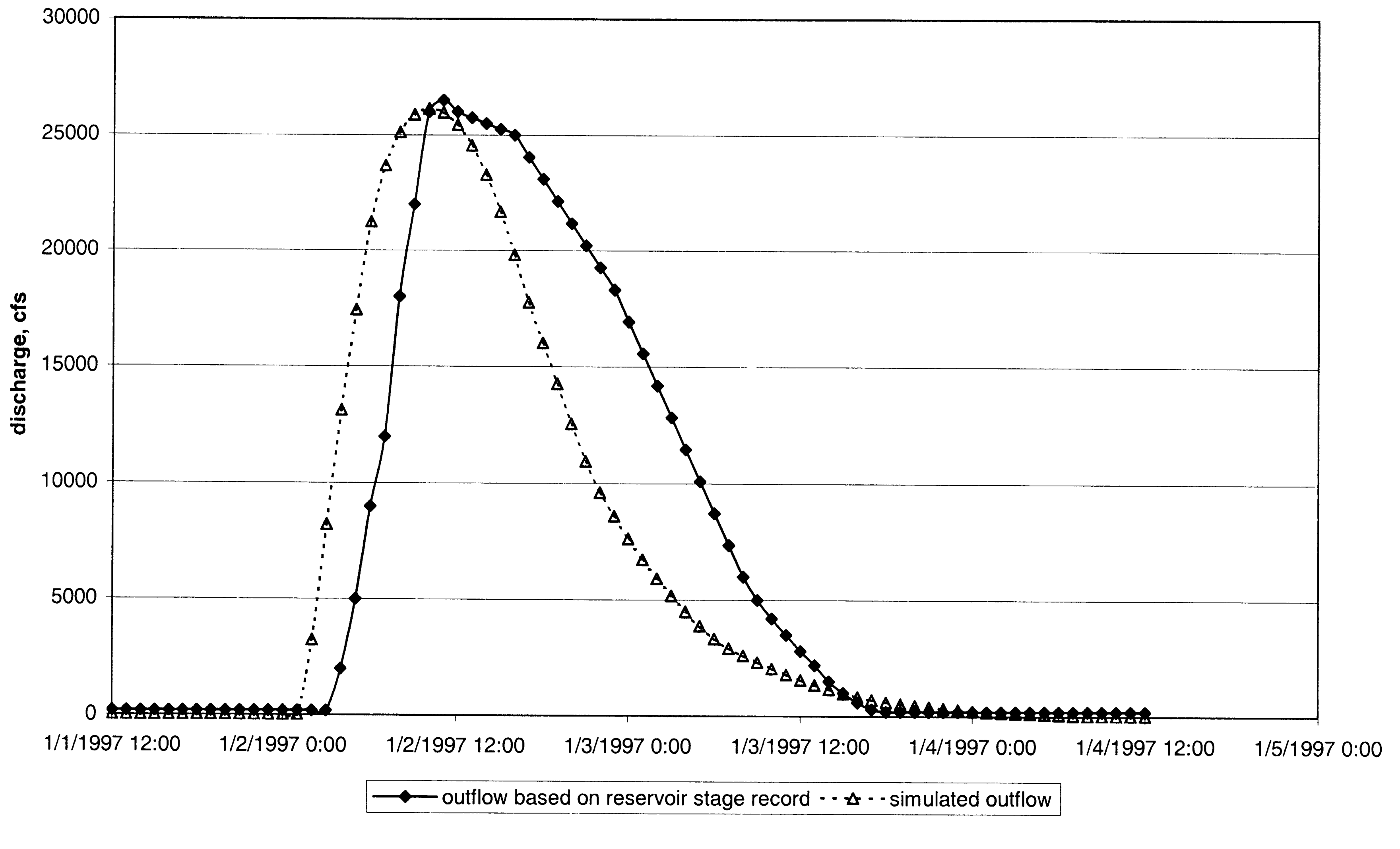


Exhibit 7B: HEC-1 Model Calibration Flow at Interbay Dam December 1996 - January 1997

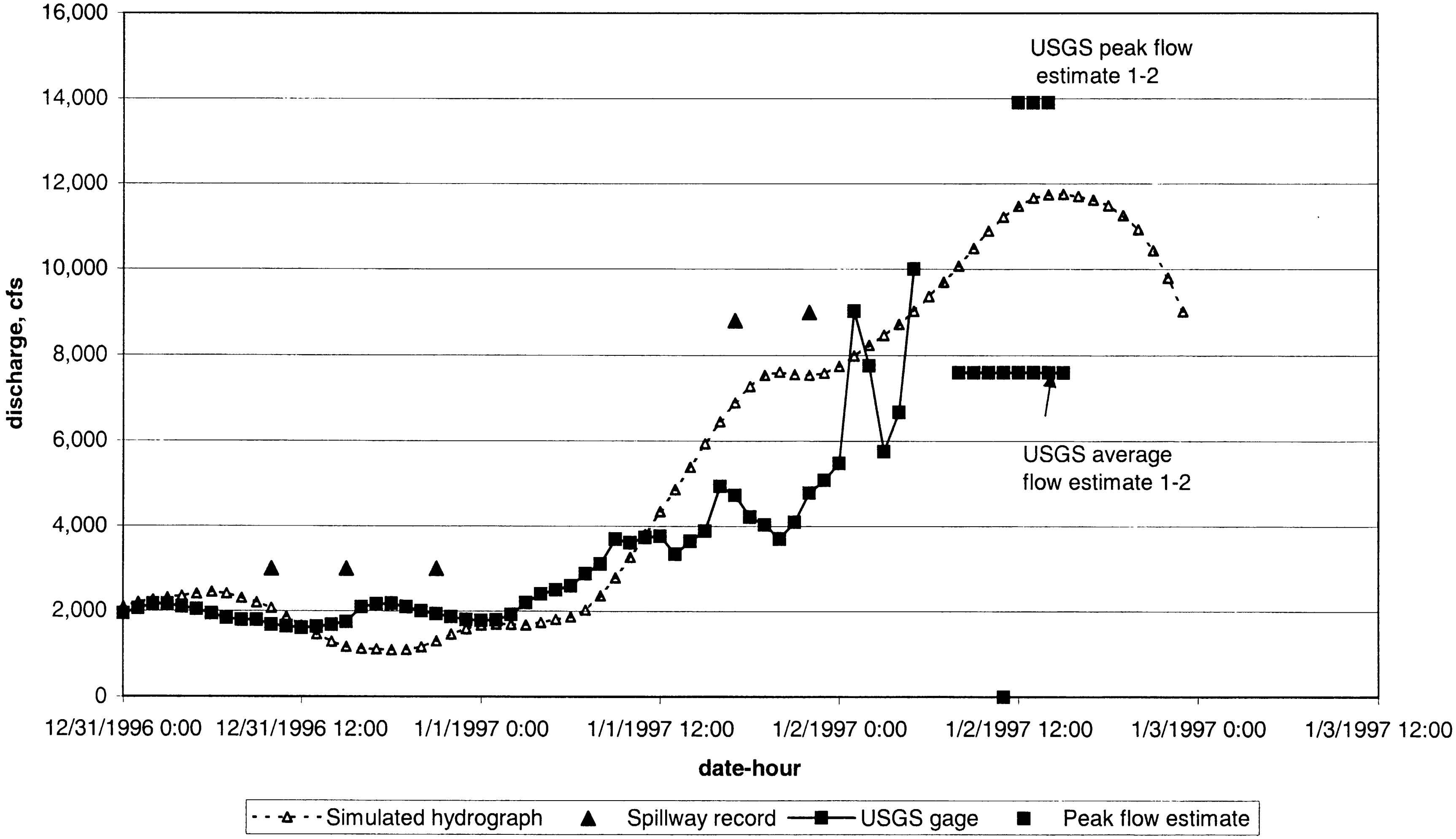


Exhibit 7C: HEC-1 Model Calibration
Flows at Ralston Afterbay Dam
December 1996- January 1997

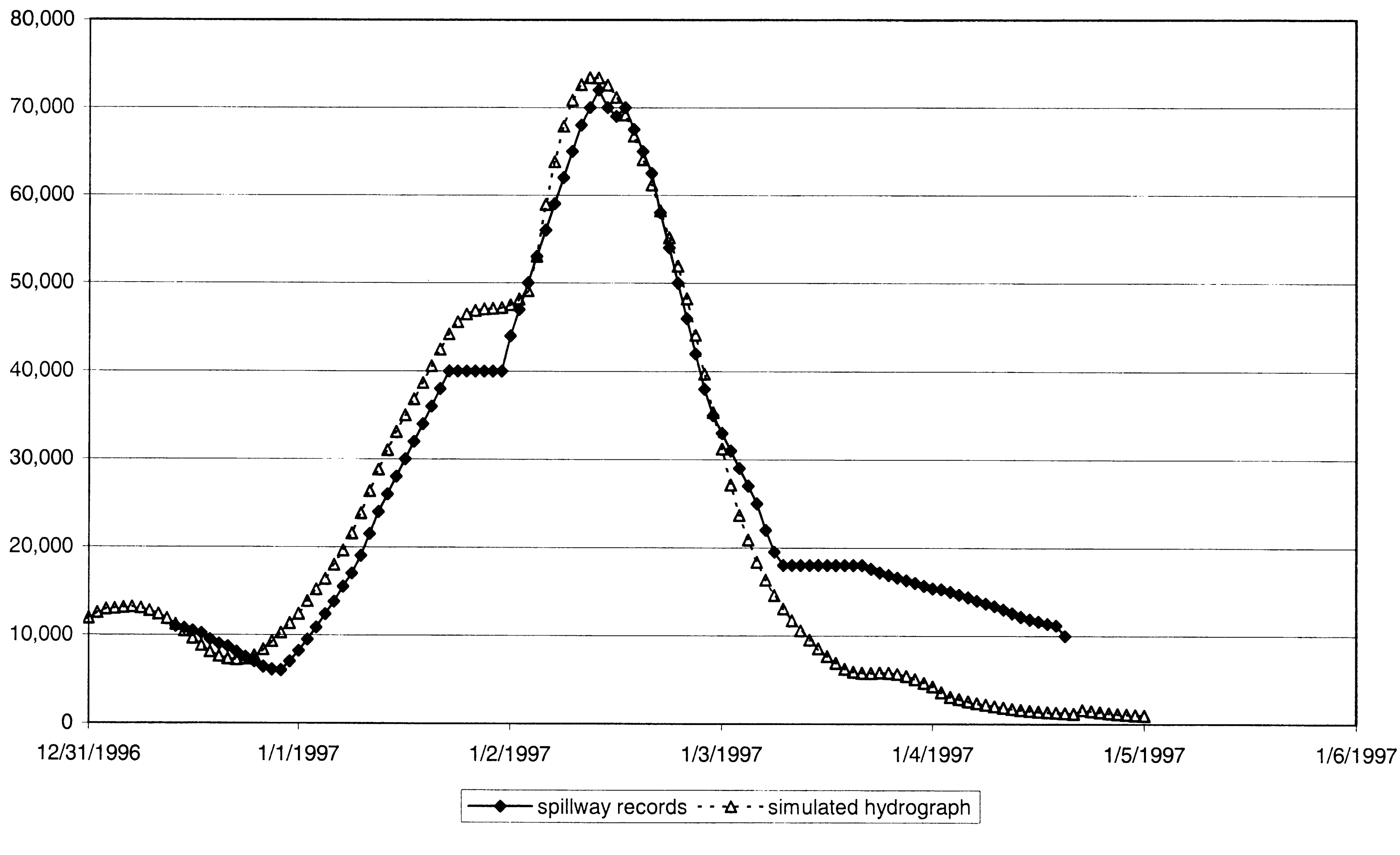


Exhibit 8. PMS and Temperature Calculations – Hell Hole Dam

Exhibit 8
PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 1 of 10: All Season Storm Calculations

Compute all season PMP for 113 square mile basin
at Hell Hole Dam **Tables, figures referenced from HMR 58**
use for November through March

Area = 113 square miles
Index PMP = 26 inches

Region = 5 (Sierra)
10 sq mi, 24 hour precip

Basin average elevation = 6000 feet

Depth duration for 10 square mile storm: Table 2.1			
duration	adjustment factor	index	depth
1	0.14	26	3.64
6	0.42	26	10.92
12	0.65	26	16.90
24	1	26	26.00
48	1.56	26	40.56
72	1.76	26	45.76

Adjust to 113 square miles: Table 2.3			
duration	adjustment factor for 113 mi2	10 mi2 depth	depth
1	0.81	3.64	2.95
6	0.83	10.92	9.06
12	0.85	16.90	14.37
24	0.864	26.00	22.46
48	0.888	40.56	36.02
72	0.91	45.76	41.64

Add points to smooth curve (see sheet 2)					
hours	depth	incremental hours	incremental inches	incremental depth per hour	per 6 hours
1.00	2.95	1	2.95	2.95	
3.00	6.00	2	3.05	1.53	
6.00	9.06	3	3.06	1.02	9.06
12.00	14.37	6	5.31	0.89	5.31
18.00	18.45	6	4.08	0.68	4.08
24.00	22.46	6	4.01	0.67	4.01
30.00	26.25	6	3.79	0.63	3.79
36.00	29.80	6	3.55	0.59	3.55
42.00	33.00	6	3.20	0.53	3.20
48.00	36.02	6	3.02	0.50	3.02
54.00	38.00	6	1.98	0.33	1.98
60.00	39.65	6	1.65	0.28	1.65
66.00	40.90	6	1.25	0.21	1.25
72.00	41.64	6	0.74	0.12	0.74

Both subbasins have same index PMP, differentiate only by elevation distribution in HEC1
Develop hourly sequence

6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments
1	1.25	1	0.19	5	4.08	25	0.65	9	3.55	49	0.64
		2	0.2			26	0.66			50	0.62
		3	0.2			27	0.67			51	0.61
		4	0.21			28	0.69			52	0.58
		5	0.22			29	0.7			53	0.56
		6	0.23			30	0.71			54	0.54
2	1.98	7	0.25	6	9.06	31	1.02	10	3.02	55	0.53
		8	0.28			32	1.53			56	0.52
		9	0.3			33	2.95			57	0.51
		10	0.36			34	1.52			58	0.5
		11	0.38			35	1.07			59	0.49
		12	0.41			36	0.97			60	0.47
3	3.2	13	0.48	7	5.31	37	0.95	11	1.65	61	0.35
		14	0.51			38	0.93			62	0.31
		15	0.53			39	0.9			63	0.28
		16	0.54			40	0.87			64	0.27
		17	0.56			41	0.84			65	0.24
		18	0.58			42	0.81			66	0.2
4	3.79	19	0.61	8	4.01	43	0.69	12	0.74	67	0.18
		20	0.62			44	0.68			68	0.16
		21	0.63			45	0.67			69	0.12
		22	0.64			46	0.67			70	0.11
		23	0.64			47	0.66			71	0.09
		24	0.65			48	0.65			72	0.08

Exhibit 8, Sheet 2 of 10
All Season PMP Depth-Area Duration Curve for Hell Hole Drainage

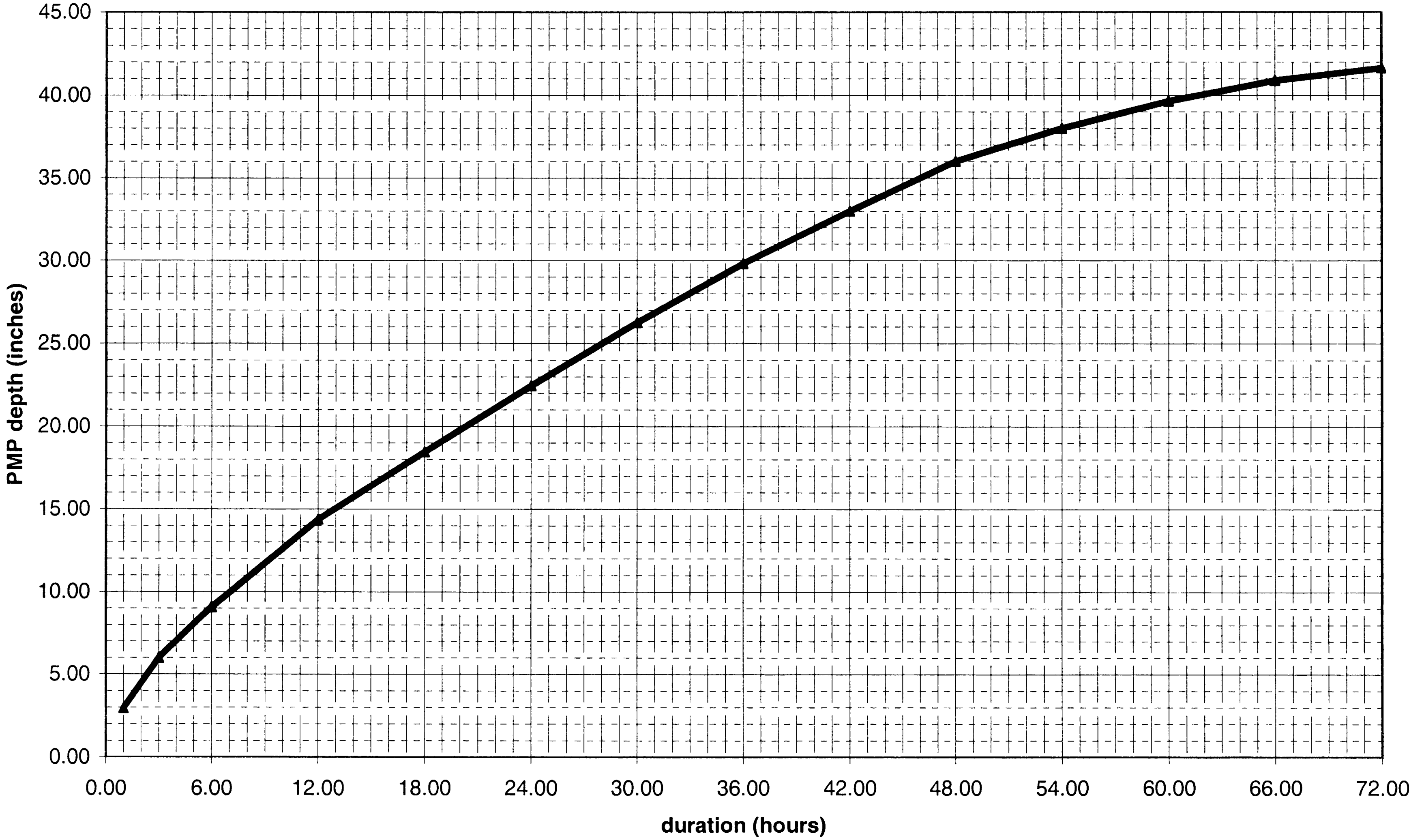


Exhibit 8, Sheet 3 of 10
All Season Probable Maximum Storm for Hell Hole Dam Drainage

