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Probable Maximum Flood Using HMR 59 Piru Basin



**Extreme Precipitation Symposium - Davis, CA
June 24, 2014**

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Pyramid Dam PMF

Topics

- Project Description
- PMP development using HMR 59
- PMP to PMF
- Conclusions



Project Description

Pyramid Dam
Location Map



34°31'6.53"N
118°36'25.13"W

0 2.5 5 10 15 20
Miles

Legend

County Boundary

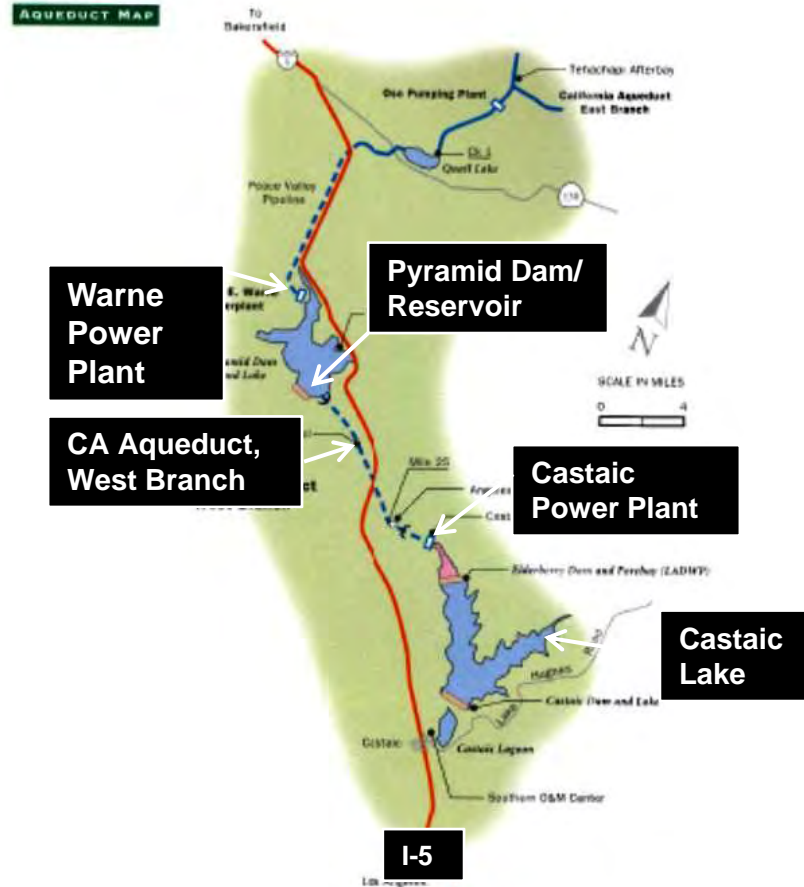


Project Description



Pyramid Dam and Reservoir

Project Description



State Water Project, West Branch



Project Description



Project water stored in reservoir, runoff is not stored





PMP/PMF History

- Initial Design (DWR, 1968)
- Hydrometeorological Report (HMR) 36, (DWR, 1990)
- HMR 59, (DWR, 2005)
- HMR 59, (DWR, 2011 update)
- Site Specific Probable Maximum Precipitation (SSPMP), 2011





