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APPENDIX 1

Depth-Area-Duration Tables

Appendix 1 contains depth-area-duration (DAD) tables, also referred to as pertinent data sheets, computed through the storm analysis procedure for each of the storms listed in Chapter 2, Table 2.1. The storm analysis procedure is covered in Chapter 5. These 31 storms were believed to be the most significant storms affecting California, based upon magnitude, location, and season of occurrence. Synoptic descriptions for each storm are in Appendix 2.

The DAD results are given for the center with the greatest precipitation amount. If more than one center was analyzed for a particular storm, only the one with the maximum DAD amounts is shown. Each center was determined from a combination of the total-storm isohyetal map and DAD curves. Latitude and longitude (in degrees/minutes), storm number, storm date, and a location description are included on the DAD sheets for convenience.

The pertinent data sheets have a standard format in which the areal component ranges from 1 mi^2 to 30,000 mi^2 and the durational component ranges from 1 hour to 96 hours. Often storms do not cover the entire area or last 96 hours.

STORM 40 - (12/9 - 12/1921)
ENTIRE STORM
48° 01' N 121° 32' W

Area (mi^2) Duration (hours)

	1	6	12	18	24	30	36	42	48	54	60	66	72
1	1.30	3.58	5.35	6.79	8.61	10.66	11.82	12.57	12.57	13.92	16.14	17.67	19.31
10	1.30	3.58	5.35	6.79	8.58	10.66	11.82	12.57	12.57	13.92	16.14	17.67	19.31
50	1.27	3.48	5.26	6.68	8.34	10.36	11.49	12.24	12.24	13.53	15.69	17.17	18.76
100	1.23	3.37	5.12	6.50	8.16	10.14	11.24	11.96	11.96	13.19	15.31	16.76	18.29
200	1.16	3.19	4.89	6.22	7.89	9.80	10.87	11.56	11.56	12.64	14.72	16.09	17.52
500	1.01	2.77	4.60	5.89	7.47	9.28	10.28	10.96	10.96	11.58	13.64	14.87	16.05
1000	0.90	2.54	4.38	5.64	7.21	8.95	9.92	10.60	10.60	10.90	12.94	14.06	14.98
2000	0.78	2.36	4.16	5.37	6.91	8.57	9.56	10.20	10.20	10.36	12.29	13.27	13.93
5000	0.63	2.06	3.59	4.62	5.91	7.39	8.33	8.92	8.92	8.95	10.63	11.43	11.90
10000	0.46	1.66	2.93	3.85	4.86	6.09	6.90	7.45	7.50	7.53	8.80	9.41	9.80
20000	0.31	1.36	2.50	3.43	4.35	5.39	6.19	6.89	6.94	6.95	7.98	8.44	8.73
27253	0.25	1.22	2.28	3.17	3.99	4.92	5.66	6.35	6.41	6.42	7.30	7.68	7.93

STORM 88 - (12/26 - 30/1937)
ENTIRE STORM
44° 55' N 123° 38' W

Area (mi^2) Duration (hours)

	1	6	12	18	24	30	36	42	48	54	60	66	72
1	1.17	3.38	5.90	8.40	10.94	13.35	15.31	16.47	17.56	17.56	17.56	19.83	20.71
10	1.17	3.32	5.80	8.26	10.76	13.13	15.05	16.19	17.26	17.26	17.26	19.49	20.36
50	1.12	3.23	5.64	8.03	10.46	12.76	14.63	15.74	16.78	16.78	16.78	18.95	19.79
100	1.02	3.07	5.40	7.66	9.98	12.21	14.01	15.07	16.05	16.05	16.05	18.13	18.95
200	0.90	2.84	4.96	6.95	9.09	11.14	12.80	13.75	14.62	14.62	14.62	16.51	17.31
500	0.74	2.44	4.20	5.72	7.40	9.12	10.53	11.37	12.02	12.06	12.14	13.64	14.58
1000	0.58	2.18	3.58	4.84	6.43	7.72	8.91	10.15	10.72	11.04	11.59	12.53	13.27
2000	0.54	2.02	3.19	4.43	5.89	7.17	8.19	9.10	9.60	9.85	10.39	11.23	12.00
5000	0.45	1.69	2.59	3.70	4.87	5.95	6.82	7.59	7.99	8.07	8.51	9.17	9.92
10000	0.34	1.33	2.31	3.33	4.31	5.23	6.00	6.65	7.00	7.13	7.54	8.18	8.99
13869	0.29	1.16	2.18	3.16	4.04	4.89	5.63	6.22	6.55	6.70	7.10	7.72	8.57

Area (mi^2) Duration (hours)

	78	84	90	96
1	22.67	24.80	26.80	27.08
10	22.28	24.38	26.34	26.61
50	21.67	23.71	25.62	25.88
100	20.80	22.78	24.63	24.88
200	19.10	20.95	22.67	22.90
500	16.12	17.75	19.25	19.49
1000	14.55	15.97	17.24	17.71
2000	13.13	14.51	15.70	16.15
5000	10.92	12.15	13.22	13.55
10000	9.90	10.93	11.81	12.18
13869	9.44	10.37	11.16	11.55

STORM 126 - (10/26 - 29/1950)
ENTIRE STORM
41° 52' N 123° 58'W

Area (mi^2)	Duration (hours)												
	1	6	12	18	24	30	36	42	48	54	60	66	72
1	1.84	6.44	11.47	13.47	15.84	16.50	17.96	18.96	19.37	19.98	20.69	20.93	21.17
10	1.84	6.44	11.47	13.47	15.84	16.50	17.96	18.96	19.37	19.98	20.69	20.93	21.17
50	1.77	6.20	11.05	13.00	15.31	15.98	17.42	18.46	18.89	19.47	20.19	20.46	20.72
100	1.58	5.63	10.12	11.98	14.21	14.95	16.47	17.68	18.30	18.88	19.56	19.97	20.35
200	1.31	4.80	8.76	10.51	12.62	13.49	15.14	16.61	17.51	18.19	18.71	19.33	19.89
500	1.01	3.91	7.05	9.03	11.02	11.78	13.69	15.65	16.88	17.71	17.90	18.73	19.18
1000	0.86	3.13	5.57	7.52	9.29	9.99	12.19	14.55	15.97	17.02	17.17	17.90	18.29
2000	0.72	2.68	4.85	6.32	7.77	9.00	11.34	13.24	14.57	15.73	15.90	16.62	17.03
5000	0.56	2.30	4.14	5.40	6.59	8.02	9.62	10.96	12.17	13.17	13.39	14.17	14.57
10000	0.45	1.89	3.41	4.58	5.68	7.02	8.41	9.51	10.56	11.26	11.47	12.23	12.65
20000	0.34	1.49	2.71	3.83	4.88	6.17	7.44	8.35	9.25	9.74	9.96	10.67	11.15
50000	0.20	1.02	1.93	2.79	3.65	4.42	5.29	5.93	6.54	6.89	7.11	7.67	8.18
80511	0.14	0.75	1.42	2.09	2.75	3.28	3.88	4.36	4.75	5.02	5.34	5.78	6.21

STORM 149 - (11/21 - 24/1961)
ENTIRE STORM
42° 10' N 123° 56' W

Area (mi^2)	Duration (hours)												
	1	6	12	18	24	30	36	42	48	54	60	66	72
1	1.11	3.91	6.80	9.35	11.18	12.22	13.10	13.96	15.12	15.72	16.68	16.93	17.00
10	0.94	3.55	6.27	8.89	10.90	12.01	13.00	13.67	14.72	15.46	16.43	16.74	16.85
50	0.78	3.34	5.89	8.38	10.56	11.66	12.77	13.34	14.18	15.06	16.01	16.38	16.51
100	0.74	3.22	5.67	8.12	10.18	11.24	12.34	12.93	13.75	14.66	15.56	15.96	16.09
200	0.70	3.06	5.42	7.68	9.47	10.48	11.64	12.36	13.12	14.18	14.97	15.41	15.53
500	0.63	2.86	5.10	7.05	8.86	10.00	11.35	12.16	12.83	13.89	14.64	15.01	15.13
1000	0.58	2.70	4.86	6.58	8.38	9.59	11.06	11.93	12.55	13.63	14.34	14.67	14.79
2000	0.49	2.47	4.53	6.10	7.57	8.71	10.02	10.87	11.71	12.78	13.43	13.71	13.80
5000	0.34	1.94	3.62	4.95	6.42	7.61	8.57	9.40	10.30	11.22	11.81	12.09	12.17
10000	0.28	1.61	2.98	4.21	5.64	6.76	7.62	8.46	9.17	9.96	10.57	10.86	10.97
20000	0.23	1.30	2.40	3.38	4.65	5.66	6.42	7.19	7.74	8.32	8.90	9.20	9.32
20850	0.23	1.28	2.36	3.32	4.57	5.58	6.33	7.09	7.63	8.19	8.77	9.07	9.20