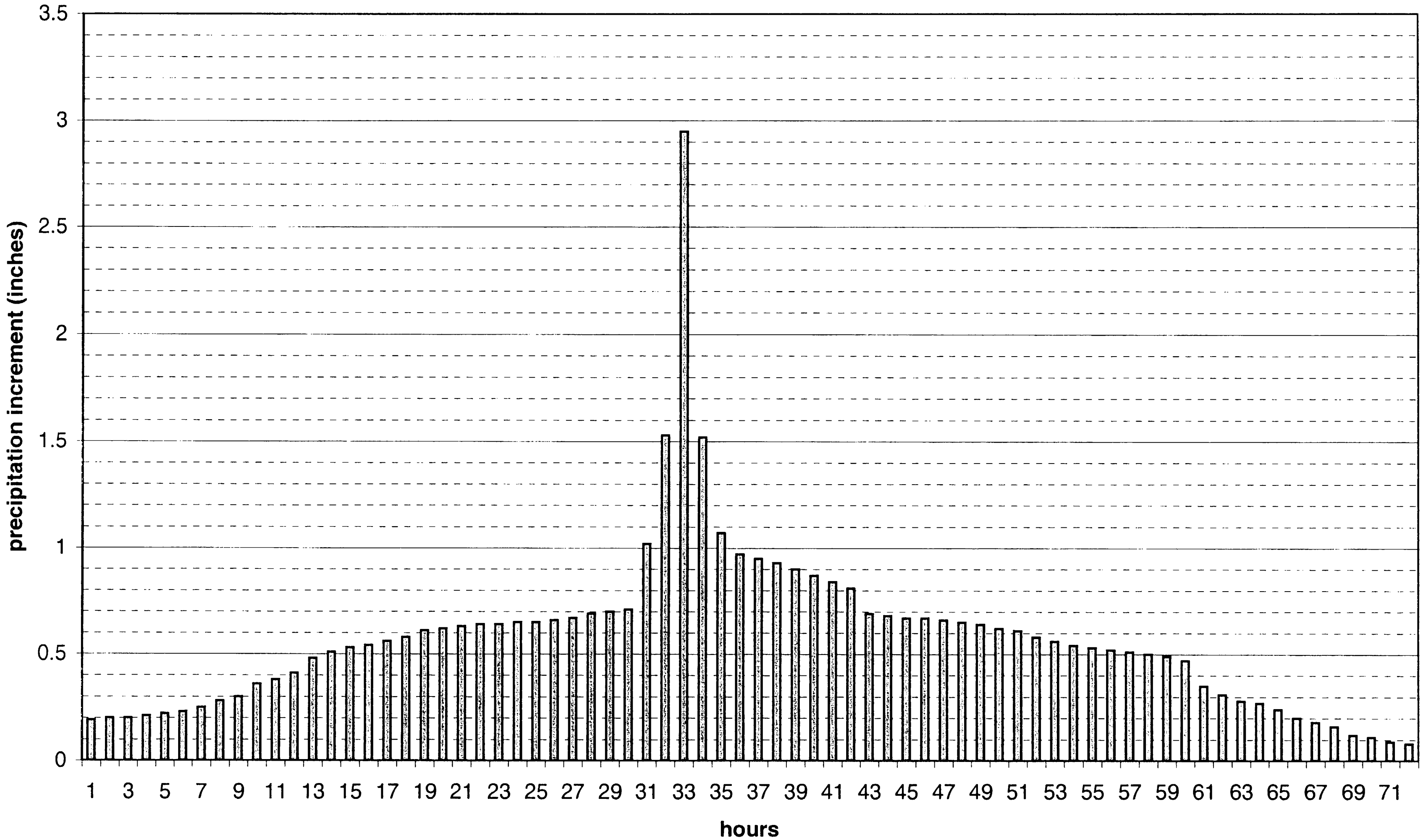


Exhibit 8
PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 4 of 10: All Season Storm Summary

Temperature sequence from sheet 10 *in degrees Fahrenheit*

6 hr block	6 hr total precip	hr	1 hr precip increments	November temps at 6000 feet	November freezing elev	March temps at 6000 feet	March freezing elev	
		-48 hours		33.4		29.8		subtract 10
		-36 hours		34.4		30.8		subtract 9
		-24 hours		36.4		32.8		subtract 7
		-12 hours'		38.9		35.3		subtract 4.5
1	0.92	1	0.19	43.4	9600	39.8	8400	
		2	0.2	43.4	9600	39.8	8400	
		3	0.2	43.4	9600	39.8	8400	
		4	0.21	43.4	9600	39.8	8400	
		5	0.22	43.4	9600	39.8	8400	
		6	0.23	43.4	9600	39.8	8400	
2	1.88	7	0.25	44.1	9900	40.2	8800	
		8	0.28	44.1	9900	40.2	8800	
		9	0.3	44.1	9900	40.2	8800	
		10	0.36	44.1	9900	40.2	8800	
		11	0.38	44.1	9900	40.2	8800	
		12	0.41	44.1	9900	40.2	8800	
3	2.91	13	0.48	45	10300	42	9200	
		14	0.51	45	10300	42	9200	
		15	0.53	45	10300	42	9200	
		16	0.54	45	10300	42	9200	
		17	0.56	45	10300	42	9200	
		18	0.58	45	10300	42	9200	
4	3.58	19	0.61	46.5	10600	42.9	9400	
		20	0.62	46.5	10600	42.9	9400	
		21	0.63	46.5	10600	42.9	9400	
		22	0.64	46.5	10600	42.9	9400	
		23	0.64	46.5	10600	42.9	9400	
		24	0.65	46.5	10600	42.9	9400	
5	3.71	25	0.65	47.6	11000	43.9	9800	
		26	0.66	47.6	11000	43.9	9800	
		27	0.67	47.6	11000	43.9	9800	
		28	0.69	47.6	11000	43.9	9800	
		29	0.7	47.6	11000	43.9	9800	
		30	0.71	47.6	11000	43.9	9800	
6	7.93	31	1.02	48.8	11600	45.5	10400	
		32	1.53	48.8	11600	45.5	10400	
		33	2.95	48.8	11600	45.5	10400	
		34	1.52	48.8	11600	45.5	10400	
		35	1.07	48.8	11600	45.5	10400	
		36	0.97	48.8	11600	45.5	10400	
7	4.67	37	0.95	48.1	11300	44.6	10100	
		38	0.93	48.1	11300	44.6	10100	
		39	0.9	48.1	11300	44.6	10100	
		40	0.87	48.1	11300	44.6	10100	
		41	0.84	48.1	11300	44.6	10100	
		42	0.81	48.1	11300	44.6	10100	
8	3.71	43	0.69	47.1	10800	43.3	9600	
		44	0.68	47.1	10800	43.3	9600	
		45	0.67	47.1	10800	43.3	9600	
		46	0.67	47.1	10800	43.3	9600	
		47	0.66	47.1	10800	43.3	9600	
		48	0.65	47.1	10800	43.3	9600	
9	3.2	49	0.64	45.7	10400	42.4	9300	
		50	0.62	45.7	10400	42.4	9300	
		51	0.61	45.7	10400	42.4	9300	
		52	0.58	45.7	10400	42.4	9300	
		53	0.56	45.7	10400	42.4	9300	
		54	0.54	45.7	10400	42.4	9300	
10	2.91	55	0.53	44.8	10200	41.7	9000	
		56	0.52	44.8	10200	41.7	9000	
		57	0.51	44.8	10200	41.7	9000	
		58	0.5	44.8	10200	41.7	9000	
		59	0.49	44.8	10200	41.7	9000	
		60	0.47	44.8	10200	41.7	9000	
11	1.8	61	0.35	43.6	9700	40	8500	
		62	0.31	43.6	9700	40	8500	
		63	0.28	43.6	9700	40	8500	
		64	0.27	43.6	9700	40	8500	
		65	0.24	43.6	9700	40	8500	
		66	0.2	43.6	9700	40	8500	
12	0.93	67	0.18	43.2	9500	39.6	8400	
		68	0.16	43.2	9500	39.6	8400	
		69	0.12	43.2	9500	39.6	8400	
		70	0.11	43.2	9500	39.6	8400	
		71	0.09	43.2	9500	39.6	8400	
		72	0.08	43.2	9500	39.6	8400	

PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 5 of 10: April General Storm Calculation

All Season index PMP	Factor Figure 2.3	April index PMP	Offset
26	0.78	20.28	1 month

April depth duration values for 10-sq mi storm:

Duration	adjustment for 1 month offset (table 2.2)	index	depth
1	0.143	20.28	2.90
6	0.424	20.28	8.60
12	0.653	20.28	13.24
24	1	20.28	20.28
48	1.513	20.28	30.68
72	1.672	20.28	33.91

Adjust to 113 square miles (Table 2.7)

Duration	adjustment factor	depth for 10 sq mi	depth for 113 sq mi
1	0.841	2.90	2.44
6	0.859	8.60	7.39
12	0.878	13.24	11.63
24	0.901	20.28	18.27
48	0.924	30.68	28.35
72	0.955	33.91	32.38

Plot and add points to smooth

Duration	depth for 113 sq mi	incremental depth	depth per hour	per 6 hours
1	2.44	2.44	2.440	
3	4.75	2.31	1.155	
6	7.39	2.64	0.880	7.39
12	11.63	4.24	0.707	4.24
18	15.20	3.57	0.595	3.57
24	18.27	3.07	0.512	3.07
30	21.27	3.00	0.500	3
36	23.90	2.63	0.438	2.63
42	26.30	2.40	0.400	2.4
48	28.35	2.05	0.342	2.05
54	29.70	1.35	0.225	1.35
60	30.68	0.98	0.163	0.98
66	31.60	0.92	0.153	0.92
72	32.38	0.78	0.130	0.78

Arrange by 6 hour blocks
Develop hourly sequence

6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments
1	0.92	1	0.15	5	3.57	25	0.55	9	2.63	49	0.45
		2	0.15			26	0.56			50	0.44
		3	0.15			27	0.57			51	0.44
		4	0.15			28	0.6			52	0.44
		5	0.16			29	0.63			53	0.43
		6	0.16			30	0.66			54	0.43
2	1.35	7	0.19	6	7.39	31	0.88	10	2.05	55	0.4
		8	0.2			32	1.16			56	0.38
		9	0.22			33	2.44			57	0.36
		10	0.23			34	1.15			58	0.32
		11	0.25			35	0.96			59	0.31
		12	0.26			36	0.81			60	0.28
3	2.4	13	0.37	7	4.24	37	0.76	11	0.98	61	0.18
		14	0.38			38	0.74			62	0.18
		15	0.39			39	0.72			63	0.17
		16	0.41			40	0.7			64	0.16
		17	0.42			41	0.67			65	0.15
		18	0.43			42	0.65			66	0.14
4	3	19	0.46	8	3.07	43	0.58	12	0.78	67	0.14
		20	0.48			44	0.56			68	0.13
		21	0.49			45	0.54			69	0.13
		22	0.51			46	0.48			70	0.13
		23	0.52			47	0.46			71	0.13
		24	0.54			48	0.45			72	0.12

Exhibit 8, Sheet 6 of 10
April PMP Depth-Area-Duration Curve for Hell Hole Drainage

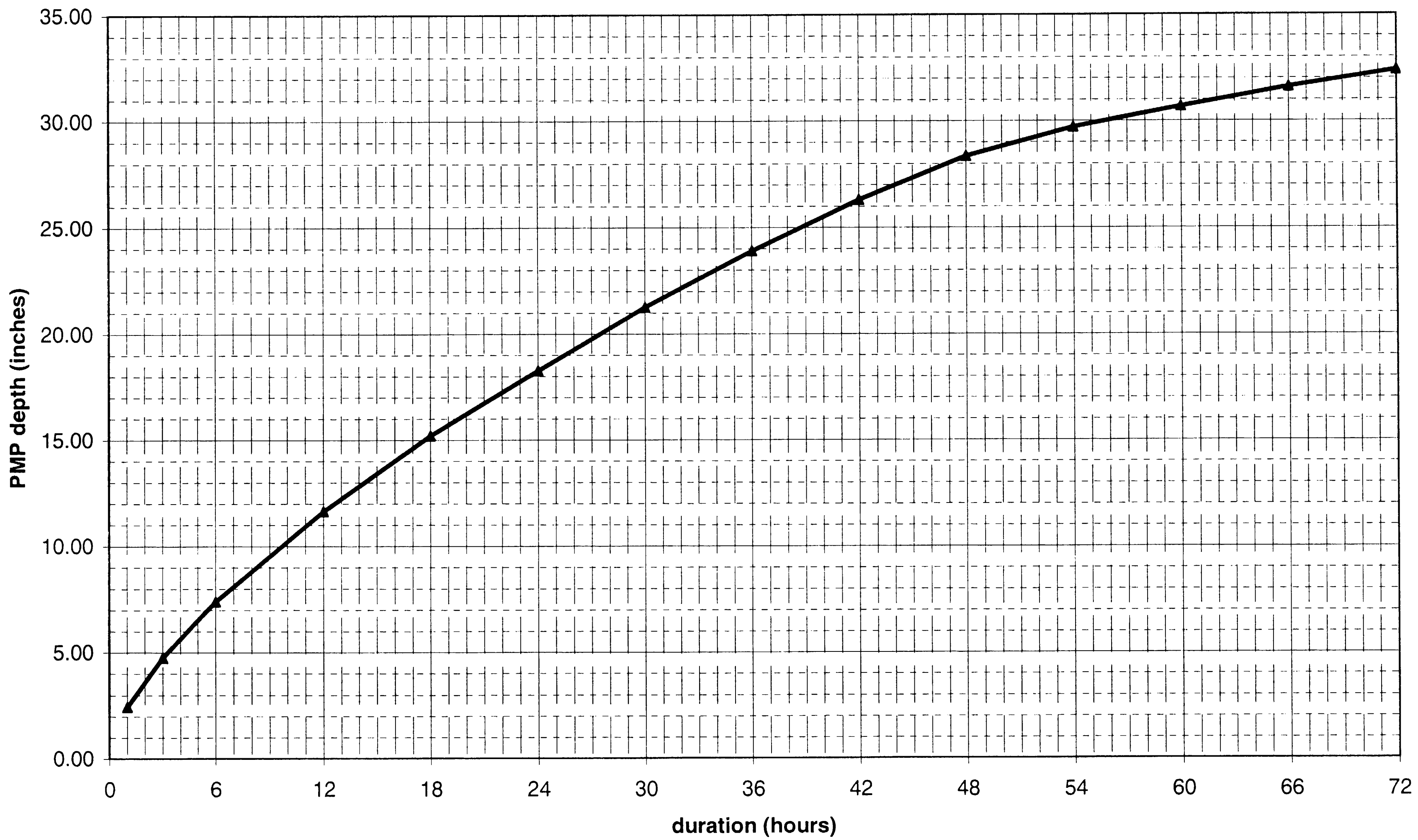


Exhibit 8, Sheet 7 of 10
April Probable Maximum Storm for Hell Hole Drainage

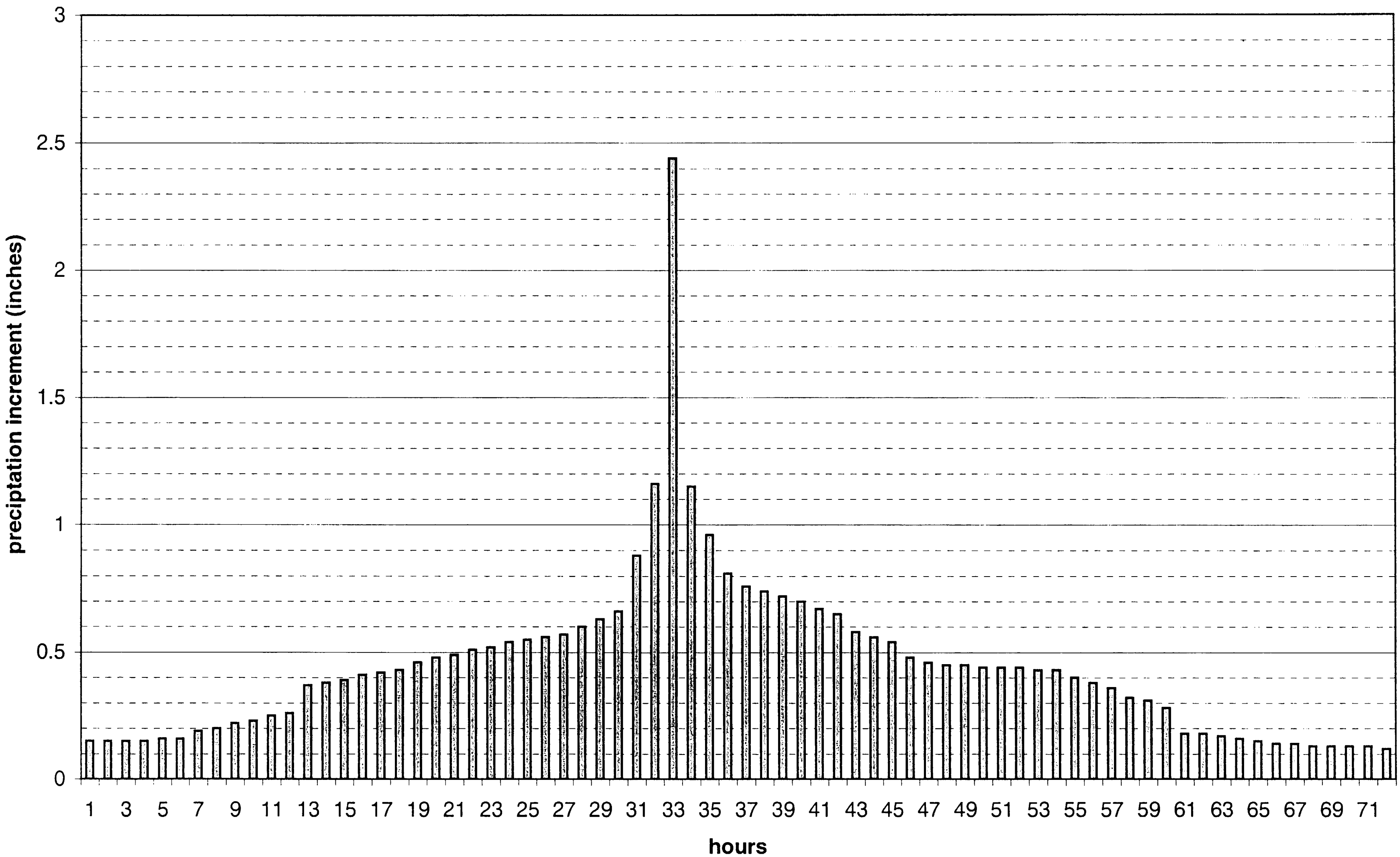


Exhibit 8
PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 8 of 10: April Storm Summary