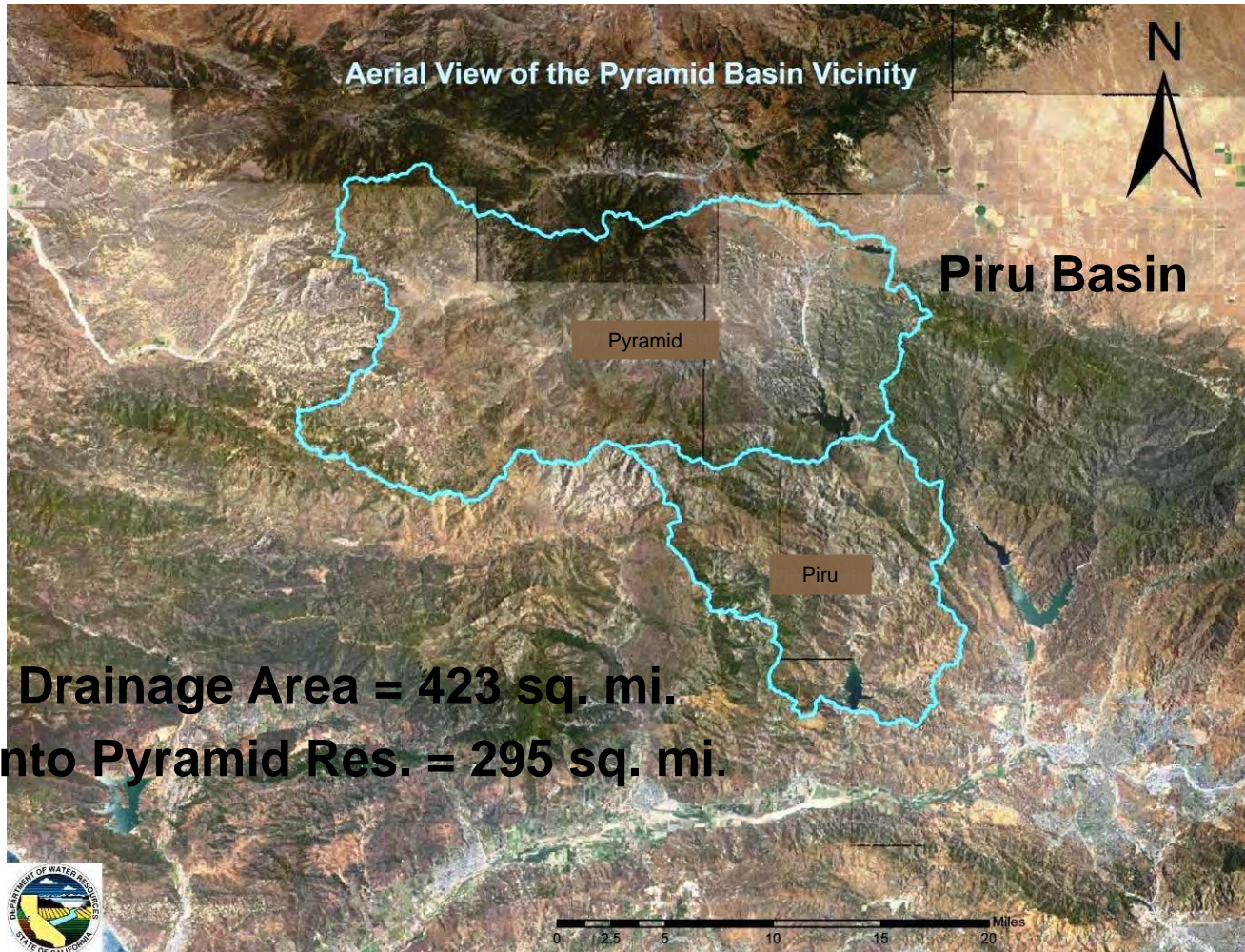
PMP Development, HMR 59

HMR 59 General Storm Procedure:

1. Drainage Outline
2. Decide - All Season or Seasonal (All Season, 72-hr)
3. All Season Index PMP Estimates
4. Seasonal Index PMP (skipped)
5. Depth-Duration Relations
6. Areal Reduction Factors
7. Incremental Estimates
8. Snowmelt, temporal, and areal distributions