STORM 156 - (12/21 - 24/1964)
ELK VALLEY REGION, NORTHWESTERN CALIFORNIA CENTER
41° 52' N 123° 40' W

Area (mi^2) Duration (hours)

	1	6	12	18	24	30	36	42	48	54	60	66	72
2	2.05	5.35	7.62	10.02	14.05	15.83	17.10	20.33	21.11	22.56	23.23	25.04	26.28
10	2.05	5.35	7.62	10.02	14.05	15.83	17.10	20.33	21.11	22.56	23.23	25.04	26.28
50	1.93	5.21	7.39	9.81	13.83	15.44	16.64	19.93	20.78	22.03	22.64	24.37	25.60
100	1.72	5.11	7.23	9.65	13.67	15.24	16.31	19.64	20.55	21.75	22.26	23.87	25.16
200	1.59	4.90	6.96	9.33	13.25	14.74	15.74	19.05	19.94	21.09	21.56	23.05	24.36
500	1.27	4.28	6.27	8.50	12.11	13.39	14.48	17.56	18.36	19.37	19.80	20.94	22.37
1000	0.97	3.63	5.64	7.86	11.04	12.14	13.42	16.12	16.90	17.83	18.25	19.11	20.57
1932	0.72	2.98	5.02	7.25	9.83	10.81	12.26	14.51	15.30	16.15	16.57	17.27	18.69

STORM 165 - (1/14 - 17/1974)
GIBSON HWY MTCE STATION REGION, NORTHWESTERN CALIFORNIA CENTER
41° 08' N 122° 16'W

Area (mi^2) Duration (hours)

	1	6	12	18	24	30	36	42	48	54	60	66	72
1	1.13	3.85	5.99	8.88	10.52	11.20	12.33	13.79	14.95	15.67	17.10	17.20	17.20
10	1.13	3.85	5.90	8.65	10.27	11.20	12.33	13.79	14.95	15.67	17.10	17.20	17.20
50	1.00	3.38	5.65	8.25	9.75	11.08	12.23	13.56	14.66	15.38	16.70	16.79	16.79
100	0.92	3.20	5.55	8.14	9.63	10.86	12.00	13.23	14.28	15.01	16.23	16.32	16.32
200	0.79	3.09	5.32	7.81	9.27	10.33	11.57	12.65	13.64	14.49	15.54	15.64	15.64
500	0.65	2.68	4.85	7.09	8.42	9.32	10.63	11.61	12.49	13.43	14.33	14.44	14.44
1000	0.57	2.36	4.41	6.43	7.63	8.52	9.60	10.66	11.47	12.25	13.20	13.40	13.42
2000	0.46	2.08	4.01	5.82	6.96	7.70	8.65	9.74	10.40	11.15	12.07	12.32	12.36
2272	0.44	2.03	3.93	5.70	6.81	7.52	8.49	9.56	10.19	10.94	11.84	12.09	12.13

STORM 175 - (12/24 - 26/1980)
ENTIRE STORM
44° 55' N 123° 44' W

Area (mi^2) Duration (hours)

	1	6	12	18	24	30	36	42	48
1	0.97	2.93	4.99	7.07	9.22	10.84	11.27	11.27	11.27
10	0.97	2.93	4.99	7.07	9.22	10.84	11.27	11.27	11.27
50	0.95	2.88	4.89	6.94	9.05	10.66	11.12	11.12	11.12
100	0.87	2.76	4.59	6.56	8.53	10.11	10.62	10.63	10.63
200	0.80	2.62	4.11	5.90	7.63	9.09	9.65	9.67	9.67
500	0.70	2.24	3.22	4.66	5.96	7.17	7.80	7.82	7.82
1000	0.58	2.06	2.77	3.99	5.08	6.18	6.84	6.87	6.87
2000	0.47	1.76	2.46	3.57	4.56	5.64	6.29	6.32	6.32
5000	0.36	1.36	2.00	2.95	3.78	4.78	5.38	5.41	5.41
10000	0.29	1.11	1.67	2.52	3.16	4.04	4.55	4.60	4.60
20000	0.23	0.90	1.43	2.19	2.68	3.48	3.95	4.03	4.03
24865	0.21	0.83	1.35	2.08	2.53	3.30	3.77	3.85	3.86

STORM 508 - (1/15 - 19/1906)
NORTHERN SIERRA CENTER
39° 54' N 121° 34' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60	72	84
1	2.16	4.46	8.07	12.51	15.33	15.33	15.33	15.33	22.70	27.80	30.51
10	2.00	4.28	7.57	12.00	14.77	14.77	14.77	14.77	20.90	26.72	29.23
50	1.78	3.88	6.92	10.96	13.65	13.65	13.65	13.65	19.30	24.38	26.63
100	1.66	3.64	6.39	10.17	12.74	12.74	12.74	12.74	17.93	22.50	24.66
200	1.58	3.30	5.79	9.10	11.52	11.52	11.52	11.52	16.20	20.21	22.06
500	1.40	2.88	5.00	7.89	10.21	10.21	10.21	10.21	14.73	18.45	20.00
1000	1.22	2.58	4.51	7.07	9.24	9.24	9.51	9.51	13.43	16.92	18.60
2000		2.15	3.75	5.84	7.72	7.72	8.19	8.19	11.37	14.25	15.66
5000			2.55	4.00	5.26	5.26	6.75	6.75	8.81	10.70	12.11
10000				2.49	3.52	3.54	5.05	5.05	6.54	7.85	9.01

STORM 523 - (5/8 - 10/1915)
NORTHERN VALLEY CENTER
40° 42' N 122° 26' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60	72
1	2.30	5.02	7.67	9.37	9.50	11.46	12.80	14.32	14.51	14.54
10	2.22	4.81	7.50	9.22	9.38	10.51	12.54	13.89	14.30	14.35
50	2.19	4.61	7.37	8.82	8.96	10.32	12.16	13.33	13.80	13.82
100	1.98	4.36	6.80	8.21	8.35	9.49	11.17	12.37	12.78	12.80
200	1.76	3.86	5.92	7.20	7.29	8.38	9.69	10.87	11.28	11.31
500	1.40	2.97	4.62	5.56	5.67	6.55	7.90	8.87	9.22	9.26
1000		2.28	3.62	4.37	4.47	5.11	6.52	7.15	7.50	7.54
2000		1.61	2.70	3.31	3.38	3.77	4.95	5.38	5.62	5.65
5000					2.15	2.92	3.39	3.75	4.45	4.49
10000					1.76	2.30	2.82	3.16	3.56	3.60
20000						1.68	2.15	2.47	2.64	2.69

STORM 525 - (1/1 - 4/1916)
NORTHERN SIERRA CENTER
39° 48' N 121° 36' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60	72
1	1.22	3.37	5.45	7.47	9.22	10.35	11.52	12.36	13.18	13.49
10	1.17	3.34	5.38	7.22	8.77	10.12	11.26	12.04	12.85	13.26
50	1.13	2.89	4.80	6.70	7.90	9.17	10.20	10.71	11.50	11.80
100	1.12	2.68	4.55	6.26	7.20	8.40	9.36	9.51	10.50	10.75
200	1.11	2.41	4.09	5.79	6.90	7.70	8.89	9.02	9.50	9.87
500		1.88	3.60	5.21	6.36	6.94	8.36	8.43	8.73	9.10
1000		1.54	3.30	4.79	5.81	6.58	7.62	7.68	8.15	8.50
2000		1.49	2.98	4.40	5.43	6.22	6.99	7.02	7.65	7.90
5000		1.48	2.56	3.80	4.62	5.26	6.16	6.21	6.56	6.94
10000			2.07	3.13	3.76	4.38	5.11	5.21	5.57	5.88
20000					2.70	3.35	3.95	4.17	4.45	4.80
30000					2.19	2.66	3.30	3.49	3.69	4.10