Temperature sequence from sheet 10 *in degrees Fahrenheit*

				April temps	April freezing elevation	
		-48 hours		32		subtract 10
		-36 hours		33		subtract 9
		-24 hours		35		subtract 7
		-12 hours'		37.5		subtract 4.5
6 hr block	6 hr total precip	hr	1 hr precip increments			
1	0.92	1	0.15	42	9200	
		2	0.15	42	9200	
		3	0.15	42	9200	
		4	0.15	42	9200	
		5	0.16	42	9200	
		6	0.16	42	9200	
2	1.35	7	0.19	42.4	9300	
		8	0.2	42.4	9300	
		9	0.22	42.4	9300	
		10	0.23	42.4	9300	
		11	0.25	42.4	9300	
		12	0.26	42.4	9300	
3	2.40	13	0.37	43	9500	
		14	0.38	43	9500	
		15	0.39	43	9500	
		16	0.41	43	9500	
		17	0.42	43	9500	
		18	0.43	43	9500	
4	3.00	19	0.46	44.3	10000	
		20	0.48	44.3	10000	
		21	0.49	44.3	10000	
		22	0.51	44.3	10000	
		23	0.52	44.3	10000	
		24	0.54	44.3	10000	
5	3.57	25	0.55	45	10300	
		26	0.56	45	10300	
		27	0.57	45	10300	
		28	0.6	45	10300	
		29	0.63	45	10300	
		30	0.66	45	10300	
6	7.39	31	0.88	47.3	10900	
		32	1.16	47.3	10900	
		33	2.44	47.3	10900	
		34	1.15	47.3	10900	
		35	0.96	47.3	10900	
		36	0.81	47.3	10900	
7	4.24	37	0.76	45.9	10500	
		38	0.74	45.9	10500	
		39	0.72	45.9	10500	
		40	0.7	45.9	10500	
		41	0.67	45.9	10500	
		42	0.65	45.9	10500	
8	3.07	43	0.58	44.7	10100	
		44	0.56	44.7	10100	
		45	0.54	44.7	10100	
		46	0.48	44.7	10100	
		47	0.46	44.7	10100	
		48	0.45	44.7	10100	
9	2.63	49	0.45	43.7	9700	
		50	0.44	43.7	9700	
		51	0.44	43.7	9700	
		52	0.44	43.7	9700	
		53	0.43	43.7	9700	
		54	0.43	43.7	9700	
10	2.05	55	0.4	42.9	9400	
		56	0.38	42.9	9400	
		57	0.36	42.9	9400	
		58	0.32	42.9	9400	
		59	0.31	42.9	9400	
		60	0.28	42.9	9400	
11	0.98	61	0.18	42.2	9200	
		62	0.18	42.2	9200	
		63	0.17	42.2	9200	
		64	0.16	42.2	9200	
		65	0.15	42.2	9200	
		66	0.14	42.2	9200	
12	0.78	67	0.14	41.7	9000	
		68	0.13	41.7	9000	
		69	0.13	41.7	9000	
		70	0.13	41.7	9000	
		71	0.13	41.7	9000	
		72	0.12	41.7	9000	

Exhibit 8
PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 9 of 10: Local Storm Calculations

1 hour, 1 square mile local PMP			8.5 inches		
No elevation adjustment - mean elev is 6000 feet					
ratio of 6 hour to 1 hour PMP:			1.2	Region B	
6 hour local PMP:		10.2 inches			
Duration	Ratio (Table 2.10, Region B)	1 hr value	depth		
0.5	0.79	8.5	6.72		
1	1	8.5	8.50		
2	1.105	8.5	9.39		
3	1.16	8.5	9.86		
4	1.18	8.5	10.03		
5	1.19	8.5	10.12		
6	1.2	8.5	10.20		
Adjust for 113 square miles (Figure 2.26)					
Duration	1-mi2 depth	adjustment	113 mi2 average depth	smoothed	**incremental**
0.5	6.72	0.43	2.89	2.89	
1	8.50	0.5	4.25	4.25	**4.25**
2	9.39	0.52	5.00	5.00	**0.75**
3	9.86	0.54	5.32	5.32	**0.32**
4	10.03	0.55	5.52	5.52	**0.19**
5	10.12	0.55	5.63	5.63	**0.11**
6	10.20	0.56	5.71	5.71	**0.08**

Exhibit 8
PMP Calculations for 113-square-mile basin at Hell Hole Dam
Sheet 10 of 10: Temperature Sequences

Average elevation = 6000 feet
Average 12 hour February persisting dewpoint = 60 degrees (Figure A8)
Wp = 1.36 inches (Figure A1)

Seasonal Adjustments (Table A1)

Month	Factor	Feb wp	adjusted
November	1.17	1.36	1.59
March	1.03	1.36	1.40
April	1.09	1.36	1.48

Distribute by 6 hour increments (Table A2)

Month	adjusted Wp	6 hr (1.04)	12 hr (1.0)	18 hr (0.97)	24 hr (0.95)	30 hr (0.93)	36 hr (0.91)	42 hr (0.89)	48 hr (0.88)	54 hr (0.86)	60 hr (0.85)	66 hr (0.84)	72 hr (0.83)
November	1.59	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
March	1.40	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
April	1.48	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23

Sea Level Temperatures (Figure A1)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov Wp	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
sea level Nov temp	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
March Wp	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
sea level March temp	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
April Wp	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23
sea level April temp	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9

Adjust to 6000 feet (Figure A2)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov temp at 6000 ft	48.8	48.1	47.6	47.1	46.5	45.7	45	44.8	44.1	43.6	43.4	43.2
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March temp at 6000 feet	45.5	44.6	43.9	43.3	42.9	42.4	42	41.7	40.2	40	39.8	39.6
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April temp at 6000 feet	47.3	45.9	45	44.7	44.3	43.7	43	42.9	42.4	42.2	42	41.7

Determine freezing level

Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov freezing elev	11600	11300	11000	10800	10600	10400	10300	10200	9900	9700	9600	9500
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March freezing elev	10400	10100	9800	9600	9400	9300	9200	9000	8800	8500	8400	8400
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April freezing elev	10900	10500	10300	10100	10000	9700	9500	9400	9300	9200	9200	9000

Temperatures before storm:

48 hours before:	subtract 10
36 hours before:	subtract 9
24 hours before:	subtract 7
12 hour before:	subtract 4.5

Exhibit 9. PMS and Temperature Calculations – Interbay Dam

Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 1 of 10: All Season Storm Calculations

Step 1
Compute all season PMP for 89 square mile basin
at Interbay Dam **Tables, figures referenced from HMR 58**
use for November through March

Area = 113 square miles
Index PMP = 27.7 inches

Region = 5 (Sierra)
10 sq mi, 24 hour precip

Basin average elevation = 6100 feet

Depth duration for 10 square mile storm: Table 2.1			
duration	adjustment factor	index	depth
1	0.14	27.7	3.88
6	0.42	27.7	11.63
12	0.65	27.7	18.01
24	1	27.7	27.70
48	1.56	27.7	43.21
72	1.76	27.7	48.75

Adjust to 89 square miles: Table 2.3			
duration	adjustment factor for 89 mi2	10 mi2 depth	depth
1	0.837	3.88	3.25
6	0.851	11.63	9.90
12	0.865	18.01	15.57
24	0.879	27.70	24.35
48	0.9	43.21	38.89
72	0.918	48.75	44.75

Add points to smooth curve (sheet 2)					
hours	depth	incremental hours	incremental inches	depth per hour	per 6 hours
1.00	3.25	1	3.25	3.25	
3.00	6.40	2	3.15	1.58	
6.00	9.90	3	3.50	1.17	9.90
12.00	15.57	6	5.67	0.95	5.67
18.00	20.00	6	4.43	0.74	4.43
24.00	24.35	6	4.35	0.73	4.35
30.00	28.50	6	4.15	0.69	4.15
36.00	32.50	6	4.00	0.67	4.00
42.00	35.90	6	3.40	0.57	3.40
48.00	38.89	6	2.99	0.50	2.99
54.00	41.00	6	2.11	0.35	2.11
60.00	42.70	6	1.70	0.28	1.70
66.00	43.90	6	1.20	0.20	1.20
72.00	44.75	6	0.85	0.14	0.85

neglect small difference in PMP between subbasins-
use same for both with elevation redistribution through HEC1

6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments
1.00	1.20	1.00	0.15	5	4.43	25.00	0.72	9	4.00	49.00	0.68
		2.00	0.18			26.00	0.73			50.00	0.67
		3.00	0.19			27.00	0.73			51.00	0.67
		4.00	0.21			28.00	0.74			52.00	0.67
		5.00	0.22			29.00	0.75			53.00	0.66
		6.00	0.25			30.00	0.76			54.00	0.65
2.00	2.11	7.00	0.30	6	9.90	31.00	1.17	10	2.99	55.00	0.60
		8.00	0.32			32.00	1.56			56.00	0.57
		9.00	0.35			33.00	3.25			57.00	0.53
		10.00	0.36			34.00	1.60			58.00	0.47
		11.00	0.38			35.00	1.25			59.00	0.43
		12.00	0.40			36.00	1.07			60.00	0.39
3.00	3.40	13.00	0.50	7	5.67	37.00	1.02	11	1.70	61.00	0.35
		14.00	0.50			38.00	0.98			62.00	0.33
		15.00	0.60			39.00	0.96			63.00	0.30
		16.00	0.60			40.00	0.93			64.00	0.26
		17.00	0.60			41.00	0.90			65.00	0.24
		18.00	0.60			42.00	0.88			66.00	0.22
4.00	4.15	19.00	0.67	8	4.35	43.00	0.76	12	0.85	67.00	0.20
		20.00	0.68			44.00	0.75			68.00	0.17
		21.00	0.69			45.00	0.73			69.00	0.15
		22.00	0.70			46.00	0.72			70.00	0.14
		23.00	0.70			47.00	0.70			71.00	0.11
		24.00	0.71			48.00	0.69			72.00	0.08

Exhibit 9, Sheet 2 of 10
All Season PMP Depth-Duration Curve for Middle Fork at Interbay Dam

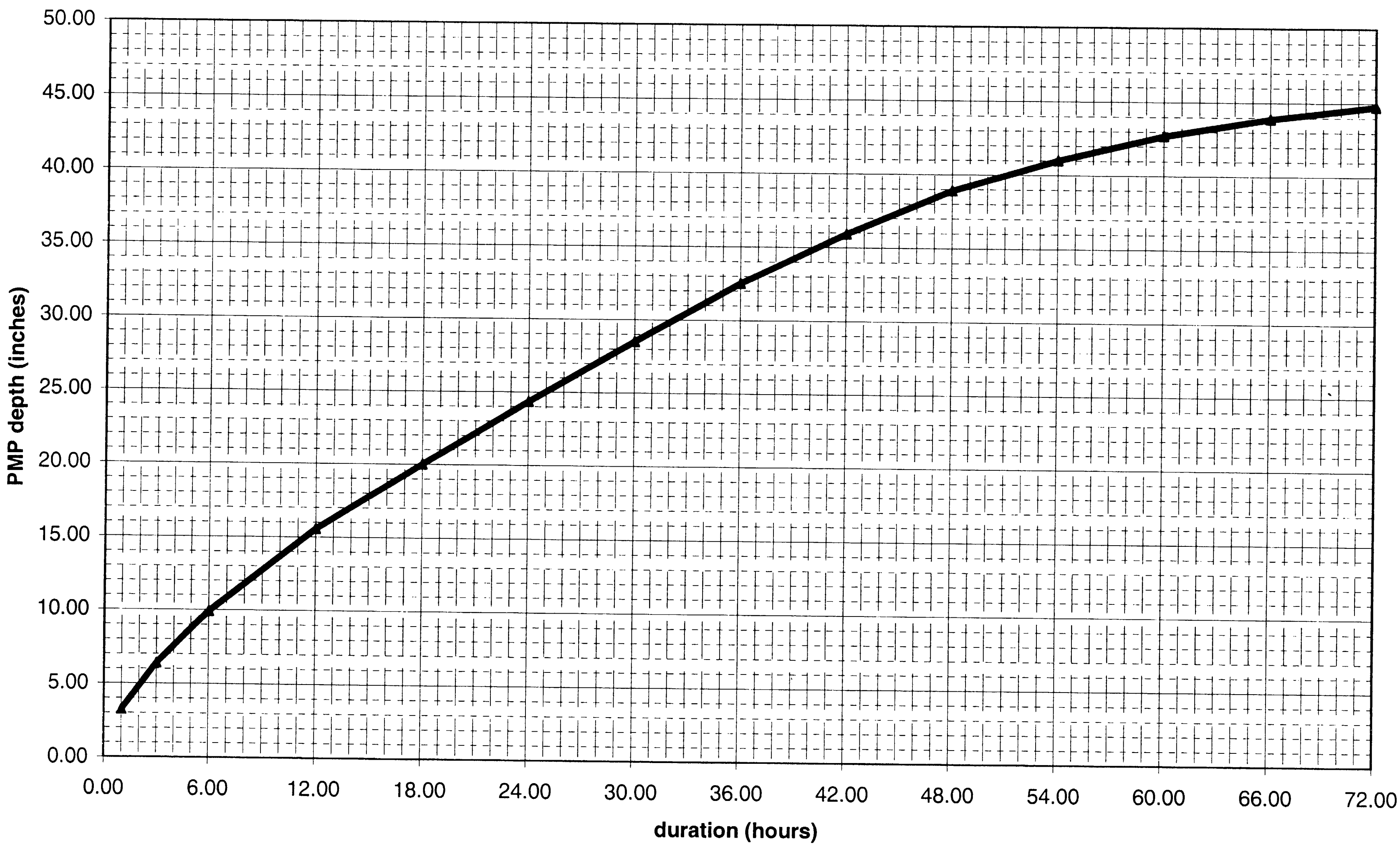


Exhibit 9, Sheet 3 of 10
All Season Probable Maximum Storm
for Middle Fork at Interbay Dam

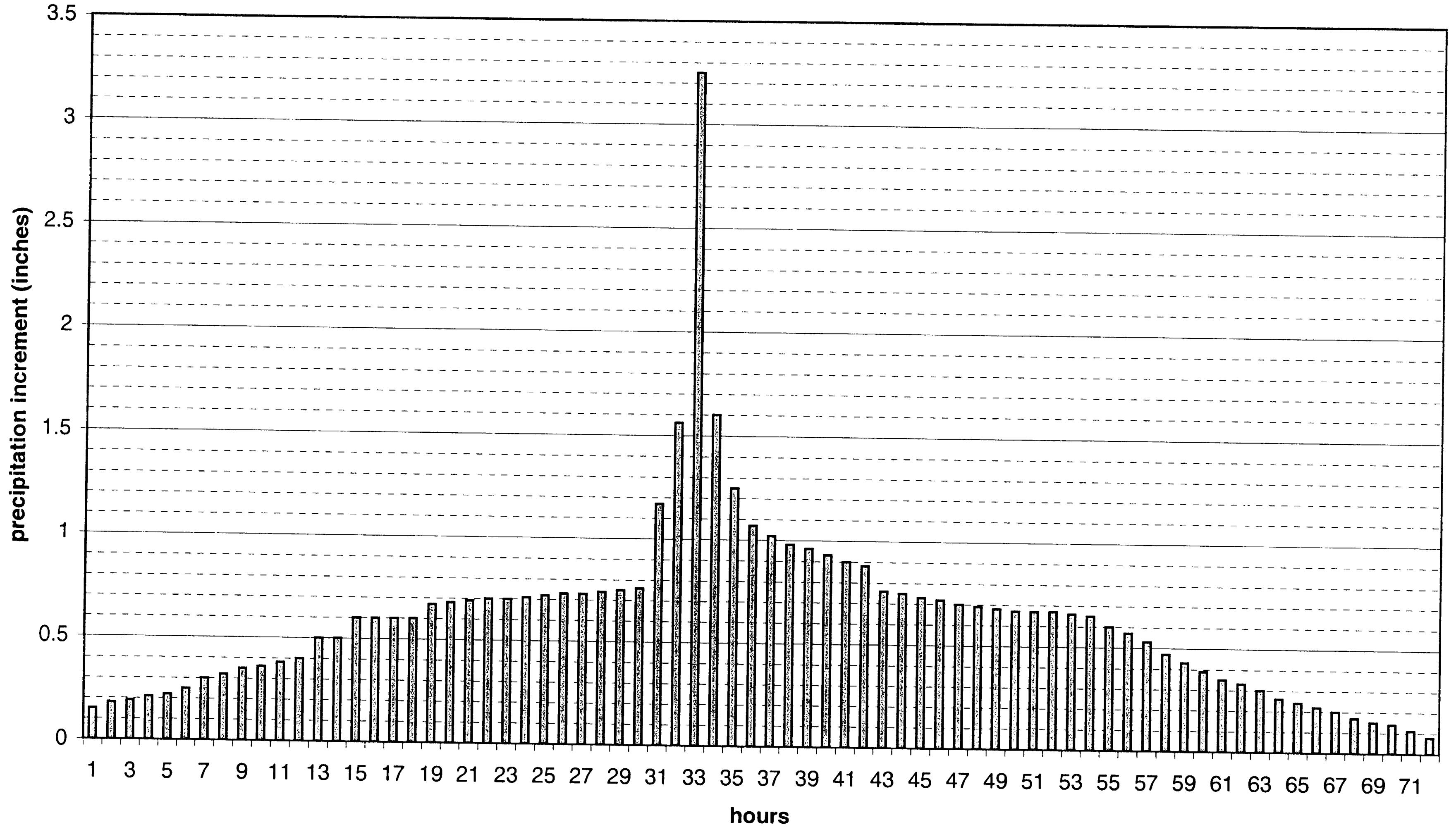


Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 4 of 10: All Season Storm Summary