PMP Development, HMR 59

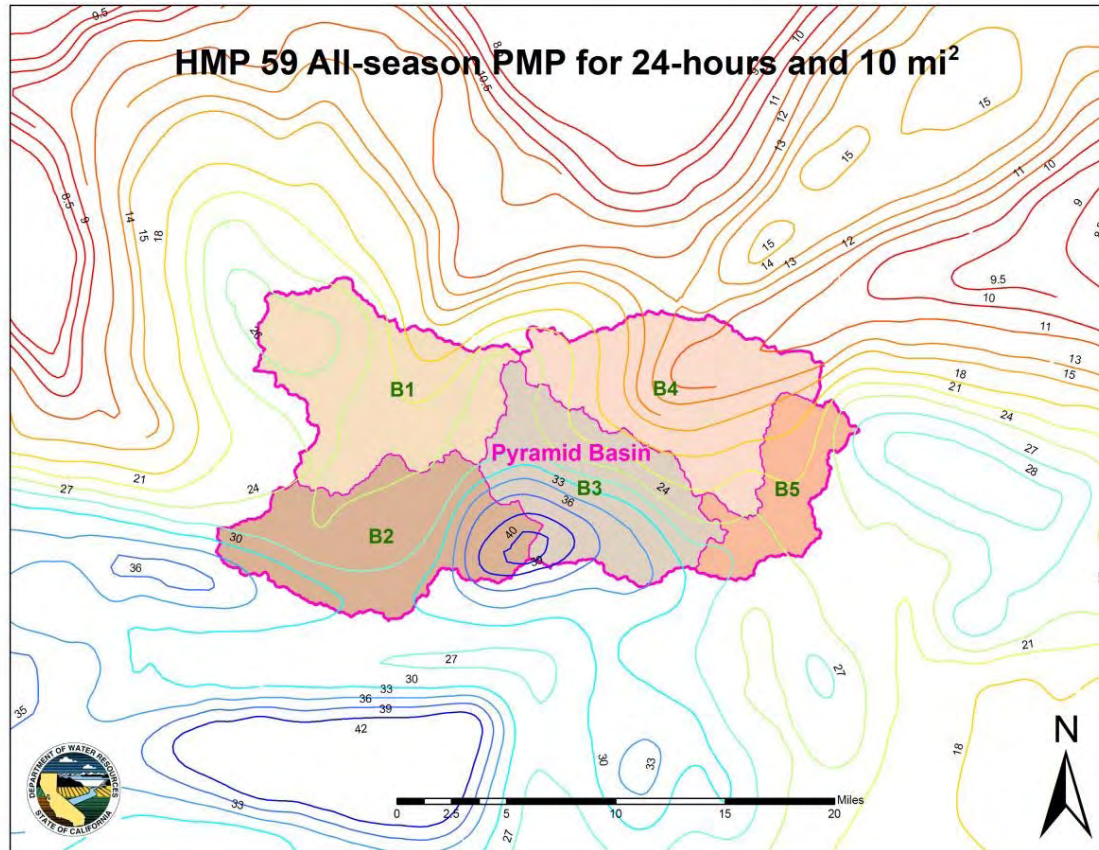


Piru Basin Drainage Area = 423 sq. mi.
Drainage into Pyramid Res. = 295 sq. mi.

Step 1 - Drainage Outline



PMP Development, HMR 59



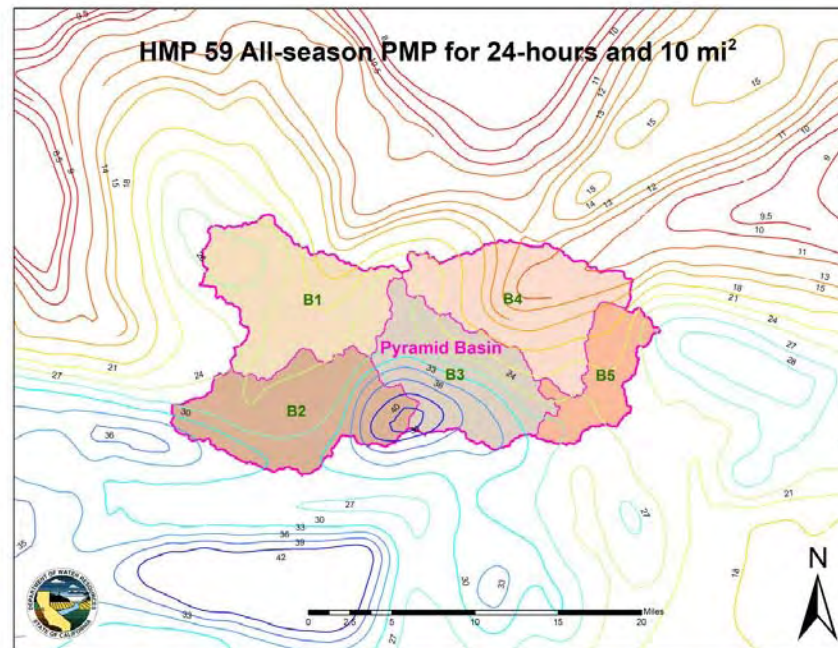
Step 3 - All Season Index PMP;
Plate 1. CA – South