STORM 544 - (12/9 - 12/1937)
NORTHERN SIERRA CENTER
40° 11' N 121° 26' W

Area (mi^2)	Duration (hours)									
	1	3	6	12	18	24	36	48	60	72
1	2.28	4.45	6.51	10.53	13.14	15.37	20.13	22.02	22.28	22.30
10	2.20	4.36	6.46	10.37	13.11	15.29	19.83	21.73	22.03	22.15
50	2.19	4.29	6.41	10.31	12.70	14.50	18.91	20.76	21.00	21.20
100	2.14	4.13	6.21	9.89	12.20	13.80	17.97	19.81	20.12	20.32
200	1.99	3.91	5.81	9.30	11.50	12.86	16.75	18.63	18.96	19.25
500	1.80	3.41	5.19	8.26	10.52	11.50	14.45	16.82	17.52	18.13
1000	1.64	2.97	4.53	7.05	8.89	10.41	13.62	16.60	16.99	17.65
2000	1.49	2.52	3.89	5.65	7.72	9.53	13.15	15.65	16.35	16.59
5000		1.92	3.01	4.25	6.39	8.19	11.33	13.80	14.40	14.76
10000			2.31	3.66	5.14	6.66	9.18	11.23	11.77	12.13
20000				2.80	3.75	4.80	6.69	8.35	8.69	8.89

STORM 572 - (12/21 - 24/1955)
SOUTHERN SIERRA CENTER
37° 59' N 119° 20' W

Area (mi^2)	Duration (hours)									
	1	3	6	12	18	24	36	48	60	72
1	2.57	5.39	7.57	11.18	12.02	13.53	18.75	21.12	22.53	23.79
10	2.49	5.23	7.38	11.14	11.70	13.42	18.58	20.89	22.46	23.56
50	2.38	5.05	7.15	10.65	11.38	12.83	17.93	20.06	21.12	22.10
100	2.36	4.80	6.80	10.15	10.87	12.28	17.07	19.19	20.60	21.29
200	2.22	4.50	6.34	9.35	10.02	11.25	15.35	18.25	20.08	20.94
500			4.78	6.23	8.85	10.37	14.33	17.13	19.23	20.16
1000			3.75	5.91	8.02	9.78	13.13	16.47	18.45	19.54
2000			3.26	5.62	7.67	9.48	12.30	15.55	18.01	18.85
5000			2.92	5.17	7.11	8.77	11.21	14.68	16.62	17.05
10000			2.50	4.28	6.05	7.53	9.78	12.77	14.55	14.85
20000				3.19	4.50	5.55	7.13	9.48	10.45	10.70
30000					3.50	4.36	5.50	7.24	8.20	8.35

STORM 575 - (10/10 - 14/1962)
NORTHERN SIERRA CENTER
40° 02' N 121° 29' W

Area (mi^2)	Duration (hours)											
	1	3	6	12	18	24	36	48	60	72	84	96
1	2.60	4.56	7.30	11.85	14.45	20.70	27.00	27.90	29.28	29.49	31.05	31.39
10	2.50	4.47	6.85	11.05	13.77	19.71	25.79	26.60	29.18	29.41	30.79	31.29
50	2.42	4.37	6.40	10.28	12.70	18.30	24.02	24.92	28.57	28.80	30.28	30.69
100	2.40	4.31	5.88	9.55	11.79	16.94	22.20	24.89	28.22	28.42	29.97	30.30
200	2.30	4.05	5.44	8.50	10.40	14.97	19.65	24.00	27.04	27.35	28.80	29.34
500	1.70	3.38	4.67	6.78	8.31	11.95	16.73	20.85	24.00	24.52	25.89	27.07
1000		2.64	3.69	5.49	7.64	10.50	14.22	18.65	22.51	23.59	24.52	26.31
2000		1.75	2.82	5.02	7.19	9.50	13.06	17.71	21.51	22.97	23.73	25.63
5000				4.13	6.01	8.19	11.03	14.75	18.35	19.42	20.00	21.38
10000				3.12	4.98	6.44	8.90	11.35	14.06	14.95	15.40	16.63

STORM 630 - (1/3 - 5/1982)
COASTAL BAY CENTER
37° 05 N 122° 01'W

Area (mi^2)	Duration (hours)								
	1	3	6	12	18	24	36	48	60
1	2.10	5.51	9.29	15.93	23.11	24.90	25.53	25.53	25.56
10	1.63	4.85	7.86	13.27	19.00	20.65	21.73	21.75	21.76
50	1.31	3.82	6.37	11.79	17.01	19.08	20.02	20.03	20.05
100	1.25	3.39	6.02	10.99	15.75	17.55	18.42	18.43	18.45
200		2.90	5.19	9.92	14.15	15.76	16.47	16.48	16.50
500		2.06	3.95	7.70	11.05	12.46	13.28	13.29	13.30
1000		1.65	3.12	5.99	8.38	9.10	10.28	10.31	10.32
2000			2.25	4.94	7.00	8.00	8.01	8.03	8.04
5000			1.89	3.65	5.22	6.49	7.47	7.51	7.51
10000				2.62	3.84	4.78	5.59	5.78	5.80
20000						3.45	4.10	4.27	4.29

STORM 1000 - (2/1 - 6/1905)
SOUTHWEST CENTER
34° 30' N 119° 10 W

Area (mi^2)	Duration (hours)											
	1	3	6	12	18	24	36	48	60	72	84	96
1	1.26	3.45	5.66	7.28	8.61	9.54	9.67	11.00	12.63	13.60	14.42	14.94
10	1.25	3.31	5.40	7.22	8.50	9.34	9.59	10.70	12.48	12.93	14.22	14.28
50	1.23	3.02	4.96	6.61	7.87	8.66	8.83	9.86	11.82	12.16	13.30	13.40
100	1.11	2.72	4.24	5.94	6.99	7.79	7.94	8.85	11.11	11.33	12.48	12.69
200	0.98	2.44	4.00	5.30	6.33	7.00	7.10	8.00	10.50	10.71	11.77	11.85
500	0.88	2.19	3.52	4.71	5.49	6.21	6.25	6.99	9.39	9.67	10.50	10.55
1000	0.77	1.97	3.20	4.22	4.94	5.52	5.63	6.33	8.48	8.81	9.50	9.63
2000	0.70	1.71	2.83	3.75	4.48	4.95	5.06	5.67	7.00	7.70	7.90	8.61
5000	0.64	1.51	2.41	3.23	3.78	4.46	4.50	4.99	5.65	6.42	6.50	7.10
10000	0.48	1.23	1.84	2.54	3.04	3.42	3.64	4.41	4.91	5.40	5.50	6.14
20000			1.05	1.84	2.00	2.59	2.60	3.43	3.77	4.31	4.45	4.87

STORM 1002 - (2/27 - 3/3/1938)
SOUTHWEST CENTER
34° 14' N 117° 32' W

Area (mi^2)	Duration (hours)											
	1	3	6	12	18	24	36	48	60	72	84	96
1	2.72	6.62	10.68	17.37	20.05	21.74	21.79	27.94	31.60	35.00	36.33	37.25
10	2.68	6.00	9.62	15.85	18.91	20.25	20.45	25.71	29.42	32.63	33.53	34.29
50	2.50	5.77	9.04	14.35	18.00	19.30	19.55	22.25	24.43	27.14	28.05	29.76
100	2.41	5.54	8.60	13.74	17.22	18.37	18.65	21.20	22.59	24.03	26.75	28.32
200	2.20	4.98	7.77	12.44	15.50	16.57	16.87	19.20	20.35	22.29	24.15	25.60
500	1.82	4.10	6.34	10.45	12.76	13.75	13.96	16.30	17.95	20.08	21.69	22.52
1000	1.30	3.10	5.14	9.82	11.88	13.18	13.38	15.45	16.60	18.30	20.01	21.12
2000	0.88	2.60	4.65	8.02	9.75	10.49	10.80	12.55	13.75	15.28	16.62	17.40
5000		1.77	3.16	5.73	6.95	7.89	8.34	9.90	10.60	11.80	12.77	13.53
10000		1.23	2.26	4.28	5.39	6.16	6.72	7.40	8.66	9.46	10.10	10.80
20000			1.25	2.60	3.64	4.17	4.50	5.20	5.88	6.40	6.87	7.41