All Season (November, March) storm summary

Temperature sequence from sheet 10 *in degrees Fahrenheit*

6 hr block	6 hr total p	hr	1 hr precip increments	November temps at 6100 feet	November freezing elev	March temps at 6100 feet	March freezing elev	
		-48 hours		32.8		29.3		subtract 10
		-36 hours		33.8		30.3		subtract 9
		-24 hours		35.8		32.3		subtract 7
		-12 hours'		38.3		34.8		subtract 4.5
1	1.2	1	0.15	42.8	9600	39.3	8400	
		2	0.18	42.8	9600	39.3	8400	
		3	0.19	42.8	9600	39.3	8400	
		4	0.21	42.8	9600	39.3	8400	
		5	0.22	42.8	9600	39.3	8400	
		6	0.25	42.8	9600	39.3	8400	
2	2.11	7	0.3	43.3	9900	39.6	8800	
		8	0.32	43.3	9900	39.6	8800	
		9	0.35	43.3	9900	39.6	8800	
		10	0.36	43.3	9900	39.6	8800	
		11	0.38	43.3	9900	39.6	8800	
		12	0.4	43.3	9900	39.6	8800	
3	3.4	13	0.5	44.3	10300	41.8	9200	
		14	0.5	44.3	10300	41.8	9200	
		15	0.6	44.3	10300	41.8	9200	
		16	0.6	44.3	10300	41.8	9200	
		17	0.6	44.3	10300	41.8	9200	
		18	0.6	44.3	10300	41.8	9200	
4	4.15	19	0.67	45.5	10600	42.4	9400	
		20	0.68	45.5	10600	42.4	9400	
		21	0.69	45.5	10600	42.4	9400	
		22	0.7	45.5	10600	42.4	9400	
		23	0.7	45.5	10600	42.4	9400	
		24	0.71	45.5	10600	42.4	9400	
5	4.43	25	0.72	46.4	11000	43.1	9800	
		26	0.73	46.4	11000	43.1	9800	
		27	0.73	46.4	11000	43.1	9800	
		28	0.74	46.4	11000	43.1	9800	
		29	0.75	46.4	11000	43.1	9800	
		30	0.76	46.4	11000	43.1	9800	
6	9.9	31	1.17	48.3	11600	44.8	10400	
		32	1.56	48.3	11600	44.8	10400	
		33	3.25	48.3	11600	44.8	10400	
		34	1.6	48.3	11600	44.8	10400	
		35	1.25	48.3	11600	44.8	10400	
		36	1.07	48.3	11600	44.8	10400	
7	5.67	37	1.02	47.2	11300	43.8	10100	
		38	0.98	47.2	11300	43.8	10100	
		39	0.96	47.2	11300	43.8	10100	
		40	0.93	47.2	11300	43.8	10100	
		41	0.9	47.2	11300	43.8	10100	
		42	0.88	47.2	11300	43.8	10100	
8	4.35	43	0.76	46.1	10800	42.7	9600	
		44	0.75	46.1	10800	42.7	9600	
		45	0.73	46.1	10800	42.7	9600	
		46	0.72	46.1	10800	42.7	9600	
		47	0.7	46.1	10800	42.7	9600	
		48	0.69	46.1	10800	42.7	9600	
9	4	49	0.68	44.9	10400	42.1	9300	
		50	0.67	44.9	10400	42.1	9300	
		51	0.67	44.9	10400	42.1	9300	
		52	0.67	44.9	10400	42.1	9300	
		53	0.66	44.9	10400	42.1	9300	
		54	0.65	44.9	10400	42.1	9300	
10	2.99	55	0.6	44	10200	41	9000	
		56	0.57	44	10200	41	9000	
		57	0.53	44	10200	41	9000	
		58	0.47	44	10200	41	9000	
		59	0.43	44	10200	41	9000	
		60	0.39	44	10200	41	9000	
11	1.7	61	0.35	42.9	9700	39.5	8500	
		62	0.33	42.9	9700	39.5	8500	
		63	0.3	42.9	9700	39.5	8500	
		64	0.26	42.9	9700	39.5	8500	
		65	0.24	42.9	9700	39.5	8500	
		66	0.22	42.9	9700	39.5	8500	
12	0.85	67	0.2	42.5	9500	39	8400	
		68	0.17	42.5	9500	39	8400	
		69	0.15	42.5	9500	39	8400	
		70	0.14	42.5	9500	39	8400	
		71	0.11	42.5	9500	39	8400	
		72	0.08	42.5	9500	39	8400	

Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 5 of 10: April General Storm Calculations

All Season index PMP	Factor Figure 2.3	April Index PMP	Offset
27.7	0.78	21.61	1 month

April depth duration values for 10-sq mi storm:

Duration	adjustment for 1 month offset (table 2.2)	index	depth
1	0.143	21.61	3.09
6	0.424	21.61	9.16
12	0.653	21.61	14.11
24	1	21.61	21.61
48	1.513	21.61	32.69
72	1.672	21.61	36.13

Adjust to 89 square miles (Table 2.7)

Duration	adjustment factor	depth for 10 sq mi	depth for 89 sq mi
1	0.863	3.09	2.67
6	0.879	9.16	8.05
12	0.896	14.11	12.64
24	0.917	21.61	19.81
48	0.937	32.69	30.63
72	0.966	36.13	34.90

Plot and add points to smooth

Duration	depth for 89 sq mi	incremental depth	incremental inch per hour	incremental depth per 6 hours
1	2.67	2.67	2.670	
3	5.10	2.43	1.215	
6	8.05	2.95	0.983	8.05
12	12.64	4.59	0.765	4.59
18	16.40	3.76	0.627	3.76
24	19.81	3.41	0.568	3.41
30	23.00	3.19	0.532	3.19
36	25.90	2.90	0.483	2.90
42	28.46	2.56	0.427	2.56
48	30.63	2.17	0.362	2.17
54	32.40	1.77	0.295	1.77
60	33.60	1.20	0.200	1.20
66	34.50	0.90	0.150	0.90
72	34.90	0.40	0.067	0.40

Arrange by 6 hour blocks

6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments
1	0.9	1	0.1	5	3.76	25	0.58	9	2.9	49	0.52
		2	0.12			26	0.6			50	0.51
		3	0.13			27	0.61			51	0.49
		4	0.17			28	0.63			52	0.48
		5	0.18			29	0.64			53	0.46
		6	0.2			30	0.7			54	0.44
2	1.77	7	0.24	6	8.05	31	0.98	10	2.17	55	0.42
		8	0.27			32	1.21			56	0.39
		9	0.29			33	2.67			57	0.37
		10	0.3			34	1.22			58	0.35
		11	0.32			35	1.02			59	0.33
		12	0.35			36	0.95			60	0.31
3	2.56	13	0.37	7	4.59	37	0.85	11	1.2	61	0.28
		14	0.39			38	0.81			62	0.25
		15	0.42			39	0.78			63	0.23
		16	0.44			40	0.75			64	0.17
		17	0.46			41	0.72			65	0.15
		18	0.48			42	0.68			66	0.12
4	3.19	19	0.5	8	3.41	43	0.62	12	0.4	67	0.09
		20	0.51			44	0.59			68	0.07
		21	0.52			45	0.57			69	0.06
		22	0.54			46	0.56			70	0.06
		23	0.55			47	0.54			71	0.06
		24	0.57			48	0.53			72	0.06

Exhibit 9, Sheet 6 of 10
April PMP Depth-Duration Curve for Middle Fork at Interbay Dam

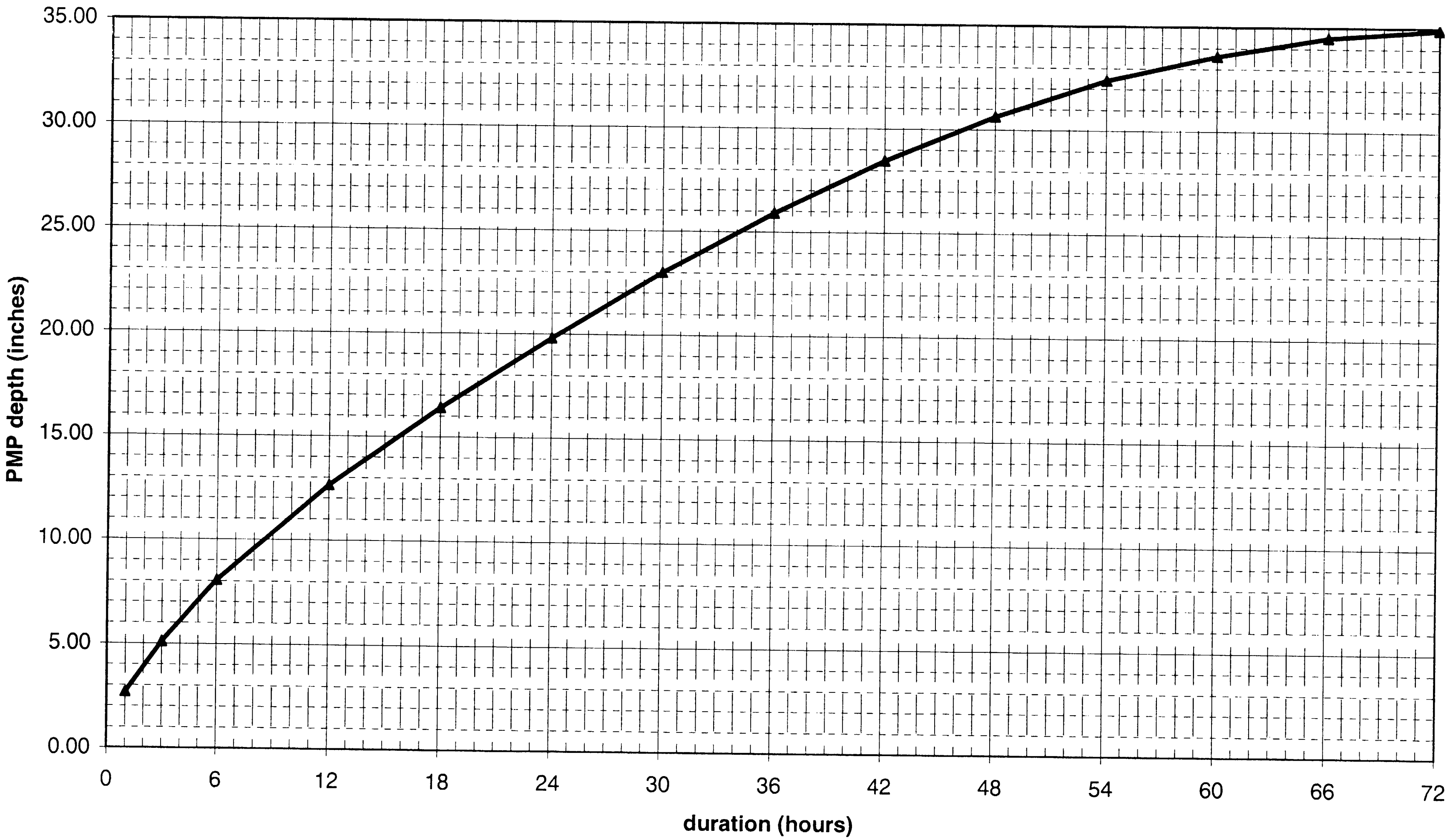


Exhibit 9, Sheet 7 of 10
April Probable Maximum Storm for Middle Fork at Interbay Dam

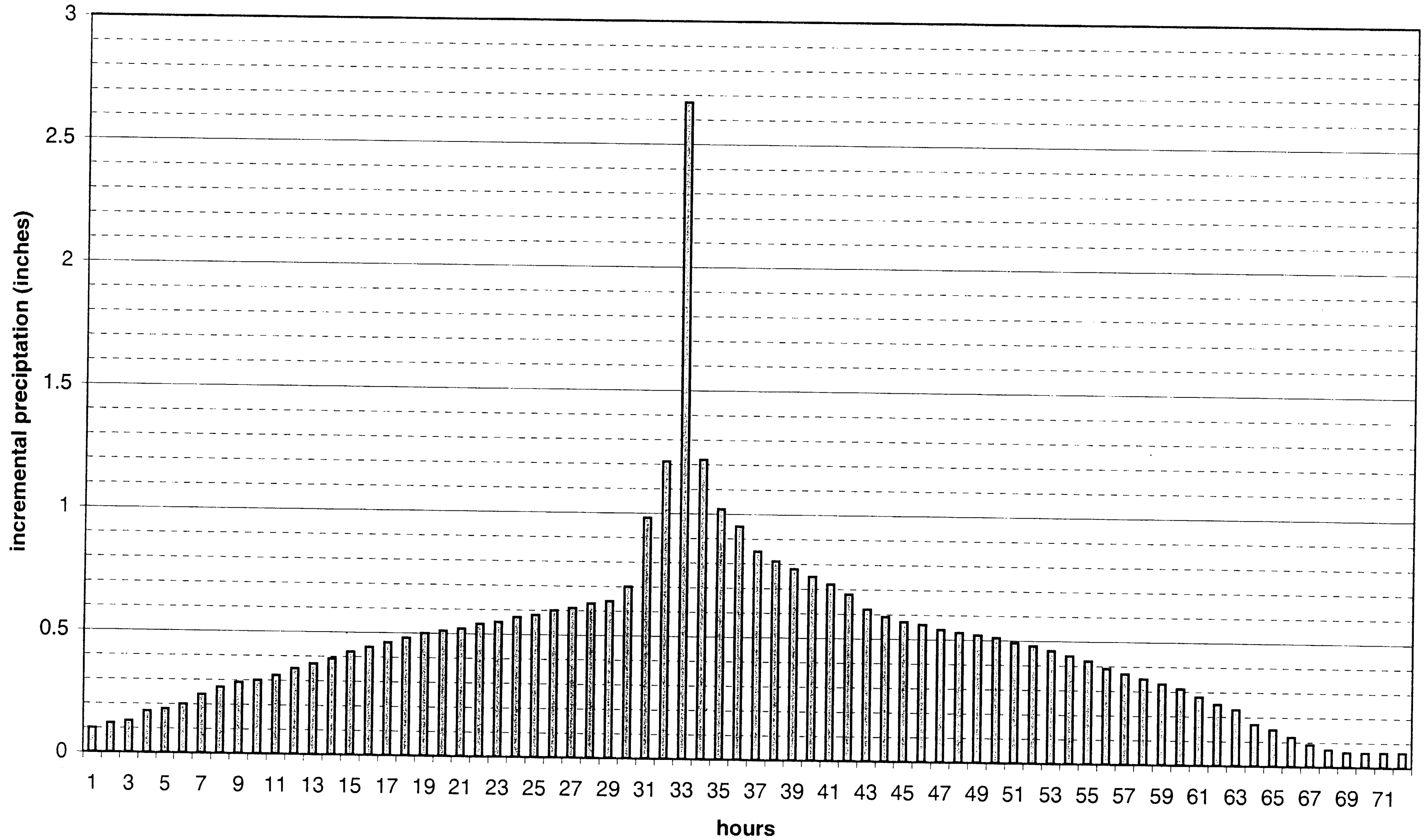


Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 8 of 10: April Storm Summary

Temperature sequence from sheet 10 — *in degrees Fahrenheit*

6 hr block	6 hr total	hr	1 hr increments	April temps	April freezing elevation	
			-48 hours	32		subtract 10
			-36 hours	33		subtract 9
			-24 hours	35		subtract 7
			-12 hours'	37.5		subtract 4.5
				'		
1	0.90	1	0.1	41.8	9200	
		2	0.12	41.8	9200	
		3	0.13	41.8	9200	
		4	0.17	41.8	9200	
		5	0.18	41.8	9200	
		6	0.2	41.8	9200	
2	1.77	7	0.24	42.1	9300	
		8	0.27	42.1	9300	
		9	0.29	42.1	9300	
		10	0.3	42.1	9300	
		11	0.32	42.1	9300	
		12	0.35	42.1	9300	
3	2.56	13	0.37	42.5	9500	
		14	0.39	42.5	9500	
		15	0.42	42.5	9500	
		16	0.44	42.5	9500	
		17	0.46	42.5	9500	
		18	0.48	42.5	9500	
4	3.19	19	0.5	43.5	10000	
		20	0.51	43.5	10000	
		21	0.52	43.5	10000	
		22	0.54	43.5	10000	
		23	0.55	43.5	10000	
		24	0.57	43.5	10000	
5	3.76	25	0.58	44.3	10300	
		26	0.6	44.3	10300	
		27	0.61	44.3	10300	
		28	0.63	44.3	10300	
		29	0.64	44.3	10300	
		30	0.7	44.3	10300	
6	8.05	31	0.98	46.3	10900	
		32	1.21	46.3	10900	
		33	2.67	46.3	10900	
		34	1.22	46.3	10900	
		35	1.02	46.3	10900	
		36	0.95	46.3	10900	
7	4.59	37	0.85	45	10500	
		38	0.81	45	10500	
		39	0.78	45	10500	
		40	0.75	45	10500	
		41	0.72	45	10500	
		42	0.68	45	10500	
8	3.41	43	0.62	43.9	10100	
		44	0.59	43.9	10100	
		45	0.57	43.9	10100	
		46	0.56	43.9	10100	
		47	0.54	43.9	10100	
		48	0.53	43.9	10100	
9	2.90	49	0.52	43	9700	
		50	0.51	43	9700	
		51	0.49	43	9700	
		52	0.48	43	9700	
		53	0.46	43	9700	
		54	0.44	43	9700	
10	2.17	55	0.42	42.4	9400	
		56	0.39	42.4	9400	
		57	0.37	42.4	9400	
		58	0.35	42.4	9400	
		59	0.33	42.4	9400	
		60	0.31	42.4	9400	
11	1.20	61	0.28	41.9	9200	
		62	0.25	41.9	9200	
		63	0.23	41.9	9200	
		64	0.17	41.9	9200	
		65	0.15	41.9	9200	
		66	0.12	41.9	9200	
12	0.40	67	0.09	41	9000	
		68	0.07	41	9000	
		69	0.06	41	9000	
		70	0.06	41	9000	
		71	0.06	41	9000	
		72	0.06	41	9000	

34.9

Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 9 of 10: Local Storm Summary