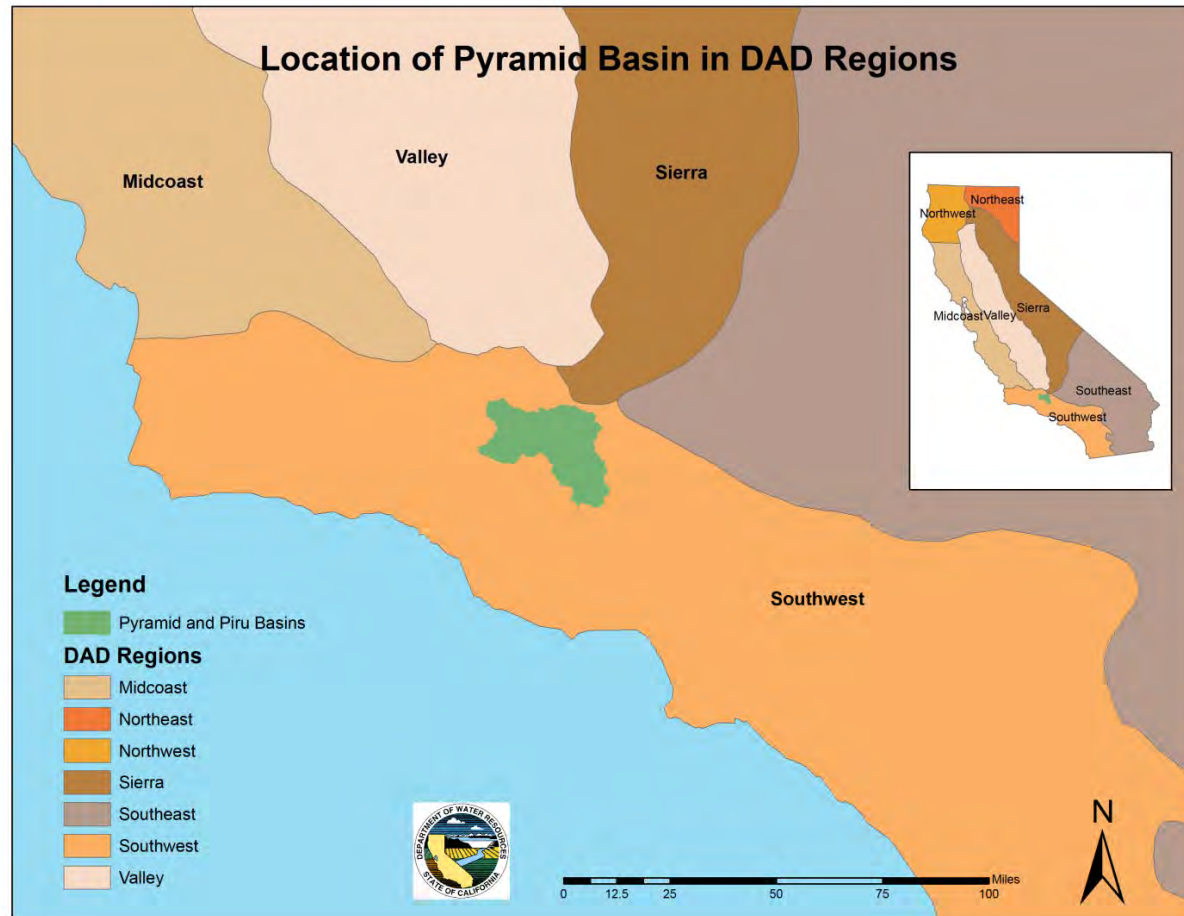
PMP Development, HMR 59

Averages for different Sub-Basins

Sub-Basin	B1	B2	B3	B4	B5
10-sq mi, 24 hr (inches)	23.58	29.23	27.15	16.02	22.4



PMP Development, HMR 59



Step 5 - Depth-Duration Relation





PMP Development, HMR 59

- Table 13.1, Ratios, Southwest Region

Duration (hrs)	1	6	12	24	48	72
Ratio (Southwest)	0.14	0.48	0.76	1.00	1.41	1.59

- From Plate 1 - All Season Index Map

Sub Basin	B1	B2	B3	B4	B5
10-sq mi, 24 hr (inches)	23.58	29.23	27.15	16.02	22.4



PMP Development, HMR 59

Sub Basin	DEPTH (IN) BY DURATION					
	1 (hr)	6 (hr)	12 (hr)	24 (hr)	48 (hr)	72 (hr)
B1	3.30	11.32	17.92	23.58	33.25	37.5
B2	4.09	14.03	22.21	29.23	41.21	46.47
B3	3.80	13.03	20.63	27.15	38.28	43.17
B4	2.24	7.69	12.18	16.02	22.59	25.48
B5	3.14	10.75	17.02	22.4	31.58	35.61

- Results for Step 5. Product of all season index depths (Plate 1) and region ratio (Table 13.1).



PMP Development, HMR 59

All-Season Depth-Area Relations (Southwest)						
Area	Duration (hour)					
	1	6	12	24	48	72
100 mi ²	81.75	83.25	84.75	86.25	87.75	89.25
200 mi ²	75.75	78.00	79.75	81.50	83.75	85.75
500 mi ²	67.50	70.50	72.50	75.00	77.50	80.00
295 mi²	72.3	73.7	76.7	78.7	81.1	83.3

- Areal Reduction Factor, Table 13.3
- Linear Interpolation between 200 and 500 sq. mi.