STORM 1003 - (1/20 - 24/1943)
SOUTHWEST CENTER
34° 12' N 118° 03' W

Area (mi^2)	Duration (hours)											
	1	3	6	12	18	24	36	48	60	72	84	96
1	2.90	5.50	9.50	16.05	20.52	25.70	33.18	36.10	36.51	36.52	36.54	36.65
10	2.43	4.78	8.55	14.62	17.80	22.90	28.76	31.60	32.28	32.30	32.86	33.00
50	2.14	4.25	7.85	13.15	16.38	20.62	26.32	28.82	29.91	30.63	30.81	30.95
100	1.97	3.92	7.25	11.77	15.42	19.60	24.96	27.63	28.56	29.19	29.25	29.38
200	1.80	3.57	6.63	10.80	14.70	18.38	23.41	26.18	26.91	27.11	27.23	27.31
500	1.65	3.20	5.91	10.28	13.38	16.62	21.13	23.55	24.16	24.52	24.62	24.65
1000	1.30	2.78	5.02	8.60	11.25	14.25	18.45	20.51	21.27	21.54	21.55	21.56
2000	0.97	2.04	4.59	7.55	9.70	12.00	16.02	17.33	18.69	18.79	18.83	18.84
5000	0.62	1.80	3.50	5.78	7.50	9.50	13.32	14.79	15.60	15.78	15.86	15.88
10000			2.67	4.38	5.75	7.25	10.21	11.45	12.01	12.40	12.78	12.80
20000				3.00	4.17	4.92	7.14	7.90	8.77	9.05	9.28	9.45
30000					3.00	3.20	5.36	6.30	6.78	7.20	7.32	7.40

STORM 1004 - (11/17 - 21/1950)
NORTHERN SIERRA CENTER
39° 08' N 120° 20' W

Area (mi^2)	Duration (hours)												
	1	3	6	12	18	24	36	48	60	72	84	96	102
1	1.30	3.39	4.52	7.71	10.13	12.38	14.40	14.76	18.18	23.76	26.14	26.53	26.67
10	1.19	2.98	4.29	7.51	9.78	12.01	14.03	14.51	17.91	23.56	25.80	26.42	26.54
50	1.13	2.56	4.19	7.36	9.53	11.54	13.50	14.09	17.27	22.80	24.91	25.24	25.81
100	0.91	2.40	4.01	7.14	9.29	11.26	13.24	13.84	16.82	22.03	24.07	24.77	25.00
200	0.64	2.05	3.81	6.82	8.92	11.00	12.92	13.67	16.49	21.24	23.25	23.99	24.21
500	0.35	1.61	3.44	6.27	8.39	10.42	12.27	12.96	15.68	20.13	22.43	23.00	23.27
1000	0.11	1.56	2.84	5.74	7.80	9.63	11.38	12.04	14.65	18.71	21.11	21.71	22.07
2000		1.42	2.37	5.16	7.07	8.65	10.29	10.84	12.96	16.59	18.90	19.73	19.96
5000		1.05	1.63	4.25	5.88	7.31	8.75	9.39	11.00	13.71	15.53	16.21	16.22
10000		0.64	1.00	3.18	4.44	5.60	6.68	7.23	8.49	10.52	11.90	12.45	12.54
20000			0.43	2.69	2.80	3.60	4.27	4.73	6.51	6.99	7.63	8.00	8.01

STORM 1005 - (1/25 - 27/1956)
SOUTHWEST CENTER
34° 13' N 117° 31'W

Area (mi^2)	Duration (hours)							
	1	3	6	12	18	24	36	48
1	1.38	3.37	5.07	8.11	10.21	11.65	14.45	16.17
10	1.33	3.34	4.87	7.77	9.91	11.45	14.25	15.96
50	1.22	3.05	4.42	7.23	9.09	10.70	12.95	14.49
100	1.09	2.75	4.08	6.78	8.57	10.33	12.63	13.86
200	0.92	2.30	3.91	6.42	8.12	10.00	12.24	13.32
500	0.75	1.95	3.56	5.64	7.40	9.17	11.16	12.48
1000	0.65	1.68	3.03	5.25	6.82	8.17	10.06	11.38
2000	0.47	1.31	2.64	4.60	5.76	7.00	9.12	9.98
5000	0.35	0.96	1.80	3.63	4.86	5.83	7.80	8.80
10000					3.48	4.39	5.82	6.80

STORM 1006 - (9/17 - 20/1959)
NORTH VALLEY CENTER
40° 43' N 122° 16' W

Area (mi^2)	Duration (hours)							
	1	3	6	12	18	24	36	48
1	3.48	7.73	10.78	12.81	16.75	18.47	18.63	18.77
10	3.27	7.44	10.49	12.02	16.58	17.83	18.19	18.29
50	2.93	6.20	9.05	10.75	15.06	16.45	16.89	17.00
100	2.75	4.39	6.57	10.11	13.38	14.90	15.74	15.81
200	2.27	3.34	5.14	8.27	10.75	12.82	14.02	14.40
500		2.27	3.57	5.95	7.45	9.27	10.70	11.81
1000		1.69	3.01	4.39	5.59	6.80	8.13	8.96
2000		1.44	2.68	3.55	3.70	3.86	5.09	6.19
5000			2.16	3.00	3.36	3.50	3.78	4.50
10000			1.76	2.82	3.06	3.22	3.43	3.50
20000			1.65	2.32	2.57	2.71	2.90	3.05
30000				2.03	2.30	2.42	2.66	2.77

STORM 1007 - (12/4 - 6/1966)
SIERRA CENTER
36° 17'N 118° 36'W

Area (mi^2)	Duration (hours)								
	1	3	6	12	18	24	36	48	54
1	4.15	8.35	13.30	16.47	18.78	22.22	32.88	35.90	35.99
10	4.00	8.19	12.80	16.00	18.21	21.69	31.48	34.38	34.51
50	3.70	7.52	11.85	14.82	16.80	19.90	28.54	31.35	31.49
100	2.69	6.14	10.05	12.22	16.15	18.75	27.55	30.59	30.61
200	2.20	4.66	8.40	10.90	15.70	18.20	26.36	29.62	29.89
500	1.47	3.82	6.14	9.50	13.98	16.20	23.22	26.11	26.28
1000		2.81	4.32	7.78	11.78	13.89	19.97	22.64	22.77
2000		2.00	3.32	5.95	9.05	11.02	15.53	17.98	18.22
5000			2.18	4.00	6.02	7.48	10.17	12.42	12.53
10000			1.88	3.22	4.75	5.55	7.80	9.32	9.41
20000				2.48	3.50	4.25	6.08	7.30	7.39
30000					2.75	3.42	4.98	5.98	6.01

STORM 1008 - (1/23 - 26/1969)
SOUTHWEST REGION
34° 13' N 117° 35' W

Area (mi^2)	Duration (hours)										
	1	3	6	12	18	24	36	48	60	72	80
1	3.13	5.75	9.38	14.00	17.45	19.53	26.68	33.60	36.08	36.61	37.10
10	2.84	5.13	8.34	13.41	16.83	19.07	25.75	31.98	34.50	35.22	35.48
50	2.35	4.24	7.42	12.56	15.75	18.23	24.14	29.95	32.30	33.03	33.10
100	1.90	4.14	7.02	11.60	14.50	17.21	21.40	26.68	28.72	29.27	29.60
200	1.69	3.80	6.46	10.54	13.34	15.76	18.56	23.25	25.15	25.79	25.85
500	1.41	3.30	5.70	9.00	11.16	13.22	14.95	18.95	20.88	21.50	21.55
1000	1.00	2.76	4.98	8.35	10.02	12.28	14.10	17.58	19.00	19.43	19.65
2000	0.86	2.35	4.17	6.80	9.13	9.47	11.50	12.77	14.77	15.46	15.55
5000	0.65	1.78	3.33	5.72	7.18	8.35	9.30	10.99	11.91	12.58	12.70
10000	0.32	1.13	2.29	4.13	5.29	6.98	7.20	8.10	9.00	9.49	9.65
20000			0.68	2.60	3.60	4.23	4.80	5.40	5.92	6.32	6.37