1 hour, 1 square mile local PMP			8.5 inches		
adjust for 6100 feet		0.991	8.4 inches		
ratio of 6 hour to 1 hour PMP:			1.2	Region B	
6 hour local PMP:		10.1 inches			
Duration	Ratio (Table 2.10, Region B)	1 hr value	depth		
0.5	0.79	8.4	6.64		
1	1	8.4	8.40		
2	1.105	8.4	9.28		
3	1.16	8.4	9.74		
4	1.18	8.4	9.91		
5	1.19	8.4	10.00		
6	1.2	8.4	10.08		
Adjust for 89 square miles (Figure 2.26)					
Duration	1-mi2 depth	adjustment	89 mi2 average depth	**incremental**	
0.5	6.64	0.46	3.05		
1	8.40	0.52	4.37	**4.37**	
2	9.28	0.55	5.11	**0.74**	
3	9.74	0.57	5.55	**0.45**	
4	9.91	0.58	5.75	**0.19**	
5	10.00	0.58	5.80	**0.05**	
6	10.08	0.59	5.95	**0.15**	

Exhibit 9
PMP Calculations for 89-square-mile basin at Interbay Dam
Sheet 10 of 10: Temperature Sequences

Average elevation = 6100 feet
Average 12 hour February persisting dewpoint = 60 degrees (Figure A8)
Wp = 1.36 inches (Figure A1)

Seasonal Adjustments (Table A1)

Month	Factor	Feb wp	adjusted
November	1.17	1.36	1.59
March	1.03	1.36	1.40
April	1.09	1.36	1.48

Distribute by 6 hour increments (Table A2)

Month	adjusted Wp	6 hr (1.04)	12 hr (1.0)	18 hr (0.97)	24 hr (0.95)	30 hr (0.93)	36 hr (0.91)	42 hr (0.89)	48 hr (0.88)	54 hr (0.86)	60 hr (0.85)	66 hr (0.84)	72 hr (0.83)
November	1.59	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
March	1.40	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
April	1.48	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23

Sea Level Temperatures (Figure A1)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov Wp	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
sea level Nov temp	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
March Wp	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
sea level March temp	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
April Wp	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23
sea level April temp	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9

Adjust to 6100 feet (Figure A2)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov temp at 6100 ft	48.3	47.2	46.4	46.1	45.8	44.9	[illegible]	44	43.3	[illegible]	42.8	[illegible]
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March temp at 6100 feet	44.8	43.8	43.1	42.7	42.4	[illegible]	41.8	41	39.6	39.5	39.3	39
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April temp at 6100 feet	46.8	45	44.3	43.9	43.5	43	42.5	42.4	[illegible]	41.9	41.8	41

Determine freezing level

Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov freezing elev	11600	11300	11000	10800	10600	10400	10300	10200	9900	9700	9600	9500
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March freezing elev	10400	10100	9800	9600	9400	9300	9200	9000	8800	8500	8400	8400
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April freezing elev	10900	10500	10300	10100	10000	9700	9500	9400	9300	9200	9200	9000

Temperatures before storm:

48 hours before:	subtract 10
36 hours before:	subtract 9
24 hours before:	subtract 7
12 hour before:	subtract 4.5

Exhibit 10. PMS and Temperature Calculations – Ralston Afterbay Dam

Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 1 of 11: All Season depth-duration calculations

Step 1
Compute all season PMP for 425 square mile basin
at Ralston Afterbay
use for October through March

Tables, figures referenced from HMR 58

Area = 425 square miles
Index PMP = 25.5 inches

Region = 5 (Sierra)
10 sq mi, 24 hour precip

Basin average elevation = 5300 feet

Depth duration for 10 square mile storm: Table 2.1

duration	adjustment factor	index	depth
1	0.14	25.5	3.57
6	0.42	25.5	10.71
12	0.65	25.5	16.58
24	1	25.5	25.50
48	1.56	25.5	39.78
72	1.76	25.5	44.88

Adjust to 425 square miles: Table 2.3

duration	adjustment factor for 425 mi2	10 mi2 depth	depth
1	0.72	3.57	2.57
6	0.74	10.71	7.93
12	0.76	16.58	12.60
24	0.785	25.50	20.02
48	0.82	39.78	32.62
72	0.85	44.88	38.15

Add points to smooth curve

hours	adjustment factor for 425 mi2	10 mi2 depth	depth	incremental hours	incremental inches	incremental depth per hour	Per 6 hour increment
1.00	0.72	3.57	2.57	1	2.57	2.57	
3.00			5.30	2	2.73	1.36	
6.00	0.74	10.71	7.93	3	2.63	0.88	7.93
12.00	0.76	16.58	12.60	6	4.67	0.78	4.67
24.00	0.79	25.50	20.02	12	7.42	0.62	3.71
30.00			23.60	6	3.58	0.60	3.58
36.00			26.80	6	3.20	0.53	3.2
48.00	0.82	39.78	32.62	12	5.82	0.48	2.91
54.00			34.50	6	1.88	0.31	1.88
60.00			36.30	6	1.80	0.30	1.8
72.00	0.85	44.88	38.15	12	1.85	0.15	0.93

Exhibit 10, Sheet 2 of 11
All Season PMP Depth-Duration Curve for Middle Fork above Ralston Afterbay

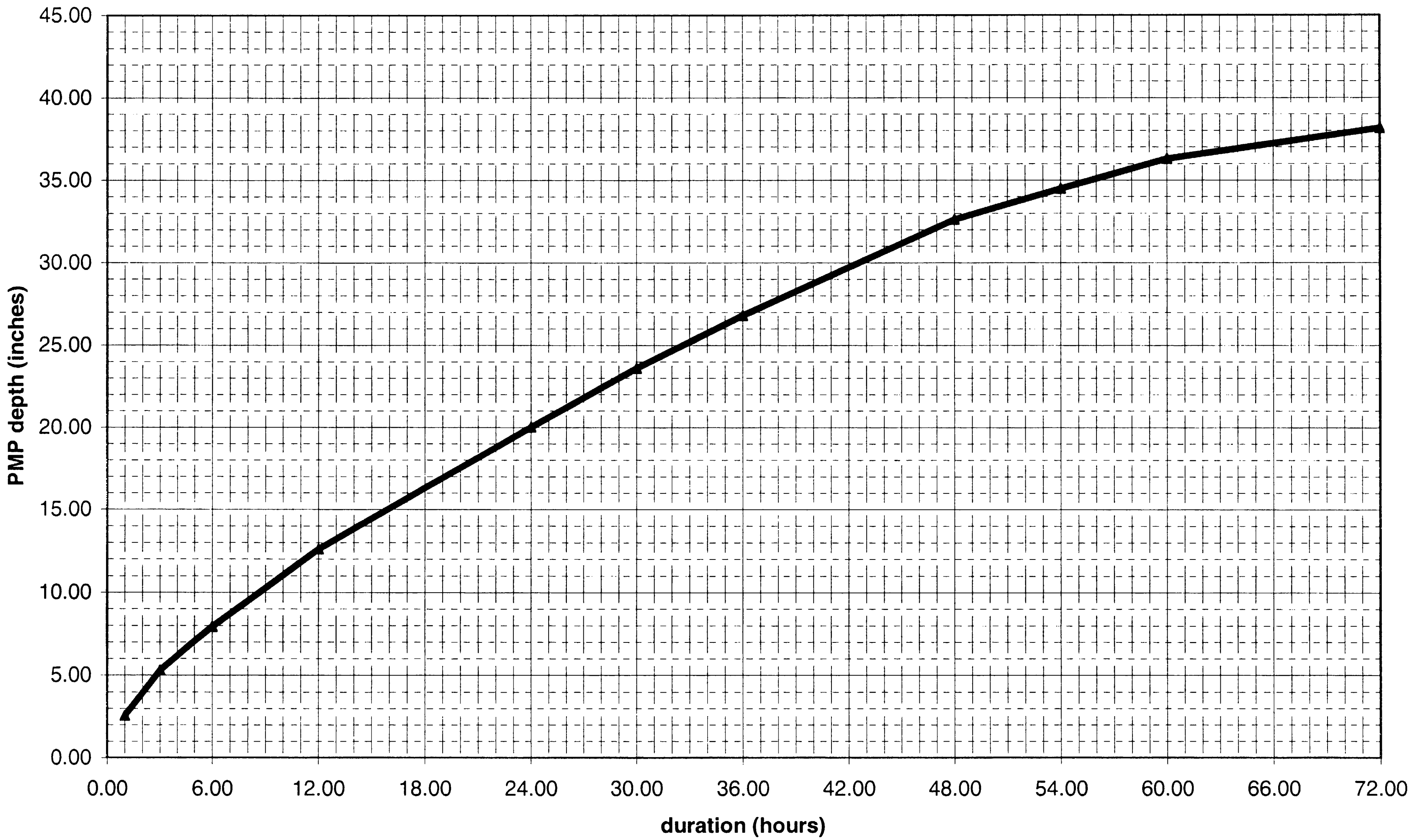


Exhibit 10, Sheet 3 of 11
Probable Maximum Storm for Middle Fork at Ralston Afterbay

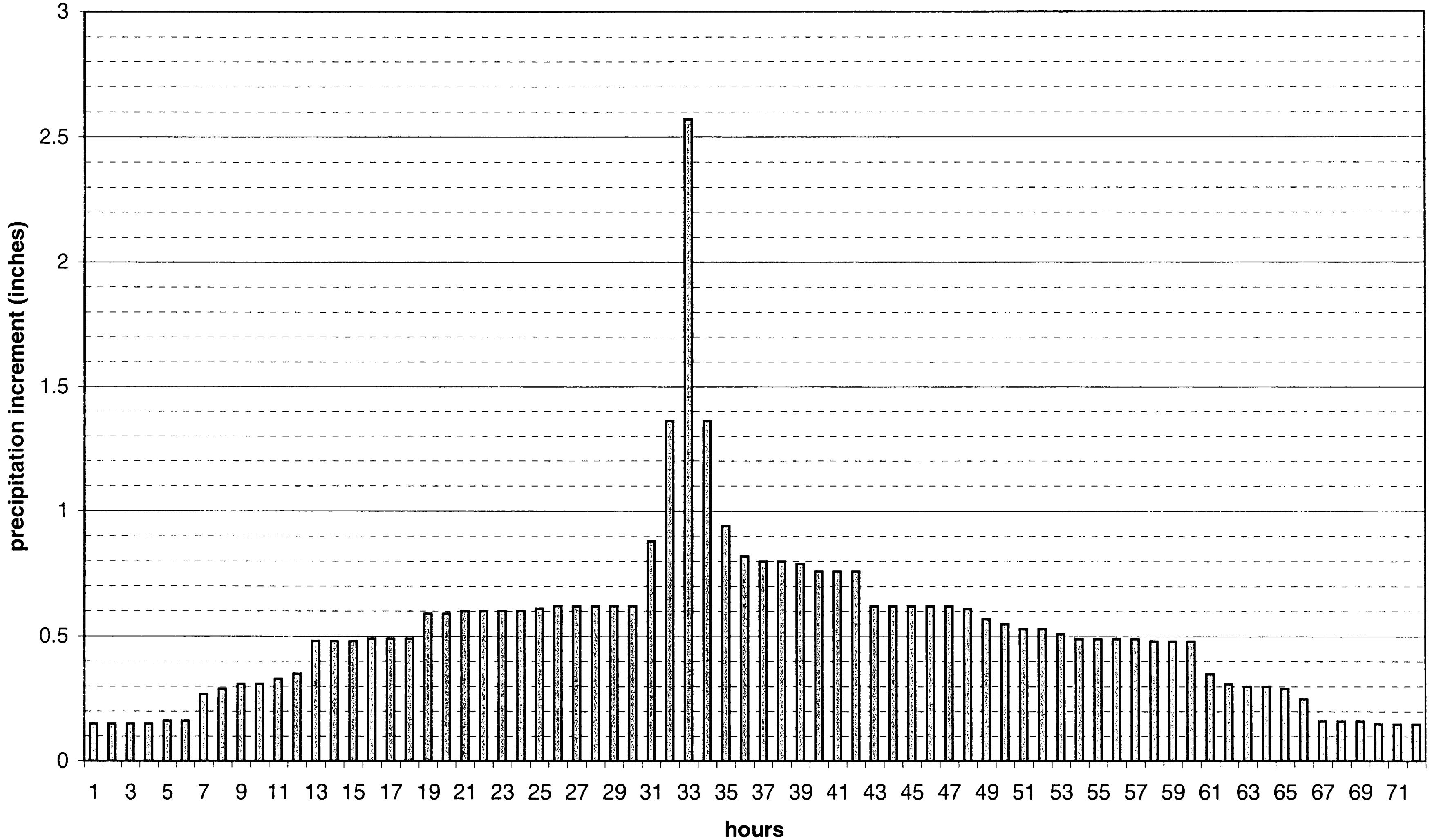


Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 4 of 11: All Season hourly precipitation sequences

Develop one hour increments
and distribute over subbasins using 100 yr/index PMP ratios

6 hr block	6 hr total	hr	whole basin 1 hr increments	FM (1.10)	UHH (1.02)	LHH (1.02)	Duncan (1.06)	Loon Lake (1.00)	Middle Rubicon (0.94)	Lower Rubicon (0.90)	Stumpy (0.94)	Long Canyon (0.98)	Lower Middle Fork (0.88)
1	0.92	1	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		2	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		3	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		4	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		5	0.16	0.176	0.163	0.163	0.173	0.160	0.150	0.144	0.150	0.157	0.141
		6	0.16	0.176	0.163	0.163	0.173	0.160	0.150	0.144	0.150	0.157	0.141
2	1.88	7	0.27	0.297	0.275	0.275	0.292	0.270	0.254	0.243	0.254	0.265	0.238
		8	0.29	0.319	0.296	0.296	0.313	0.290	0.273	0.261	0.273	0.284	0.255
		9	0.31	0.341	0.316	0.316	0.335	0.310	0.291	0.279	0.291	0.304	0.273
		10	0.31	0.341	0.316	0.316	0.335	0.310	0.291	0.279	0.291	0.304	0.273
		11	0.33	0.363	0.337	0.337	0.356	0.330	0.310	0.297	0.310	0.323	0.290
		12	0.35	0.385	0.357	0.357	0.378	0.350	0.329	0.315	0.329	0.343	0.308
3	2.91	13	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
		14	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
		15	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
		16	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
		17	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
		18	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
4	3.58	19	0.59	0.649	0.602	0.602	0.637	0.590	0.555	0.531	0.555	0.578	0.519
		20	0.59	0.649	0.602	0.602	0.637	0.590	0.555	0.531	0.555	0.578	0.519
		21	0.6	0.660	0.612	0.612	0.648	0.600	0.564	0.540	0.564	0.588	0.528
		22	0.6	0.660	0.612	0.612	0.648	0.600	0.564	0.540	0.564	0.588	0.528
		23	0.6	0.660	0.612	0.612	0.648	0.600	0.564	0.540	0.564	0.588	0.528
		24	0.6	0.660	0.612	0.612	0.648	0.600	0.564	0.540	0.564	0.588	0.528
5	3.71	25	0.61	0.671	0.622	0.622	0.659	0.610	0.573	0.549	0.573	0.598	0.537
		26	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		27	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		28	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		29	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		30	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
6	7.93	31	0.88	0.968	0.898	0.898	0.950	0.880	0.827	0.792	0.827	0.862	0.774
		32	1.36	1.496	1.387	1.387	1.469	1.360	1.278	1.224	1.278	1.333	1.197
		33	2.57	2.827	2.621	2.621	2.776	2.570	2.416	2.313	2.416	2.519	2.262
		34	1.36	1.496	1.387	1.387	1.469	1.360	1.278	1.224	1.278	1.333	1.197
		35	0.94	1.034	0.959	0.959	1.015	0.940	0.884	0.846	0.884	0.921	0.827
		36	0.82	0.902	0.836	0.836	0.886	0.820	0.771	0.738	0.771	0.804	0.722
7	4.67	37	0.8	0.880	0.816	0.816	0.864	0.800	0.752	0.720	0.752	0.784	0.704
		38	0.8	0.880	0.816	0.816	0.864	0.800	0.752	0.720	0.752	0.784	0.704
		39	0.79	0.869	0.806	0.806	0.853	0.790	0.743	0.711	0.743	0.774	0.695
		40	0.76	0.836	0.775	0.775	0.821	0.760	0.714	0.684	0.714	0.745	0.669
		41	0.76	0.836	0.775	0.775	0.821	0.760	0.714	0.684	0.714	0.745	0.669
		42	0.76	0.836	0.775	0.775	0.821	0.760	0.714	0.684	0.714	0.745	0.669
8	3.71	43	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		44	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		45	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		46	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		47	0.62	0.682	0.632	0.632	0.670	0.620	0.583	0.558	0.583	0.608	0.546
		48	0.61	0.671	0.622	0.622	0.659	0.610	0.573	0.549	0.573	0.598	0.537
9	3.2	49	0.57	0.627	0.581	0.581	0.616	0.570	0.536	0.513	0.536	0.559	0.502
		50	0.55	0.605	0.561	0.561	0.594	0.550	0.517	0.495	0.517	0.539	0.484
		51	0.53	0.583	0.541	0.541	0.572	0.530	0.498	0.477	0.498	0.519	0.466
		52	0.53	0.583	0.541	0.541	0.572	0.530	0.498	0.477	0.498	0.519	0.466
		53	0.51	0.561	0.520	0.520	0.551	0.510	0.479	0.459	0.479	0.500	0.449
		54	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
10	2.91	55	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
		56	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
		57	0.49	0.539	0.500	0.500	0.529	0.490	0.461	0.441	0.461	0.480	0.431
		58	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
		59	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
		60	0.48	0.528	0.490	0.490	0.518	0.480	0.451	0.432	0.451	0.470	0.422
11	1.8	61	0.35	0.385	0.357	0.357	0.378	0.350	0.329	0.315	0.329	0.343	0.308
		62	0.31	0.341	0.316	0.316	0.335	0.310	0.291	0.279	0.291	0.304	0.273
		63	0.3	0.330	0.306	0.306	0.324	0.300	0.282	0.270	0.282	0.294	0.264
		64	0.3	0.330	0.306	0.306	0.324	0.300	0.282	0.270	0.282	0.294	0.264
		65	0.29	0.319	0.296	0.296	0.313	0.290	0.273	0.261	0.273	0.284	0.255
		66	0.25	0.275	0.255	0.255	0.270	0.250	0.235	0.225	0.235	0.245	0.220
12	0.93	67	0.16	0.176	0.163	0.163	0.173	0.160	0.150	0.144	0.150	0.157	0.141
		68	0.16	0.176	0.163	0.163	0.173	0.160	0.150	0.144	0.150	0.157	0.141
		69	0.16	0.176	0.163	0.163	0.173	0.160	0.150	0.144	0.150	0.157	0.141
		70	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		71	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132
		72	0.15	0.165	0.153	0.153	0.162	0.150	0.141	0.135	0.141	0.147	0.132

Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 5 of 11: All season hourly precipitation sequences

All Season (November and March) storm summary

	November temps at 5300 feet	November freezing elev	March temps at 5300 feet	March freezing elev	
-48 hours	35		32		subtract 10
-36 hours	36		33		subtract 9
-24 hours	38		35		subtract 7
-12 hours'	40.5		37.5		subtract 4.5

6 hr block	6 hr total precip	hr	basin average 1 hr precip increments	FM (1.10)	UHH (1.02)	LHH (1.02)	Duncan (1.08)	Loon Lake (1.00)	Middle Rubicon (0.94)	Lower Rubicon (0.90)	Stumpy (0.94)	Long Canyon (0.98)	Lower Middle Fork (0.88)	November temps at 5300 feet	November freezing elev	March temps at 5300 feet	March freezing elev	
1	0.92	1	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	45	9600	42	8400	
		2	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	45	9600	42	8400	
		3	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	45	9600	42	8400	
		4	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	45	9600	42	8400	
		5	0.16	0.18	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.16	0.14	45	9600	42	8400	
		6	0.16	0.18	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.16	0.14	45	9600	42	8400	
2	1.88	7	0.27	0.30	0.28	0.28	0.29	0.27	0.25	0.24	0.25	0.26	0.24	45.8	9900	42.2	8800	
		8	0.29	0.32	0.30	0.30	0.31	0.29	0.27	0.26	0.27	0.28	0.26	45.8	9900	42.2	8800	
		9	0.31	0.34	0.32	0.32	0.33	0.31	0.29	0.28	0.29	0.30	0.27	45.8	9900	42.2	8800	
		10	0.31	0.34	0.32	0.32	0.33	0.31	0.29	0.28	0.29	0.30	0.27	45.8	9900	42.2	8800	
		11	0.33	0.36	0.34	0.34	0.36	0.33	0.31	0.30	0.31	0.32	0.29	45.8	9900	42.2	8800	
		12	0.35	0.39	0.36	0.36	0.38	0.35	0.33	0.32	0.33	0.34	0.31	45.8	9900	42.2	8800	
3	2.91	13	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.9	10300	44.1	9200	
		14	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.9	10300	44.1	9200	
		15	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.9	10300	44.1	9200	
		16	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.9	10300	44.1	9200	
		17	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.9	10300	44.1	9200	
		18	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.9	10300	44.1	9200	
4	3.58	19	0.59	0.65	0.60	0.60	0.64	0.59	0.55	0.53	0.55	0.58	0.52	47.9	10600	44.6	9400	
		20	0.59	0.65	0.60	0.60	0.64	0.59	0.55	0.53	0.55	0.58	0.52	47.9	10600	44.6	9400	
		21	0.6	0.66	0.61	0.61	0.65	0.60	0.56	0.54	0.56	0.59	0.53	47.9	10600	44.6	9400	
		22	0.6	0.66	0.61	0.61	0.65	0.60	0.56	0.54	0.56	0.59	0.53	47.9	10600	44.6	9400	
		23	0.6	0.66	0.61	0.61	0.65	0.60	0.56	0.54	0.56	0.59	0.53	47.9	10600	44.6	9400	
		24	0.6	0.66	0.61	0.61	0.65	0.60	0.56	0.54	0.56	0.59	0.53	47.9	10600	44.6	9400	
5	3.71	25	0.61	0.67	0.62	0.62	0.66	0.61	0.57	0.55	0.57	0.60	0.54	48.9	11000	45.7	9800	
		26	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.9	11000	45.7	9800	
		27	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.9	11000	45.7	9800	
		28	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.9	11000	45.7	9800	
		29	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.9	11000	45.7	9800	
		30	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.9	11000	45.7	9800	
6	7.93	31	0.88	0.97	0.90	0.90	0.95	0.88	0.83	0.79	0.83	0.86	0.77	50.5	11600	47.4	10400	
		32	1.36	1.50	1.39	1.39	1.47	1.36	1.28	1.22	1.28	1.33	1.20	50.5	11600	47.4	10400	
		33	2.57	2.83	2.62	2.62	2.78	2.57	2.42	2.31	2.42	2.52	2.26	50.5	11600	47.4	10400	
		34	1.36	1.50	1.39	1.39	1.47	1.36	1.28	1.22	1.28	1.33	1.20	50.5	11600	47.4	10400	
		35	0.94	1.03	0.96	0.96	1.02	0.94	0.88	0.85	0.88	0.92	0.83	50.5	11600	47.4	10400	
		36	0.82	0.90	0.84	0.84	0.89	0.82	0.77	0.74	0.77	0.80	0.72	50.5	11600	47.4	10400	
7	4.67	37	0.8	0.88	0.82	0.82	0.86	0.80	0.75	0.72	0.75	0.78	0.70	49.6	11300	46.4	10100	
		38	0.8	0.88	0.82	0.82	0.86	0.80	0.75	0.72	0.75	0.78	0.70	49.6	11300	46.4	10100	
		39	0.79	0.87	0.81	0.81	0.85	0.79	0.74	0.71	0.74	0.77	0.70	49.6	11300	46.4	10100	
		40	0.76	0.84	0.78	0.78	0.82	0.76	0.71	0.68	0.71	0.74	0.67	49.6	11300	46.4	10100	
		41	0.76	0.84	0.78	0.78	0.82	0.76	0.71	0.68	0.71	0.74	0.67	49.6	11300	46.4	10100	
		42	0.76	0.84	0.78	0.78	0.82	0.76	0.71	0.68	0.71	0.74	0.67	49.6	11300	46.4	10100	
8	3.71	43	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.4	10800	45	9600	
		44	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.4	10800	45	9600	
		45	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.4	10800	45	9600	
		46	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.4	10800	45	9600	
		47	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	48.4	10800	45	9600	
		48	0.61	0.67	0.62	0.62	0.66	0.61	0.57	0.55	0.57	0.60	0.54	48.4	10800	45	9600	
9	3.2	49	0.57	0.63	0.58	0.58	0.62	0.57	0.54	0.51	0.54	0.56	0.50	47.6	10400	44.4	9300	
		50	0.55	0.61	0.56	0.56	0.59	0.55	0.52	0.50	0.52	0.54	0.48	47.6	10400	44.4	9300	
		51	0.53	0.58	0.54	0.54	0.57	0.53	0.50	0.48	0.50	0.52	0.47	47.6	10400	44.4	9300	
		52	0.53	0.58	0.54	0.54	0.57	0.53	0.50	0.48	0.50	0.52	0.47	47.6	10400	44.4	9300	
		53	0.51	0.56	0.52	0.52	0.55	0.51	0.48	0.46	0.48	0.50	0.45	47.6	10400	44.4	9300	
		54	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	47.6	10400	44.4	9300	
10	2.91	55	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.7	10200	43.3	9000	
		56	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.7	10200	43.3	9000	
		57	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.7	10200	43.3	9000	
		58	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.7	10200	43.3	9000	
		59	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.7	10200	43.3	9000	
		60	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.7	10200	43.3	9000	
11	1.8	61	0.35	0.39	0.36	0.36	0.38	0.35	0.33	0.32	0.33	0.34	0.31	45.3	9700	42.1	8500	
		62	0.31	0.34	0.32	0.32	0.33	0.31	0.29	0.28	0.29	0.30	0.27	45.3	9700	42.1	8500	
		63	0.3	0.33	0.31	0.31	0.32	0.30	0.28	0.27	0.28	0.29	0.26	45.3	9700	42.1	8500	
		64	0.3	0.33	0.31	0.31	0.32	0.30	0.28	0.27	0.28	0.29	0.26	45.3	9700	42.1	8500	
		65	0.29	0.32	0.30	0.30	0.31	0.29	0.27	0.26	0.27	0.28	0.26	45.3	9700	42.1	8500	
		66	0.25	0.28	0.26	0.26	0.27	0.25	0.24	0.23	0.24	0.25	0.22	45.3	9700	42.1	8500	
12	0.93	67	0.16	0.18	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.16	0.14	44.8	9500	41.8	8400	
		68	0.16	0.18	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.16	0.14	44.8	9500	41.8	8400	
		69	0.16	0.18	0.16	0.16	0.17	0.16	0.15	0.14	0.15	0.16	0.14	44.8	9500	41.8	8400	
		70	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	44.8	9500	41.8	8400	
		71	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	44.8	9500	41.8	8400	
		72	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	44.8	9500	41.8	8400	

Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 6 of 11: April PMP Calculations

All Season index PMP	Factor Figure 2.3	April index PMP	Offset
25.5	0.8	20.4	1 month

April depth duration values for 10-sq mi storm:

Duration	adjustment for 1 month offset (table 2.2)	index	depth
1	0.143	20.4	2.92
6	0.424	20.4	8.65
12	0.653	20.4	13.32
24	1	20.4	20.40
48	1.513	20.4	30.87
72	1.672	20.4	34.11

Adjust to 425 square miles (Table 2.7)

Duration	adjustment factor	depth for 10 sq mi	depth for 425 sq mi
1	0.69	2.92	2.01
6	0.73	8.65	6.31
12	0.76	13.32	10.12
24	0.8	20.40	16.32
48	0.84	30.87	25.93
72	0.87	34.11	29.67

Plot and add points to smooth

Duration	adjustment factor	depth for 10 sq mi	depth for 425 sq mi	cumulative 6 hr depth	incremental 6 hr depth	incremental inch per hour
1	0.69	2.92	2.01			2.010
3			4.10			1.045
6	0.73	8.65	6.31	6.31	6.31	0.737
12	0.76	13.32	10.12	10.12	3.81	0.635
18			13.24	13.24	3.12	0.520
24	0.8	20.40	16.32	16.32	3.08	0.513
30			19.30	19.30	2.98	0.497
36			22.00	22.00	2.70	0.450
42			24.10	24.10	2.10	0.350
48	0.84	30.87	25.93	25.93	1.83	0.305
54			27.25	27.25	1.32	0.220
60			28.30	28.30	1.05	0.175
66			29.10	29.10	0.80	0.133
72	0.87	34.11	29.67	29.67	0.57	0.096

Arrange by 6 hour blocks
reapportion by subbasin through precip ratio in HEC1

6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments	6 hr block	6 hr total	hr	1 hr increments
1	0.8	1	0.1	5	3.08	25	0.5	9	2.7	49	0.47
		2	0.13			26	0.5			50	0.46
		3	0.13			27	0.51			51	0.45
		4	0.13			28	0.51			52	0.45
		5	0.14			29	0.52			53	0.44
		6	0.17			30	0.53			54	0.43
2	1.32	7	0.2	6	6.31	31	0.737	10	1.83	55	0.33
		8	0.21			32	1.045			56	0.31
		9	0.22			33	2.01			57	0.31
		10	0.22			34	1.045			58	0.3
		11	0.23			35	0.8			59	0.3
		12	0.24			36	0.67			60	0.28
3	2.1	13	0.3	7	3.81	37	0.65	11	1.05	61	0.22
		14	0.33			38	0.64			62	0.2
		15	0.35			39	0.635			63	0.18
		16	0.35			40	0.635			64	0.17
		17	0.37			41	0.63			65	0.15
		18	0.4			42	0.62			66	0.13
4	2.98	19	0.49	8	3.12	43	0.56	12	0.57	67	0.1
		20	0.49			44	0.54			68	0.1
		21	0.5			45	0.53			69	0.1
		22	0.5			46	0.51			70	0.09
		23	0.5			47	0.5			71	0.09
		24	0.5			48	0.48			72	0.09

Exhibit 10, Sheet 7 of 11
April PMP Depth-Duration Curve for Middle Fork at Ralston Afterbay

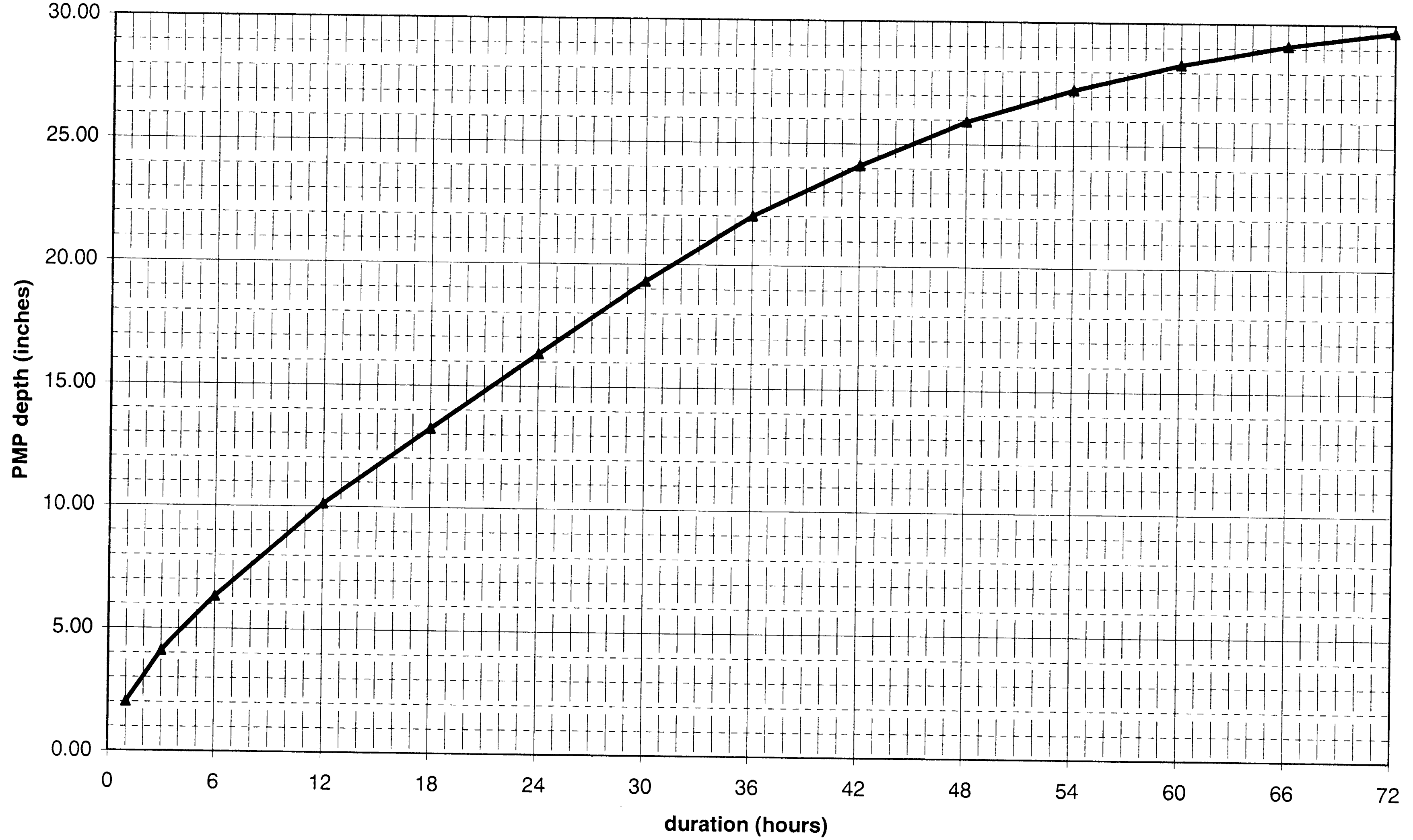


Exhibit 10, Sheet 8 of 11
April Probable Maximum Storm for Middle Fork at Ralston Afterbay

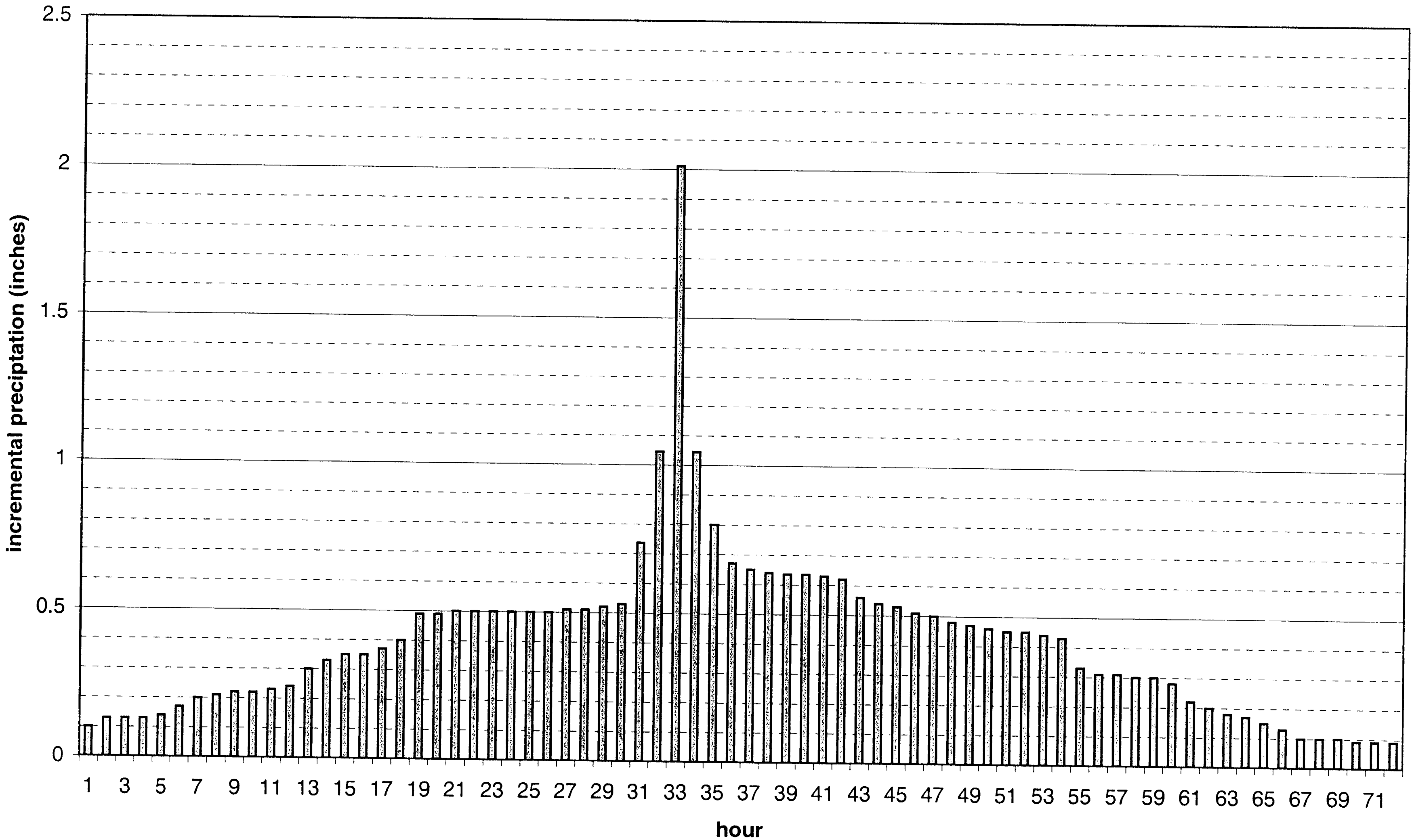


Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 9 of 11: April Storm Summary