Step 6 - Areal Reduction Factor



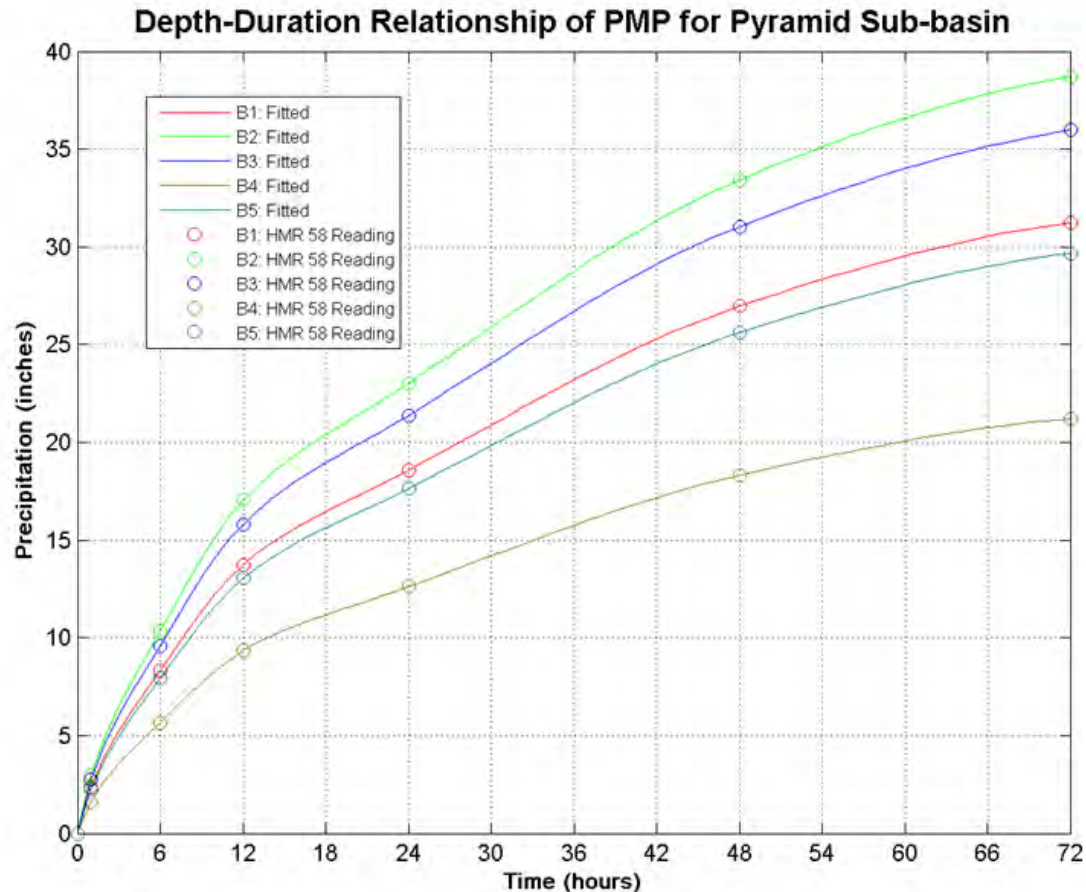
PMP Development, HMR 59

Six Hour Cumulative Depths (inches)						
	Duration (hour)					
Sub Basin	1	6	12	24	48	71
B1	2.39	8.34	13.74	18.57	26.97	31.24
B2	2.96	10.34	17.03	23.02	33.42	38.72
B3	2.75	9.6	15.82	21.38	31.05	35.97
B4	1.62	5.67	9.34	12.62	18.32	21.23
B5	2.27	7.92	13.05	17.64	25.61	29.67
Mean	2.40	8.40	13.85	18.72	27.18	31.49