STORM 1010 - (2/14 - 19/1986)
SIERRA REGION
39° 54' N 121° 12' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60	72	84	96	108	120
1	2.02	4.18	5.45	10.19	14.30	18.48	24.68	29.31	29.72	32.61	34.84	36.40	38.68	40.40
10	1.90	3.75	5.40	9.87	13.87	18.12	24.28	28.21	28.99	31.91	34.56	35.70	38.24	39.81
50	1.71	3.35	5.34	9.41	13.16	17.09	22.78	26.59	27.56	30.66	33.09	34.17	36.53	37.96
100	1.63	3.17	4.99	8.90	12.46	16.11	21.41	25.04	25.86	28.98	31.38	32.24	34.57	35.80
200	1.54	2.98	4.62	7.99	11.04	14.50	19.26	22.44	23.12	25.82	28.19	29.21	31.48	32.72
500	1.18	2.47	3.97	6.69	9.43	12.39	16.50	19.68	20.70	23.42	25.60	26.78	29.08	30.20
1000	0.92	1.81	3.43	5.80	8.52	10.90	15.46	17.79	19.13	21.50	23.50	25.39	27.39	29.83
2000		1.52	2.86	5.14	7.63	9.70	13.87	15.95	17.90	20.18	22.00	23.99	25.83	27.00
5000		0.53	2.23	3.99	6.10	7.92	11.29	13.02	14.89	17.92	18.53	20.83	22.20	23.31
10000			1.82	3.38	4.87	6.39	9.01	11.47	12.43	14.00	15.60	17.31	18.50	19.37
20000			0.80	2.35	3.50	4.64	6.58	7.58	9.03	10.24	11.15	12.73	13.57	14.34
30000			0.10	0.72	2.32	3.38	5.11	5.73	7.00	7.76	8.51	9.88	10.65	11.07

STORM 1011 - (9/25 - 26/1939)
SOUTHWEST CENTER
34° 16' N 118°04' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	42
1	2.15	3.95	6.10	7.75	9.70	10.50	11.85	12.42
10	1.87	3.60	5.59	7.48	9.30	10.08	11.29	11.72
50	1.41	3.32	4.52	6.21	8.74	9.50	10.36	10.57
100		2.80	3.89	5.63	8.01	8.77	9.47	9.76
200		2.21	3.09	4.89	7.30	7.72	8.49	8.78
500		1.59	2.73	4.78	6.46	6.80	7.38	8.09
1000			2.60	4.51	5.80	6.12	6.81	7.22
2000				4.01	5.13	5.57	6.14	6.28
5000						3.72	4.22	4.26

STORM 1012 - (5/18 - 19/1957)
SIERRA CENTER
39° 57' N 121°27 W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60
1	1.15	1.60	3.13	4.63	6.70	7.27	7.82	8.47	8.60
10	1.08	1.50	3.00	4.55	6.60	7.23	7.68	8.30	8.48
50		1.38	2.75	4.45	6.50	7.19	7.58	7.90	8.30
100		1.35	2.70	4.34	6.48	6.92	7.54	7.57	8.00
200		1.33	2.52	4.29	6.30	6.66	7.33	7.47	7.75
500		1.28	2.44	3.96	5.83	6.26	6.97	7.19	7.43
1000		1.25	2.15	3.75	5.18	5.93	6.61	6.94	7.20
2000			1.80	3.42	4.78	5.51	6.19	6.59	6.93
5000				2.72	3.77	4.21	5.02	5.41	5.69
10000					2.80	3.40	4.03	4.36	4.50
20000							2.72	3.03	3.08

STORM 1013 - (6/1 - 2/1958)
NORTHWEST CENTER
42° 15' N 123° 25' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48
1	1.20	3.00	3.76	4.25	4.40	4.55	4.65	4.67
10	1.15	2.95	3.60	4.05	4.20	4.33	4.55	4.57
50	1.10	2.81	3.45	3.87	4.02	4.17	4.40	4.45
100	1.01	2.53	3.15	3.45	3.74	4.02	4.30	4.35
200	0.95	2.27	2.70	3.05	3.35	3.62	4.10	4.17
500	0.70	1.67	2.19	2.68	2.90	3.12	3.75	3.85
1000	0.60	1.25	1.70	2.15	2.40	2.65	3.10	3.20
2000		0.75	1.20	1.60	1.80	2.05	2.48	2.67
5000			0.50	0.80	0.92	1.04	1.48	1.75

STORM 1014 - (7/8 - 10/1974)
SIERRA CENTER
38° 50' N 120° 41' W

Area (mi^2)	Duration (hours)							
	1	3	6	12	18	24	36	48
1	2.25	3.20	4.10	4.57	5.30	6.25	7.35	7.50
10	1.86	2.90	3.95	4.48	5.25	6.20	7.25	7.40
50	1.55	2.52	3.80	4.40	5.12	5.85	7.10	7.15
100	1.43	2.45	3.67	4.37	4.95	5.58	6.97	7.02
200	1.28	2.25	3.55	4.25	4.60	5.33	6.78	6.85
500		2.00	3.15	3.85	4.25	4.97	6.55	6.61
1000		1.87	2.60	3.40	3.95	4.65	6.10	6.20
2000		1.65	2.20	2.97	3.50	4.30	5.54	5.70
5000				2.15	2.67	3.30	4.50	4.55
10000						2.35	3.50	3.55

STORM 1015 - (8/13 - 16/1976)
SIERRA CENTER
40° 43' N 122° 16' W

Area (mi^2)	Duration (hours)							
	1	3	6	12	18	24	36	48
1	1.86	2.86	4.33	4.81	4.85	5.21	5.54	5.67
10	1.84	2.83	4.24	4.65	4.72	5.11	5.39	5.44
50	1.75	2.80	4.13	4.47	4.67	4.87	5.28	5.35
100	1.73	2.67	4.00	4.40	4.60	4.73	5.18	5.28
200	1.54	2.39	3.86	4.33	4.47	4.60	5.00	5.13
500	1.11	1.87	3.43	3.93	4.12	4.25	4.73	4.88
1000		1.51	2.80	3.29	3.42	3.60	4.33	4.50
2000		1.10	1.95	2.53	2.80	2.93	3.70	3.90
5000				1.57	1.87	2.02	2.63	2.79
10000						1.33	1.85	1.98

STORM 1016 - (9/9 - 11/1976)
SOUTHWEST CENTER
34° 20' N 117° 03' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48
1	2.15	3.42	5.80	10.15	13.58	15.55	17.20	17.20
10	2.07	3.15	5.62	9.77	13.15	15.10	16.65	16.70
50	1.79	2.86	5.10	8.71	11.60	13.30	14.60	15.10
100	1.50	2.67	4.66	7.90	10.63	12.15	13.32	14.05
200	1.28	2.51	4.02	7.13	9.50	10.90	11.80	12.60
500	1.02	2.10	3.12	6.00	8.00	9.02	9.60	10.60
1000		1.76	2.73	5.08	6.67	7.60	8.40	9.02
2000		1.50	2.41	4.40	5.67	6.30	7.02	7.60
5000		1.35	2.24	3.50	4.42	4.90	5.45	5.80
10000			2.03	2.77	3.30	3.90	4.40	5.55
20000						2.95	3.33	3.50

STORM 1017 - (8/15 - 17/1977)
SOUTHEAST CENTER
34° 50' N 115° 41' W

Area (mi^2) Duration (hours)