Summary - April storm by subbasin

temperatures: see sheet 11		
48 hours before:	subtract 10	34.1
36 hours before:	subtract 9	35.1
24 hours before:	subtract 7	37.1
12 hour before:	subtract 4.5	39.6

	hr	1 hr increments	FM (1.10)	UHH (1.02)	LHH (1.02)	Duncan (1.06)	Loon Lake (1.00)	Middle Rubicon (0.94)	Lower Rubicon (0.90)	Stumpy (0.94)	Long Canyon (0.98)	Lower Middle Fork (0.88)	temperature at 5300 feet	freezing elev
1	1	0.1	0.11	0.10	0.10	0.11	0.10	0.09	0.09	0.09	0.10	0.09	44.1	9200
	2	0.13	0.14	0.13	0.13	0.14	0.13	0.12	0.12	0.12	0.13	0.11	44.1	9200
	3	0.13	0.14	0.13	0.13	0.14	0.13	0.12	0.12	0.12	0.13	0.11	44.1	9200
	4	0.13	0.14	0.13	0.13	0.14	0.13	0.12	0.12	0.12	0.13	0.11	44.1	9200
	5	0.14	0.15	0.14	0.14	0.15	0.14	0.13	0.13	0.13	0.14	0.12	44.1	9200
	6	0.17	0.19	0.17	0.17	0.18	0.17	0.16	0.15	0.16	0.17	0.15	44.1	9200
2	7	0.2	0.22	0.20	0.20	0.22	0.20	0.19	0.18	0.19	0.20	0.18	44.4	9300
	8	0.21	0.23	0.21	0.21	0.23	0.21	0.20	0.19	0.20	0.21	0.18	44.4	9300
	9	0.22	0.24	0.22	0.22	0.24	0.22	0.21	0.20	0.21	0.22	0.19	44.4	9300
	10	0.22	0.24	0.22	0.22	0.24	0.22	0.21	0.20	0.21	0.22	0.19	44.4	9300
	11	0.23	0.25	0.23	0.23	0.25	0.23	0.22	0.21	0.22	0.23	0.20	44.4	9300
	12	0.24	0.26	0.24	0.24	0.26	0.24	0.23	0.22	0.23	0.24	0.21	44.4	9300
3	13	0.3	0.33	0.31	0.31	0.32	0.30	0.28	0.27	0.28	0.29	0.26	44.8	9500
	14	0.33	0.36	0.34	0.34	0.36	0.33	0.31	0.30	0.31	0.32	0.29	44.8	9500
	15	0.35	0.39	0.36	0.36	0.38	0.35	0.33	0.32	0.33	0.34	0.31	44.8	9500
	16	0.35	0.39	0.36	0.36	0.38	0.35	0.33	0.32	0.33	0.34	0.31	44.8	9500
	17	0.37	0.41	0.38	0.38	0.40	0.37	0.35	0.33	0.35	0.36	0.33	44.8	9500
	18	0.4	0.44	0.41	0.41	0.43	0.40	0.38	0.36	0.38	0.39	0.35	44.8	9500
4	19	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.1	10000
	20	0.49	0.54	0.50	0.50	0.53	0.49	0.46	0.44	0.46	0.48	0.43	46.1	10000
	21	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.1	10000
	22	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.1	10000
	23	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.1	10000
	24	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.1	10000
5	25	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.8	10300
	26	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.8	10300
	27	0.51	0.56	0.52	0.52	0.55	0.51	0.48	0.46	0.48	0.50	0.45	46.8	10300
	28	0.51	0.56	0.52	0.52	0.55	0.51	0.48	0.46	0.48	0.50	0.45	46.8	10300
	29	0.52	0.57	0.53	0.53	0.56	0.52	0.49	0.47	0.49	0.51	0.46	46.8	10300
	30	0.53	0.58	0.54	0.54	0.57	0.53	0.50	0.48	0.50	0.52	0.47	46.8	10300
6	31	0.737	0.81	0.75	0.75	0.80	0.74	0.69	0.66	0.69	0.72	0.65	48.6	10900
	32	1.045	1.15	1.07	1.07	1.13	1.05	0.98	0.94	0.98	1.02	0.92	48.6	10900
	33	2.01	2.21	2.05	2.05	2.17	2.01	1.89	1.81	1.89	1.97	1.77	48.6	10900
	34	1.045	1.15	1.07	1.07	1.13	1.05	0.98	0.94	0.98	1.02	0.92	48.6	10900
	35	0.8	0.88	0.82	0.82	0.86	0.80	0.75	0.72	0.75	0.78	0.70	48.6	10900
	36	0.67	0.74	0.68	0.68	0.72	0.67	0.63	0.60	0.63	0.66	0.59	48.6	10900
7	37	0.65	0.72	0.66	0.66	0.70	0.65	0.61	0.59	0.61	0.64	0.57	47.7	10500
	38	0.64	0.70	0.65	0.65	0.69	0.64	0.60	0.58	0.60	0.63	0.56	47.7	10500
	39	0.635	0.70	0.65	0.65	0.69	0.64	0.60	0.57	0.60	0.62	0.56	47.7	10500
	40	0.635	0.70	0.65	0.65	0.69	0.64	0.60	0.57	0.60	0.62	0.56	47.7	10500
	41	0.63	0.69	0.64	0.64	0.68	0.63	0.59	0.57	0.59	0.62	0.55	47.7	10500
	42	0.62	0.68	0.63	0.63	0.67	0.62	0.58	0.56	0.58	0.61	0.55	47.7	10500
8	43	0.56	0.62	0.57	0.57	0.60	0.56	0.53	0.50	0.53	0.55	0.49	46.5	10100
	44	0.54	0.59	0.55	0.55	0.58	0.54	0.51	0.49	0.51	0.53	0.48	46.5	10100
	45	0.53	0.58	0.54	0.54	0.57	0.53	0.50	0.48	0.50	0.52	0.47	46.5	10100
	46	0.51	0.56	0.52	0.52	0.55	0.51	0.48	0.46	0.48	0.50	0.45	46.5	10100
	47	0.5	0.55	0.51	0.51	0.54	0.50	0.47	0.45	0.47	0.49	0.44	46.5	10100
	48	0.48	0.53	0.49	0.49	0.52	0.48	0.45	0.43	0.45	0.47	0.42	46.5	10100
9	49	0.47	0.52	0.48	0.48	0.51	0.47	0.44	0.42	0.44	0.46	0.41	45.5	9700
	50	0.46	0.51	0.47	0.47	0.50	0.46	0.43	0.41	0.43	0.45	0.40	45.5	9700
	51	0.45	0.50	0.46	0.46	0.49	0.45	0.42	0.41	0.42	0.44	0.40	45.5	9700
	52	0.45	0.50	0.46	0.46	0.49	0.45	0.42	0.41	0.42	0.44	0.40	45.5	9700
	53	0.44	0.48	0.45	0.45	0.48	0.44	0.41	0.40	0.41	0.43	0.39	45.5	9700
	54	0.43	0.47	0.44	0.44	0.46	0.43	0.40	0.39	0.40	0.42	0.38	45.5	9700
10	55	0.33	0.36	0.34	0.34	0.36	0.33	0.31	0.30	0.31	0.32	0.29	44.6	9400
	56	0.31	0.34	0.32	0.32	0.33	0.31	0.29	0.28	0.29	0.30	0.27	44.6	9400
	57	0.31	0.34	0.32	0.32	0.33	0.31	0.29	0.28	0.29	0.30	0.27	44.6	9400
	58	0.3	0.33	0.31	0.31	0.32	0.30	0.28	0.27	0.28	0.29	0.26	44.6	9400
	59	0.3	0.33	0.31	0.31	0.32	0.30	0.28	0.27	0.28	0.29	0.26	44.6	9400
	60	0.28	0.31	0.29	0.29	0.30	0.28	0.26	0.25	0.26	0.27	0.25	44.6	9400
11	61	0.22	0.24	0.22	0.22	0.24	0.22	0.21	0.20	0.21	0.22	0.19	44.3	9200
	62	0.2	0.22	0.20	0.20	0.22	0.20	0.19	0.18	0.19	0.20	0.18	44.3	9200
	63	0.18	0.20	0.18	0.18	0.19	0.18	0.17	0.16	0.17	0.18	0.16	44.3	9200
	64	0.17	0.19	0.17	0.17	0.18	0.17	0.16	0.15	0.16	0.17	0.15	44.3	9200
	65	0.15	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13	44.3	9200
	66	0.13	0.14	0.13	0.13	0.14	0.13	0.12	0.12	0.12	0.13	0.11	44.3	9200
12	67	0.1	0.11	0.10	0.10	0.11	0.10	0.09	0.09	0.09	0.10	0.09	43.3	9000
	68	0.1	0.11	0.10	0.10	0.11	0.10	0.09	0.09	0.09	0.10	0.09	43.3	9000
	69	0.1	0.11	0.10	0.10	0.11	0.10	0.09	0.09	0.09	0.10	0.09	43.3	9000
	70	0.09	0.10	0.09	0.09	0.10	0.09	0.08	0.08	0.08	0.09	0.08	43.3	9000
	71	0.09	0.10	0.09	0.09	0.10	0.09	0.08	0.08	0.08	0.09	0.08	43.3	9000
	72	0.09	0.10	0.09	0.09	0.10	0.09	0.08	0.08	0.08	0.09	0.08	43.3	9000

Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 10 of 11: Local Storm Calculations

1 hour, 1 square mile local PMP 8.2 inches
No elevation adjustment

ratio of 6 hour to 1 hour PMP: 1.3 Region C

6 hour local PMP: 10.8 inches

Duration	Ratio (Table 2.10, Region C)	1 hr value	depth
0.5	0.79	8.2	6.48
1	1	8.2	8.20
2	1.14	8.2	9.35
3	1.2	8.2	9.84
4	1.25	8.2	10.25
5	1.28	8.2	10.50
6	1.3	8.2	10.66

Adjust for 425 square miles (Figure 2.27)

Duration	1-mi2 depth	adjustment	425 mi2 average depth	smoothed	**incremental**	FM (1.10)	UHH (1.02)	LHH (1.02)	Duncan (1.08)	Loon Lake (1.00)	Middle Rubicon (0.94)	Lower Rubicon (0.90)	Stumpy (0.94)	Long Canyon (0.98)	Lower Middle Fork (0.88)
0.5	6.48	0.21	1.36	1.36											
1	8.20	0.26	2.13	2.13	**2.13**	2.34	2.17	2.17	2.30	2.13	2.00	1.92	2.00	2.09	1.87
2	9.35	0.33	3.08	3.08	**0.95**	1.05	0.97	0.97	1.03	0.95	0.90	0.86	0.90	0.93	0.84
3	9.84	0.35	3.44	3.44	**0.36**	0.40	0.37	0.37	0.39	0.36	0.34	0.32	0.34	0.35	0.32
4	10.25	0.36	3.69	3.72	**0.28**	0.30	0.28	0.28	0.30	0.28	0.26	0.25	0.26	0.27	0.24
5	10.50	0.37	3.88	3.90	**0.18**	0.20	0.18	0.18	0.19	0.18	0.17	0.16	0.17	0.18	0.16
6	10.66	0.38	4.05	4.05	**0.15**	0.17	0.15	0.15	0.16	0.15	0.14	0.14	0.14	0.15	0.13

Exhibit 10
PMP Calculations for 425-square-mile basin at Ralston Afterbay Dam
Sheet 11 of 11: Temperature Sequence

Average elevation = 5300 feet
Average 12 hour February persisting dewpoint = 60 degrees (Figure A8)
Wp = 1.36 inches (Figure A1)

Seasonal Adjustments

Month	Factor	Feb wp	adjusted
November	1.17	1.36	1.59
March	1.03	1.36	1.40
April	1.09	1.36	1.48

Distribute by 6 hour increments (Table A2)

Month	adjusted Wp	6 hr (1.04)	12 hr (1.0)	18 hr (0.97)	24 hr (0.95)	30 hr (0.93)	36 hr (0.91)	42 hr (0.89)	48 hr (0.88)	54 hr (0.86)	60 hr (0.85)	66 hr (0.84)	72 hr (0.83)
November	1.59	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
March	1.40	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
April	1.48	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23

Sea Level Temperatures (Figure A1)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov Wp	1.65	1.59	1.54	1.51	1.48	1.45	1.42	1.40	1.37	1.35	1.34	1.32
sea level Nov temp	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
March Wp	1.46	1.40	1.36	1.33	1.30	1.27	1.25	1.23	1.20	1.19	1.18	1.16
sea level March temp	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
April Wp	1.54	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.27	1.26	1.25	1.23
sea level April temp	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9

Adjust to 5300 feet (Figure A2)

hours:	6	12	18	24	30	36	42	48	54	60	66	72
Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov temp at 5300 ft	50.5	49.6	48.9	48.4	47.9	47.6	46.9	46.7	45.8	45.3	45	44.8
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March temp at 5300 feet	47.4	46.4	45.7	45	44.6	44.4	44.1	43.3	42.2	42.1	42	41.8
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April temp at 5300 feet	48.6	47.7	46.8	46.5	46.1	45.5	44.8	44.6	44.4	44.3	44.1	43.3

Determine freezing level

Nov temp at sea level	63.8	63	62.3	62	61.6	61.1	60.8	60.6	59.9	59.6	59.5	59.3
Nov freezing elev	11600	11300	11000	10800	10600	10400	10300	10200	9900	9700	9600	9500
March temp at sea level	61	60.4	59.8	59.4	59	58.6	58.4	57.9	56.8	56.7	56.6	56.4
March freezing elev	10400	10100	9800	9600	9400	9300	9200	9000	8800	8500	8400	8400
April temp at sea level	62.1	61.2	60.8	60.5	60.1	59.7	59.3	59	58.6	58.5	58.4	57.9
April freezing elev	10900	10500	10300	10100	10000	9700	9500	9400	9300	9200	9200	9000

Temperatures before storm:

48 hours before:	subtract 10
36 hours before:	subtract 9
24 hours before:	subtract 7
12 hour before:	subtract 4.5

Exhibit 11. PMF Inflow, Outflow, and Stage Hydrographs at Hell Hole Dam

Exhibit 11: November PMF Hydrographs at Hell Hole Dam (November Storm)