Results for Step 6. Areal Reduction Factor applied to each sub-basin



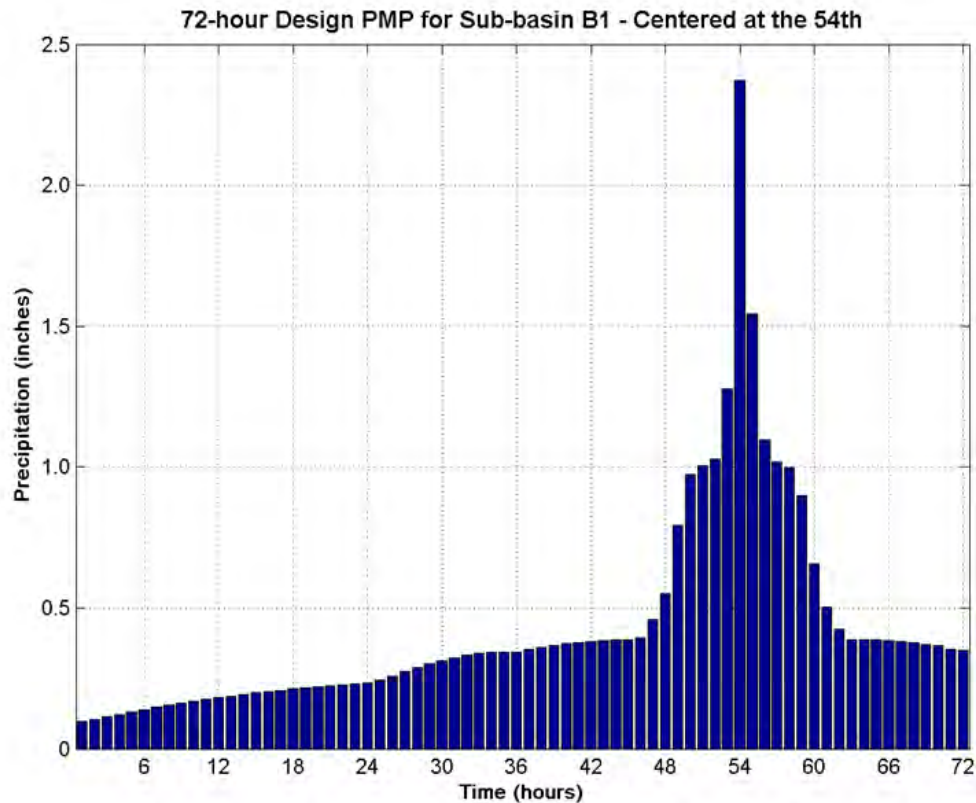
PMP Development, HMR 59



Step 7 - Incremental Relationships



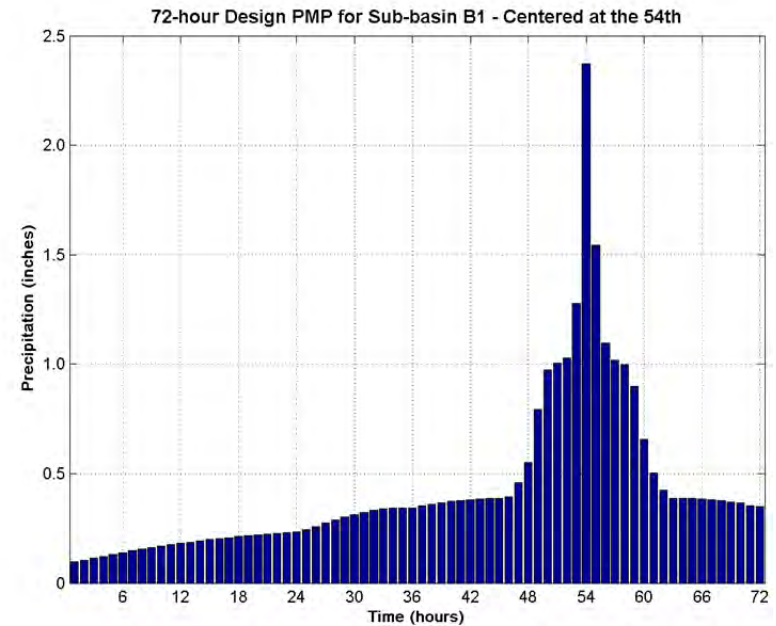
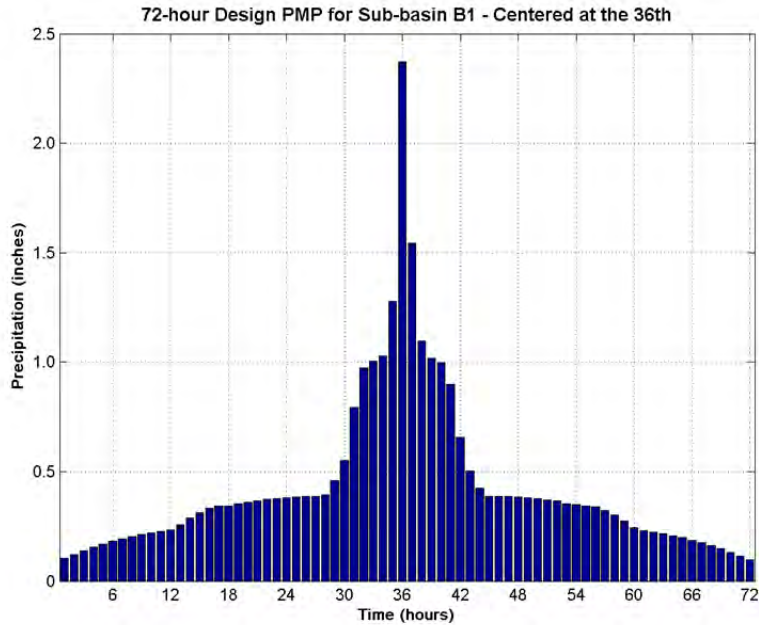
PMP Development, HMR 59