	1	3	6	12	18	24	36	48	60
1	2.39	2.77	3.45	5.33	5.33	5.86	5.86	6.24	6.25
10	2.27	2.65	3.34	5.26	5.26	5.70	5.70	6.16	6.17
50	2.21	2.55	3.30	5.18	5.18	5.59	5.59	6.12	6.12
100	2.07	2.51	3.27	5.17	5.17	5.53	5.53	6.03	6.03
200	1.89	2.48	3.26	4.92	4.92	5.49	5.49	5.82	5.82
500	1.65	2.44	2.89	4.53	4.53	5.02	5.02	5.28	5.28
1000	1.49	2.10	2.60	4.01	4.01	4.44	4.44	4.81	4.81
2000	1.31	1.69	2.11	3.16	3.16	3.52	3.53	3.85	3.85
5000		1.49	1.55	2.10	2.10	2.47	2.57	2.88	2.88
10000				1.63	1.68	1.80	1.89	2.37	2.39
20000				1.23	1.39	1.63	1.70	1.86	1.91

STORM 1018 - (7/27 - 29/1984)
SOUTHEAST CENTER
34° 58' N 115° 31' W

Area (mi^2)	Duration (hours)						
	1	3	6	12	18	24	36
1	5.05	5.58	5.78	5.89	5.89	5.89	5.90
10	4.98	5.48	5.68	5.79	5.79	5.79	5.80
50	4.79	5.36	5.51	5.70	5.70	5.70	5.71
100	4.70	5.21	5.36	5.51	5.51	5.51	5.52
200	4.51	4.96	5.12	5.32	5.32	5.32	5.34
500	4.02	4.47	4.66	4.75	4.75	4.75	4.78
1000	3.30	3.67	3.80	3.93	3.93	3.93	4.09
2000	2.52	2.80	3.00	3.34	3.34	3.34	3.40
5000	0.78	1.70	2.20	2.46	2.50	2.50	2.56
10000			1.45	1.87	1.96	1.96	2.09
20000				1.28	1.31	1.39	1.49

APPENDIX 2

Synoptic Descriptions

The following synoptic descriptions cover storms considered most significant to this study (Chapter 2, Table 2.1), and are included to give insight to the types of conditions supporting these major events. These nine storms provided the greatest non-orographic precipitation for the regions indicated in Chapter 6, Figure 6.2. These synoptic discussions are brief, qualitative analyses in which no detailed cross-sections or isentropic examination were conducted. Such analysis was determined to be beyond the scope of this project and was not possible in some cases due to limited data. Various maps and discussions from other hydrometeorological reports, i.e. HMR 37 (1962) and HMR 50 (1981), were available but were not included for sake of brevity.

The first four storm descriptions are nearly identical to those in HMR 57 (1994). The only differences that may arise are due to the selection of a different precipitation center than that used in HMR 57. In some cases, mesoscale meteorological factors occurring further south played a more significant role in California, as than in Oregon and Washington.

STORM: 40
DATE: 12/9 - 12/1921
LOCATION: North Central Cascades
DURATION: 72 hours

SYNOPTIC DESCRIPTION: A broad area of surface high pressure extended from the Great Basin southwestward into the Pacific off California. A plume of moist air, on the backside of this ridge, followed a trajectory from near Hawaii to the coastal area of Washington on the 9th. Over the Aleutians, a low pressure system moved to the north-northeast, with a trailing cold front. The cold front became occluded as it pushed onshore through British Columbia, with surface winds increasing to more than 30 knots along the Washington coast. The

low-pressure system intensified very quickly as it moved toward the northeast on the 10th. A secondary cold front moved onshore on the 11th. This caused a wind shift to the west before shifting back to the southwest ahead of the next system.

By the 12th, winds increased to 40 knots along the coast as the occluded front brought an intensified pressure gradient along with it. This appeared to have produced the heaviest core precipitation in the core region. Rainfall ended on the 13th.

The cause of the heavy rainfall was attributed to the strong southwesterly flow encountering the coastal and Cascade Mountains during the 10th and 11th, supported by a strong pressure gradient. The rainfall occurred in two surges; the first and lesser surge was from the afternoon of the 9th to the morning of the 10th, while the heavier surge occurred between late on the 10th through the morning of the 12th. At Silverton, Washington a rainfall amount of 15.38 inches was recorded.

STORM: 88
DATE: 12/26 - 30/1937
LOCATION: Coastal Mountains of Washington, Oregon
DURATION: 96 hours

SYNOPTIC DESCRIPTION: This storm brought moist flows into the coastal mountains of Oregon and Washington, with numerous rainfall centers in excess of 10 inches. The largest observed amount occurred near Valsetz, Oregon, where some 25 inches fell on the southwest facing slopes. The mountains in this region rise to levels between 3500 and 4000 feet.

The primary storm of the 28th to 30th followed a series of quick moving, low pressure centers that passed through western Washington to the east. On the 26th, a low pressure system moved into the Gulf of Alaska and rapidly deepened during the next 30 hours. This resulted in both a slowing of movement and an intensification of the onshore gradient that increased the winds to the coastal mountains. A quasi-stationary front developed along the Washington/Oregon border. Several short waves passed along this frontal surface that provided rain impulses during the storm. Movement of the frontal surface south and then

back north may have contributed to the maximum rains occurring in Oregon since the boundary was over the same region twice.

By the 30th, the front had been displaced eastward and the rains ceased along the coastal mountains except for a few showers. Most of the mass curves for this storm show rain occurring in two bursts separated by nearly 30 hours. It is apparent from these curves that little convective activity was associated with this event.

From the Northern Hemisphere Daily Weather Maps, dewpoints are in the low 40's, with air temperatures ranging between 55° and 61° F. Temperatures at this level are indicative of trajectories from subtropical latitudes at this time of year.

STORM: 149
DATE: 11/21 - 24/1961
LOCATION: Southwestern Oregon
DURATION: 72 hours

SYNOPTIC DESCRIPTION: A deep low pressure center, located over southwestern Alaska on the 20th, moved toward the southeastern Alaskan coast by the 21st. Central pressure was less than 970 mb, and an occluded front trailed southward along the coast to the southern end of Vancouver Island. Here, a warm front branched off and into the Oregon coast that initiated a three-day period of rainfall over western Washington and Oregon. On the 22nd, the warm front was replaced by a cold front that rotated clockwise to align itself east-west across the coast by the end of the 23rd. The tight gradient through this sequence pulled strong southwesterly winds onshore into the coastal mountains. Heavy snow was reported throughout the mountains, causing power outages and some road closings. The heaviest rains were noted along the coast with Brookings, Oregon, recording over 10 inches. Precipitation ended the morning of the 24th, as a wave passed along the front, pulling it southward into California.

It is possible that some moisture entering this storm was pulled northward from the remnants of tropical storm Dot; however, available synoptic analyses were insufficiently

clear off the coast to support this claim. Moisture from such a source would more than account for the heavy rains observed.

Most of the precipitation fell in the western portions of the two states. It was believed that the combination of strong convergent flows and orographic lifting concentrated most of the heavy rains against the major mountain slopes. Unseasonably cold temperatures preceded the passage of the warm front into the region. This undoubtedly accounted for the heavy snows reported in the mountains.

STORM: 165
DATE: 1/13 - 17/1974
LOCATION: Coastal Washington and Oregon
DURATION: 72 hours

SYNOPTIC DESCRIPTION: A strong high-pressure system prevailed over the Gulf of Alaska, representing a block to storms and the jet stream entering the west coast on the 10th. An arctic airmass was centered to the north and northeast of the storm location. Large negative temperature departures were observed over portions of Washington and Oregon, with below-zero temperatures reported throughout the region east of the Cascades. The blocking high began to regress westward by the 11th, allowing a surge of warm air to enter the coast at the southern end of the region. Both temperatures and dewpoint temperatures rose significantly during a 24-hour period beginning the 12th. Rapid cyclogensis developed in the Gulf in place of the high-pressure system, and a number of short waves moved around the trough at the time of increasing temperature and moisture flows. Early snowfall changed to rain that intensified with time as the gradient increased and as the orographic influences took over.