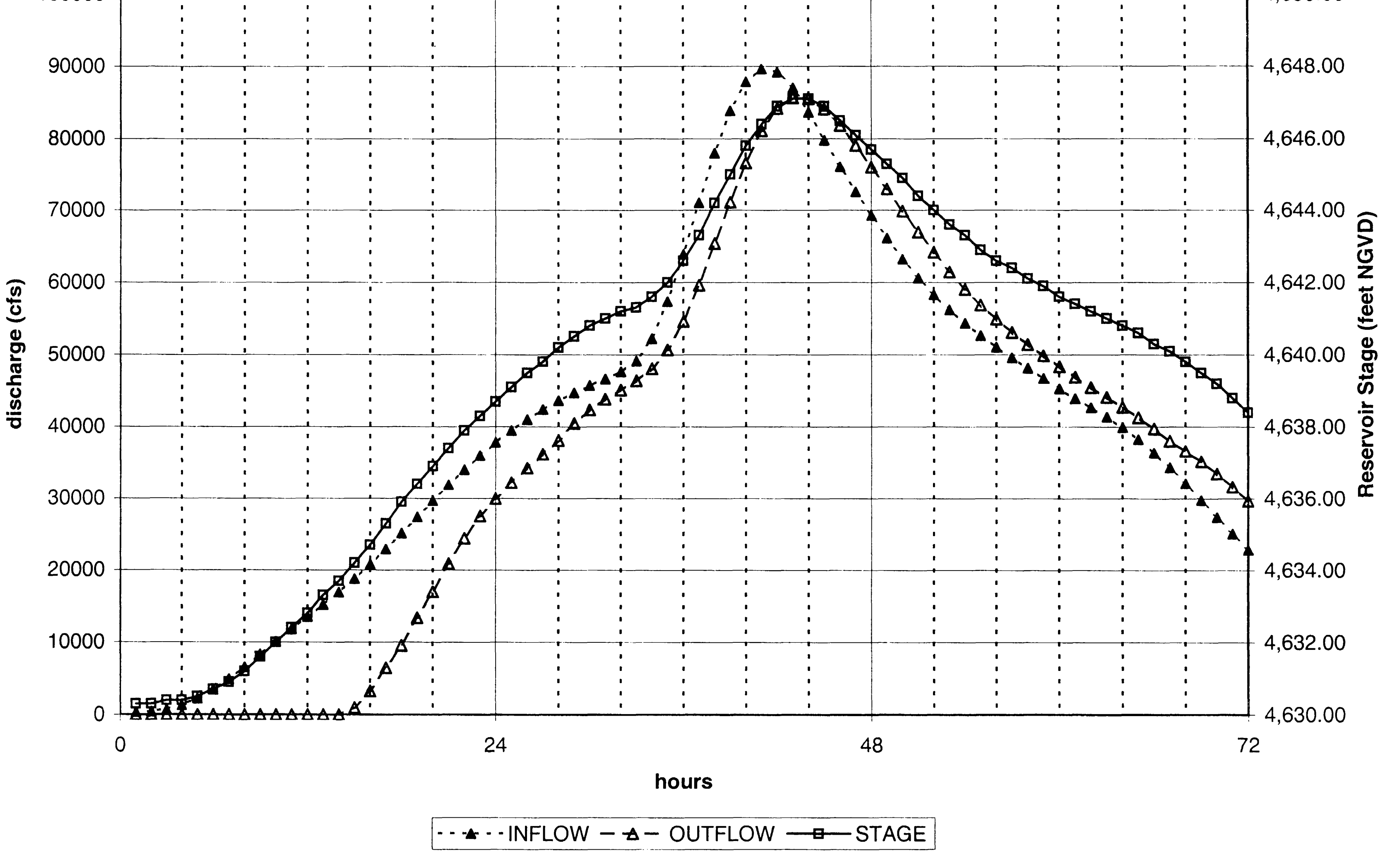
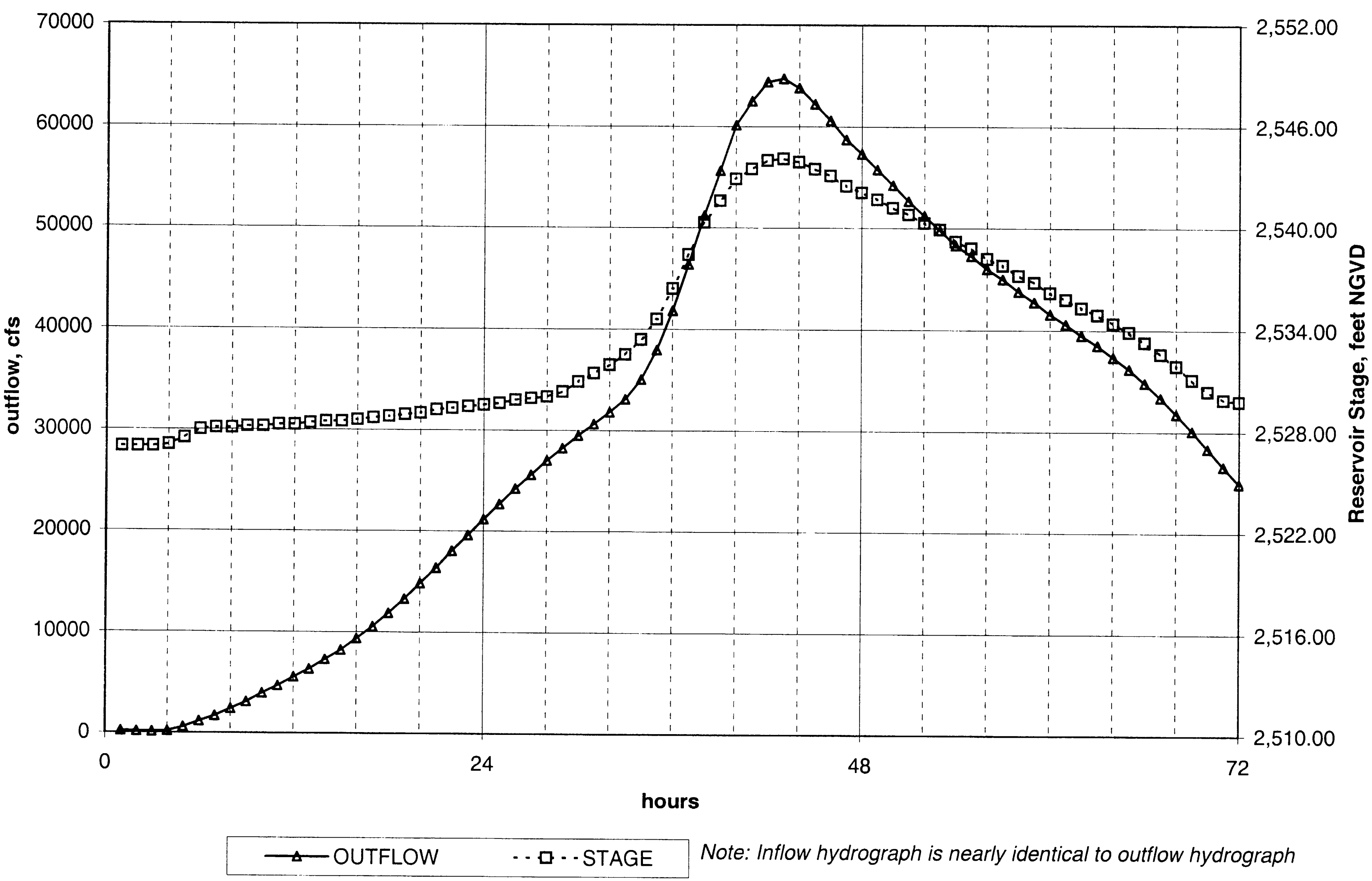


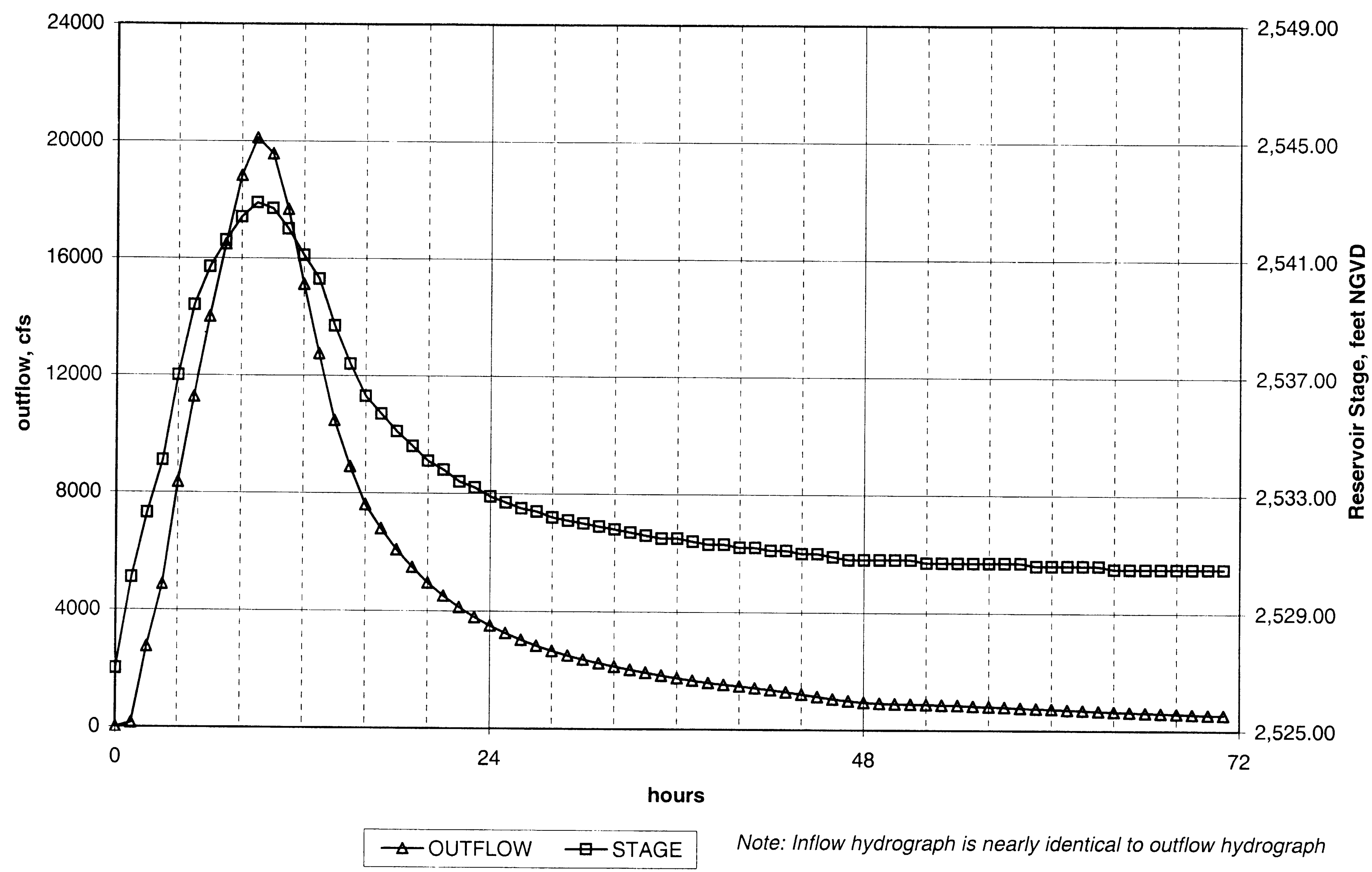
Exhibit 12. PMF Outflow and Stage Hydrographs at Interbay Dam

Exhibit 12, sheet 1: November PMF Hydrographs at Interbay Dam



Note: Inflow hydrograph is nearly identical to outflow hydrograph

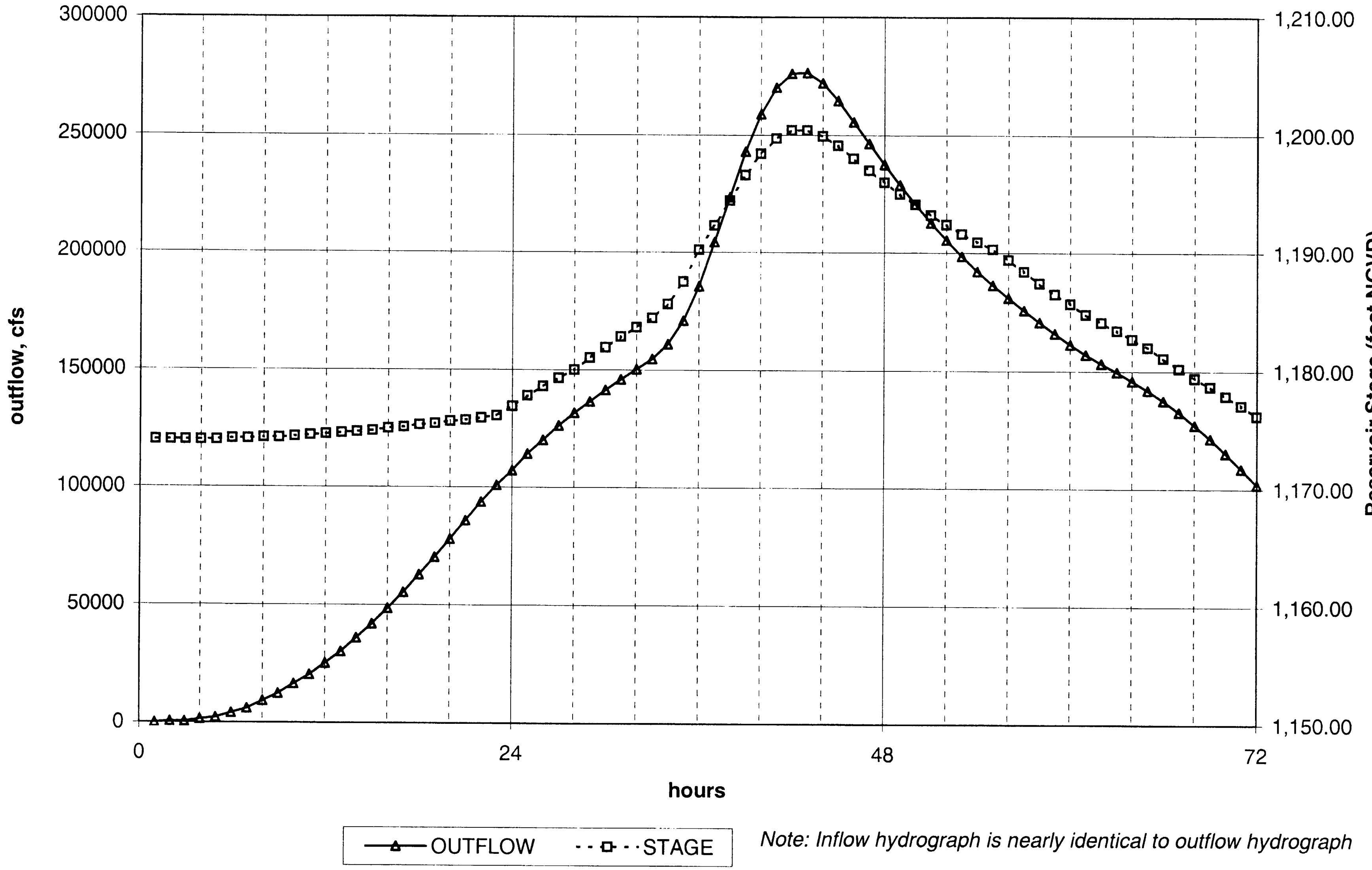
Exhibit 12, sheet 2:
Local Storm PMF Hydrographs at Interbay Dam



Note: Inflow hydrograph is nearly identical to outflow hydrograph

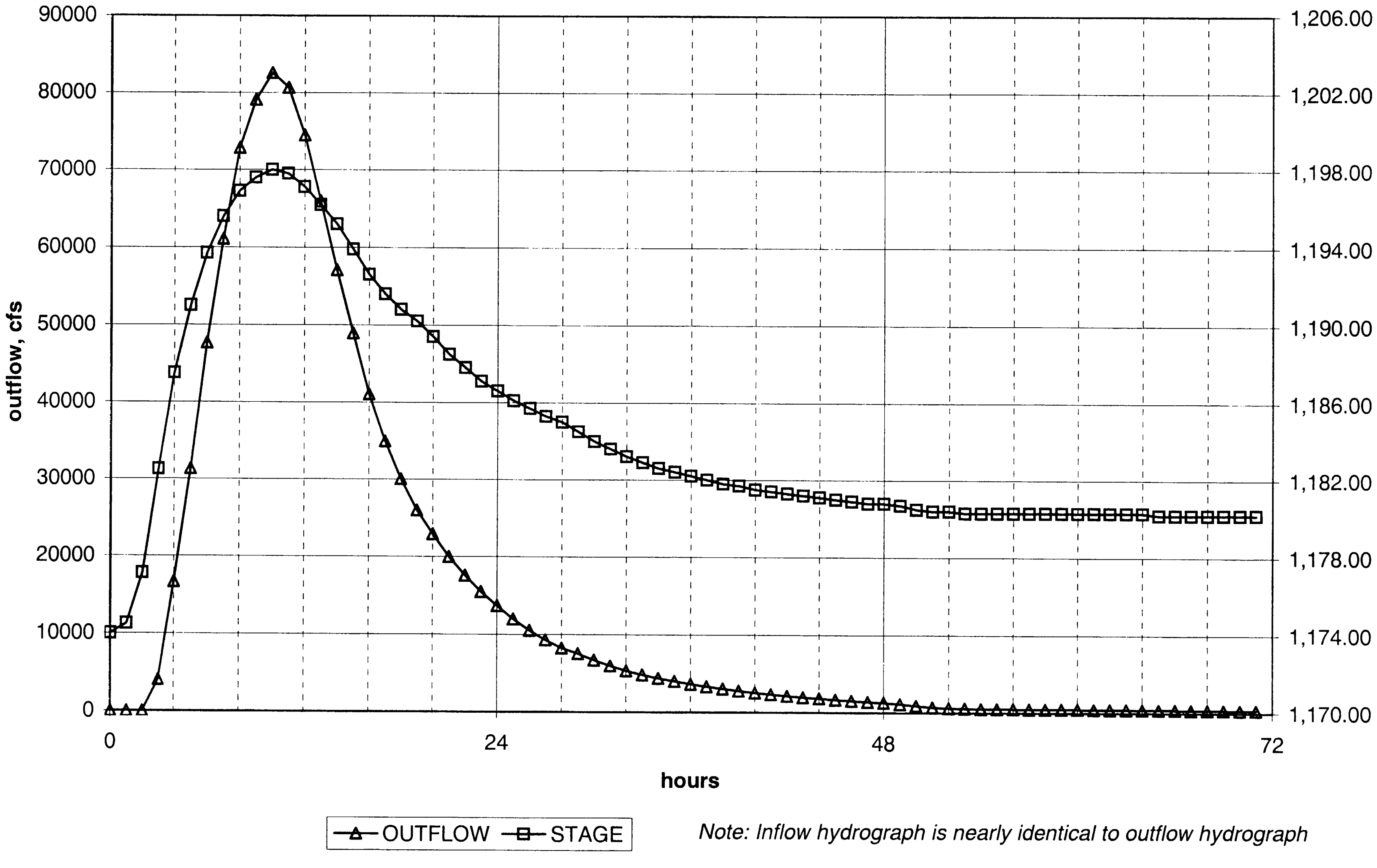
Exhibit 13. PMF Outflow and Stage Hydrographs at Ralston Afterbay Dam

Exhibit 13, sheet 1:
November PMF Hydrographs at Ralston Afterbay Dam



Note: Inflow hydrograph is nearly identical to outflow hydrograph

Exhibit 13, Sheet 2:
Local Storm PMF Hydrographs at Ralston Afterbay Dam



Note: Inflow hydrograph is nearly identical to outflow hydrograph

Exhibit 14. Wave Runup Calculations for Hell Hole Dam

EXHIBIT 14

HELL HOLE RESERVOIR
Wave Analysis for the Probable Maximum WINTER Storm Event
Based on the following U.S. Army Corps of Engineers Documents:
1. ETL 1110-2-305 - Determining Sheltered Water Wave Characteristics, 1984.
2. ETL 1110-2-221 - Wave Runup and Setup on Reservoir Embankments, 1976.

PARAMETER	VALUE
1. FETCH DISTANCE (mi.)	2.0
2. DESIGN WIND	
a) Wind speed (Max 1-hour wind speed w/ NO reduction)	48
b) Over water wind speed (mph)	53
3. WAVE CHARACTERISTICS	
a) Wave Type	Deep
b) Significant Wave Height, H_s (ft)	3.0
c) Wave Period, T_s (sec)	3.0
d) Wave Length, L_o (ft)	46.1
4. EMBANKMENT CHARACTERISTICS	
a) Embankment Slope (horiz:vert)	1.4:1
a) Slope Protection	Riprap
5. WAVE RUNUP	
a) Runup, R_s (ft)	4.0
b) Max Runup, R_m (ft)	5.9
6. WIND SETUP (ft)	
a) Average Water Depth, D	200
b) Wind Setup, S (ft)	0.02
7. TOTAL WAVE RUNUP AND WIND SETUP	6.0
8. MAXIMUM WATER SURFACE ELEVATION	
a) Peak PMF Stage - Local Storm	4647.0
b) Peak Stage Including Wave Runup and Setup	4653.0