Step 8 - Incremental Relationships



PMP Development, HMR 59



Rainfall distribution,
variation, Sub-Basin B1





PMP Development, Comparison

DURATION (hrs)	DEPTH (inches)				
	DESIGN DWR (1968)	HMR 36, DWR (1990)	HMR 59 DWR (2005) DWR (2011)		SSPMP (2011)
1	-	1.68	2.39	2.40	1.29
6	1.27	6.27	8.48	8.40	4.48
12	2.73	10.49	13.75	13.85	7.18
24	6.58	16.66	18.57	18.72	10.36
48	22.74	23.97	26.96	27.18	13.78
72	26.14	28.12	31.21	31.49	15.32





PMP to PMF

- PMP entered into HEC-HMS to estimate runoff.
- Items to consider:
 - Rainfall/runoff relationship – unit hydrograph;
 - Loss rates;
 - Rain on snow, is it a factor?
 - Routing through the reservoir.



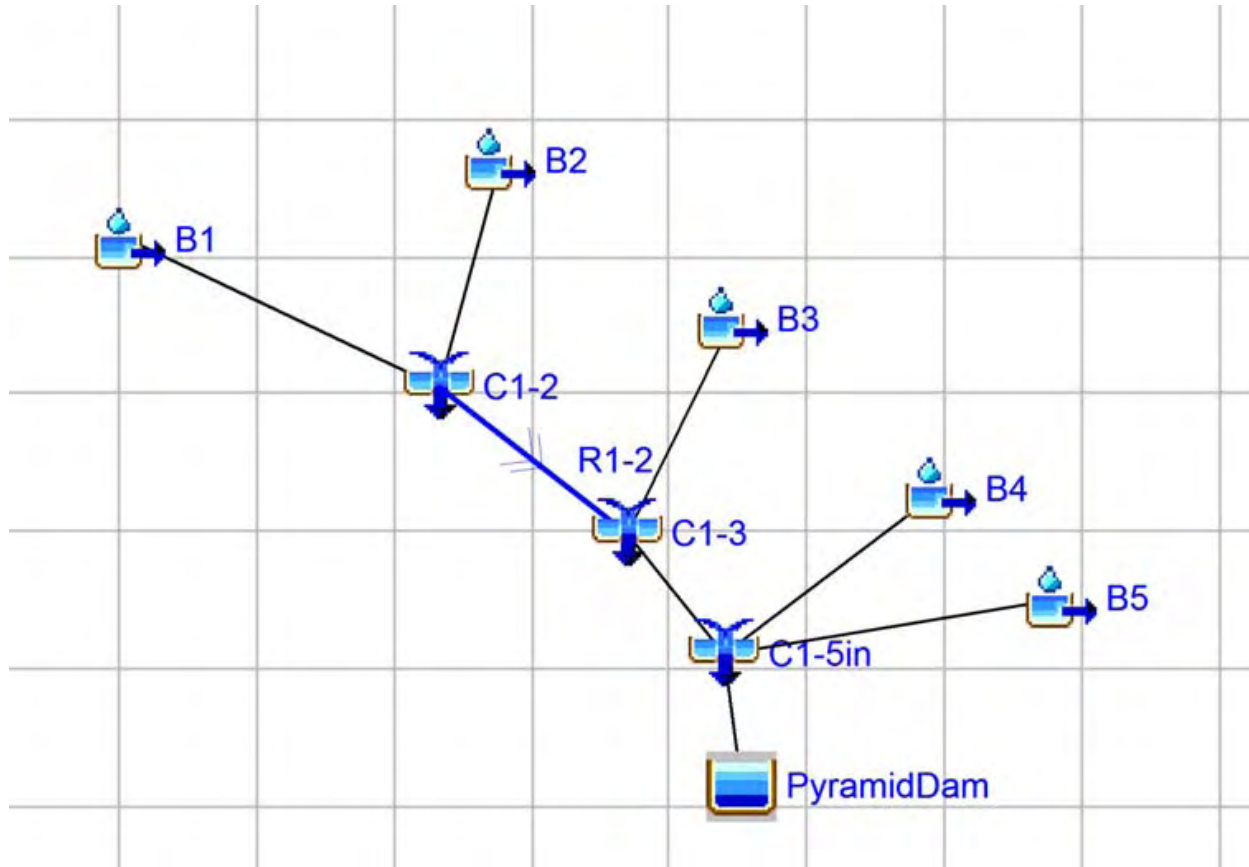


PMP to PMF

- Reservoir is full (but not spilling), outlet works are not functional;
- Control spillway is functional, radial gate can open;
- Radial gate rating curve.