Coastal winds were reported at 60 mph along the Washington coast, increasing to 75-100 mph along the Oregon coast. Winds of such magnitude cause considerable damage but also support the strong orographic effects noted in the precipitation pattern for this storm. Beginning on the 16th, a second short wave began to push through the region, bringing an end to this period of heavy rains.

Mount Shasta, California, set an all-time 24-hour rainfall of 6.97 inches during this storm, and Sexton Summit, Oregon, set 12-, 24-, and 72-hour records of 3.39, 5.98, and 11.52 inches, respectively. More than 9 inches fell on a large portion of western Oregon, while a few stations had maxima of nearly 13 inches.

STORM: 630
DATE: 1/3 - 5/1982
LOCATION: Mid-coast California
DURATION: 60 Hours

SYNOPTIC DESCRIPTION: The upper-level features preceding and during this January event were such that prolonged advection of warm moist subtropical air over modified polar air at the surface was certain. A low-amplitude trough, situated over the Pacific Northwest and eventually sagging southward, steered short waves into the Northern California coast. The trough by itself allowed polar air continually to refresh the California interior with new cooler air. A split jet stream beginning much further to the west, due to a blocking pattern at 500 mb, caused the northern branch of the jet stream to steer north into Alaska and the other branch to track far to the south over subtropical ocean waters. The southern stream dipped to near Hawaii and recurved to meet the northern branch nearly over California where the flow was closer to westerly.

From January 1 through the 2nd, a strong short wave moved along the northern branch through Alaska and down into the Pacific Northwest. The short wave brought cold and damp conditions to northern and central California. Freezing levels were down to sea level in the northern California region and were near 2500 feet in the San Francisco Bay area. Winds were northerly with reinforcing cold air advection occurring the rest of the day. Another shot of cold air slid across the area with the next wave, that also originated in the Gulf of Alaska. This wave moved well north of California on the 3rd but had the effect of keeping the surface airmass much colder than normal and strengthening the temperature gradient between the approaching southern-stream wave and the continental air. An additional effect of the temperature gradient was steering the jet stream nearly parallel to the coast of California near the San Francisco Bay thus *locking* in a pattern.

Meanwhile, a southern-stream short wave was strengthening just northeast of Hawaii. This wave was able to entrain large amounts of moisture as it developed and moved east-northeast toward the coast. As this disturbance approached California, precipitation began along the coast on the afternoon of the 3rd. A surface warm front, associated the low pressure system, stalled along and nearly parallel the coast as the subtropical airmass collided with the cold air in place. For at least the next 24 hours, the front sat acting as a ramp for overrunning precipitation in California. The corresponding short wave moved over northwest California and into Oregon leaving the quasi-stationary warm front essentially intact along the California coast.

A secondary low formed offshore and it too moved northeast eventually through central California pulling a cold front behind it, virtually shutting down the precipitation mechanism responsible for the extreme rainfall over the San Francisco Bay area. As it moved slowly toward the coast, however, it kept the flow of warm moist maritime air focused on the same area that had received the brunt of the heavy precipitation thus far. By early on the 5th of January the second low pressure system had moved well inland and only scattered precipitation was left over.

Observed rainfalls were extremely high over the coastal regions and much less not far inland. The persistence of the warm front just offshore and the frictional convergence of the coastal mountains both combined to make the rainfall spectacular along these uplift areas. Rainfall totals for 30 to 36 hours were more than 24 inches in localized spots and well over 10 inches over a broad area of the coast just west of San Francisco. Mass curves near or along the coast show a constant stream of precipitation through the storm period with few interruptions or pulses of rainfall. The rainfall seemed very general and consistent in behavior and not extremely convective, just very constant.

STORM: 1003
DATE: 1/20 - 24/1943
LOCATION: Southwest California
DURATION: 96 hours

SYNOPTIC DESCRIPTION: Major Pacific coast storms have several important characteristics in common. These include blocking patterns in the central or eastern Pacific, which split the jet stream and steer disturbances north and south for days or weeks, abundant cold polar or arctic air over the intermontaine region, a tropical/subtropical connection, and a strong southwesterly flow that continues for an extended time. All these factors came into play in January 1943 over California. First, a series of three low-pressure systems were pushed further and further south by a large-scale blocking pattern situated to the north and west of California. The first system moved southeasterly out of the Gulf of Alaska and into Washington on the 19th and 20th of January before weakening and continuing east. The corresponding cold front moved south down the coast through northern California and stalled between San Francisco and Los Angeles. The cold air associated with the front filtered down through most of the state. To the west, the stalled remnant front extended west-southwest over the ocean and set the stage for the next developing storm system that would track along the frontal boundary.

The second low-pressure system developed along the southern branch of the jet stream near Hawaii. It intensified rapidly upon moving northeast and into contact with the colder polar air to the north of the frontal boundary. The center of the second low moved into southern Oregon and continued northeast, weakening rapidly. The third and final wave followed quickly after the second short wave but did not deepen as much as the preceding one as it moved into northern California.

Meanwhile throughout the storm's history, rainfall progressed further and further south, as each succeeding low-pressure system pulled the cold-front boundary further south. Flow ahead of each wave shifted from westerly to southwesterly and became increasingly warm and moist. Extremely strong winds carried the subtropical air into the mountain barriers along the southern coast of California. Very low pressure associated with the

disturbances and the subtropical high poised to the south caused a tight gradient to form over the West coast.

Strong and persistent southwesterly flow over southern California ushered in the extreme precipitation values recorded over much of the south. The most prodigious precipitation began early on the 21st, in the central part of the state, and quickly moved south to where the front had slowed considerably until the front associated with the third, and final, low-pressure system came through on the 23rd. Generally, precipitation over most of the southwestern portions of California was due to coastal convergence, instability, and orographic lifting. *Perfect* flow trajectories (i.e., the Pineapple Express) with high winds focused the rainfall on those orographic zones aligned perpendicular to mean flow from the surface to 700 mb. More than 26 inches was recorded at Hoegee's Camp, high in the San Gabriel's, over 24 hours and more than 36 inches in four days of rainfall.

In many ways this was similar to storm 1002 (2/27 - 3/3/1938). Both storms tapped the warm moist maritime tropical air of the central Pacific and pulled it north into southern California. Sustained high winds transported the moisture to the coast and inland due to large pressure differences north-south across the region. More than one short wave developed and moved onshore in each storm throughout the rainy period as well. Another commonality was the slow moving or stationary front in the vicinity of the extreme rainfall as well as lingering polar (maritime) air entrenched before the rains began. The most intense precipitation, in both storms, fell in the mountains north and east of Los Angeles making both storms primarily orographically driven.

STORM: 1004
DATE: 11/17-21/1950
LOCATION: Sierra Center
DURATION: 102 hours

SYNOPTIC DESCRIPTION: A series of short waves and their corresponding fronts over a relatively short period, combined with a moist tropical connection caused excessive precipitation to fall over north-central California. A blocking ridge did exist during this

storm, but the block was weak, centered around 180° W, allowing short waves to travel both north and south of the ridge. Those disturbances traveling south of the ridge were also weak and did not intensify much before they crossed the coast line. A significant quasi-stationary upper-level low churned away for most of the storm duration just off the coast of southwestern Canada. An upper-level trough moved northeast from its position near the Hawaiian Islands toward the Pacific coast thereby providing a track for the southern-stream low pressure systems to follow up the Pacific coast and extending to the low already off the coast of Canada.

The storm period began with a cold front moving southeast out of the Gulf of Alaska on November 15th and 16th into northern California where the front became stationary. The front stretched back west-southwest where the next short wave was evolving and moving northeast toward the Pacific coast. Tropical flow preceding the next rapidly intensifying short wave crashed into California on the 18th and dumped very heavy rains and snows in the coastal mountains, as well as in the central and southern Sierra. Meso-lows moved along the stationary east-west oriented front during the day increasing rainfall totals. By the next morning the front was slowly moving south of Sacramento and dissipating as high pressure built in from the south.

As the ridge began to move toward the east another disturbance began to organize southwest of California and in the northern stream another cold front approached from the northwest. Again the convergence of the frontal boundary and the southwest short wave caused rapid intensification just offshore on November 19th. The frontal boundary, swinging southeastward again, slowed to a nearly stationary position just north of where the first front became stationary on the 17th. A ridge aloft, began to build rapidly to the northwest on the 20th effectively cutting off the narrow warm moist plume to the southwest thus ending the precipitation in California. The stationary front slowly edged south and became indistinct as the pressure rose across California and into the Pacific.