PMP to PMF

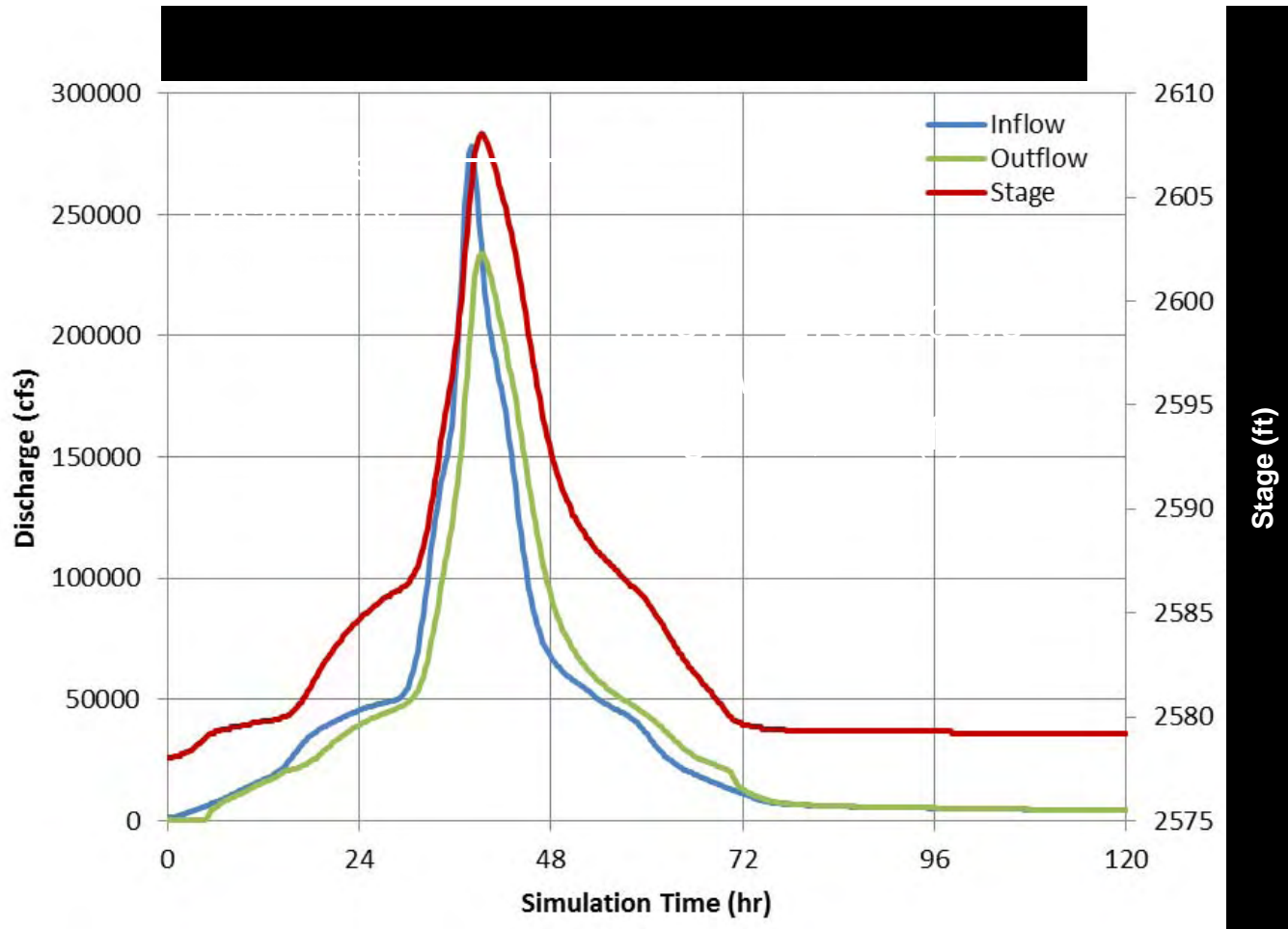


PMP input into Hydrologic Model (HEC-HMS, Version 3.4). Results show...





PMF Results, HMR 59 (2011)





PMF Results, Comparison

	Design (1968)	HMR 36 (DWR, 1990)	HMR 59		SSPMP (2011)
			(DWR, 2005)	(DWR, 2011)	
Peak Inflow (cfs)	180,000	180,400	250,700	278,400	136,400
Peak Outflow (cfs)	-	165,900	223,000	234,100	105,600
Max Stage (elev)	-	2,601	2,607	2,608	2,594



Conclusions

- Using HMR 59 PMP (as is) results in overtopping of Pyramid.
- PMP estimates have changed with time effecting the adequacy of the spillway.
- These changes lead to required modifications if spillway becomes undersized (dam overtops).
- Does not consider likelihood (return period).



Pyramid Dam PMF

QUESTIONS?



Pyramid Dam control spillway release and stream release into Piru Creek, 2005