The heaviest precipitation fell in two general areas, the southern and central Sierra mountains early in the storm period (November 18th) and the northern Sierra mountains (primarily November 20th) with the second bout of rainfall. Most 24-hour rainfall totals from early on the 18th in the central Sierra region exceeded 8 inches with several stations recording more than 10 inches during this period. At Hetch Hetchy over 13 inches fell for

this duration. Later on the 20th, as the next precipitation surge hit the Sierra, heavy rains fell over some of the same areas inundated two days before. At Blue Canyon, for example, more than 8.5 inches fell over the 24-hour period beginning at midnight on the 19th.

While other more extreme storms have hit the Sierra mountains, none has centered so distinctly in such a remote location as this storm (see Chapter 6). Due to a constricted moisture source to the west-southwest and a nearly stationary front draped east-west across northern California, most of the extreme precipitation fell in narrow bands across the mountains. Winds, although strong, were not as severe as many comparable storms to the region.

STORM: 1010
DATE: 2/14 - 19/1986
LOCATION: Sierra Center
DURATION: 120 hours

SYNOPTIC DESCRIPTION: The conditions resulting in the February 1986 extended heavy precipitation event over California were a result of a blocking pattern upstream of the Pacific west coast. A strong high-pressure ridge formed over the eastern Pacific early in February, essentially diverting flow around to the north and south of it. Through time the ridge strengthened and eventually became cut off in the Gulf of Alaska. As the ridge developed and slowly progressed northeast, much of the upper-level flow undercut the block, near latitude 30° to 40° N, entraining air from the warm tropical ocean surrounding Hawaii.

Although some rains began on February 11th, the heavier rainfall began on the 14th as the first major low-pressure system tracked into Washington. The trailing strong cold front brought widespread heavy rains and gusty winds. Behind the front the rains continued as the warm moist inflow continued to pump up and over the colder polar air at the surface. The next major disturbance influenced the state on February 16th as the second major short wave exploded off the Pacific coast. The cold front that had moved into southern California on the 15th stalled and began moving northward on the 16th as a warm front. Overrunning rains continued over the central and northern portions of California. Snow levels during the

entire event were quite high as the warm moist air, originating as far south as 5° to 10° N, was advected northeast ahead of the low-pressure system. The rain continued through the 17th and 18th as the next and final short wave in the series smashed into the coast. By the 19th snow levels had dropped as a dry cool airmass moved into place and a more westerly wind cut off the tropical moisture that had brought so much precipitation to the Pacific west coast.

Throughout the storm period precipitation fell over a broad area of California and the west coast. As each short wave intensified, occluded, and moved onshore, it brought heavy rainfall with it. The rainfall, however, focused on the northern and central Sierra mountains and coastal regions from central to northern California. From February 12th to 21st, more than 45 inches fell over parts of the Sierra and more than 18 inches fell at Bucks Lake in 24 hours from the morning of the 16th. Although individual stations show heavy 24-hour amounts, the storm is more remarkable for its length of heavy rainfall duration.

The source region of tropical air, south of Hawaii, makes this storm extraordinary as does the duration of that connection. Other factors include strong jet stream winds that were reflected down to the surface. The strong southwesterly winds allowed the rapid and uninterrupted transport of tropical moisture to central and northern California even after a cold front at the surface (February 14 -15) had moved south of the area. Finally, since the overall flow was perpendicular to the prevailing mountain orientation, orographic forcing became the rule.

STORM: 1017
DATE: 8/15 - 17/1977
LOCATION: Southeast Region
DURATION: 60 hours

SYNOPTIC DESCRIPTION: For southeast California the most extreme rainfall events occur during the summer months mainly July through September. These storms are commonly the result of tropical storms or the residue of a tropical storm that has drifted northward near or into southern California. In this case, tropical storm Doreen was the cause

of the terrific rains recorded across the deserts of California and the areas around Los Angeles. However, in locations along the coast and the adjacent mountains, west of the desert, the rainfall associated with Doreen, pales in comparison to the all-season amounts recorded during the winter in these same regions.

A *typical* summer regime set up over the southwestern United States with a heat low centered over the deserts at the surface and high pressure aloft. Low-level moisture was advected to the north and east of the surface low circulation centered near Death Valley. Evidence of the very high dewpoints in southeastern California can be noted long before the storm actually began. These dewpoints may be partially related to the moisture shield surrounding the tropical storm off the Baja coast. The moisture appeared at least 24 hours before the heavy rains began on the 15th of August.

As Doreen made her way north, moisture became more abundant and widespread. Dewpoints in the 70's covered most of southeastern California by August 16th. Due to limited observations, coverage in this part of the region and the chaotic manner in which the rains fell, detailed analysis at the mesoscale level proved difficult. Suffice to say, heavy convective elements developed late on the 15th and early on the 16th. This precipitation, however, was primarily confined to the United States-Mexican border. The following 24-hours resulted in the more widespread rainfall as the tropical storm, still west of Baja, moved closer causing more instability. Heavy rains began by the afternoon of the 16th and lasted through most of the night as they slowly worked north over the southeastern portion of California.

More than 6 inches were recorded at Mitchell Caverns late August 16th into early on the 17th. Heavy rains similar to these rains fell across other parts of the desert during this period. West of the coastal mountains, heavy tropical rains fell almost 24 hours later as the remnant tropical depression worked its way northward along the coast. The tropical moisture and heavy rains were eventually pulled northeast into central Nevada essentially ending the precipitation in California by the 19th.

Although not obvious, several factors could have caused this storm to release its potential over southeast California. Diurnal heating patterns contributed to the moisture flow into the area. The tropical storm provided a deeper than normal moisture column and

increased dynamics as it approached. Some orographic factors may also be linked but discerning it with the lack of records is hard. Mitchell Caverns is higher (3700 feet) than much of the area surrounding it especially to the south. It is therefore possible that some orographic influence held sway in some localized regions of rapid upslope. The mountains around Los Angeles had greater precipitation than in the city; therefore, some orographic factors were definitely involved there.

APPENDIX 3

Local Storm List

This list of 137 storms represents all the additional local storms examined for HMR 59. The storm locations are shown on the map in Figure A3.1. While the storms listed in Chapter 9, Figure 9.1 were considered the most extreme, these additional storms were considered important for this study. The local storms provided below are included for the benefit of the user and for future study. All latitudes are degrees north, negative longitudes are degrees west. A 24-hour clock is used for the hour of maximum rainfall.

Table A3.1. *Extreme local storms in California.*

#	Location	Latitude (degrees)	Longitude (degrees)	Elevation (feet)	Date	Hour of maximum rainfall	Max 1-hour rainfall (inches)	Max 6-hour rainfall (inches)
1	IRON MOUNTAIN	34°08'	-115°08'	922	7/22/1948	22	1.19	1.20
2	KYBURZ STRAWBERRY	38°48'	-120°09'	5700	7/31/1949	14	1.04	1.06
3	HEMET RESERVOIR	33°40'	-116°40'	4360	10/15/1949	10	1.18	1.43
4	MILL CREEK INTAKE	34°05'	-116°56'	4945	7/6/1950	13	1.02	1.31
5	TRINITY CENTER RS	41°00'	-122°41'	2300	9/15/1950	18	1.02	1.03
6	POINT ARENA	38°54'	-123°42'	100	4/16/1951	14	1.03	1.32
7	TERMO 1 E	40°52'	-120°26'	5300	6/20/1951	15	1.03	1.03
8	SIERRAVILLE RS	39°35'	-120°22'	4975	8/19/1951	14	1.02	1.22
9	BLYTHE FAA AP	33°37'	-114°43'	390	8/20/1951	19	1.08	1.46
10	TRINITY CENTER RS	41°00'	-122°41'	2300	8/22/1951	17	1.01	1.43
11	CRAWFORD RANCH	32°53'	-116°17'	1500	8/26/1951	16	1.99	2.50
12	SANTA FE DAM	34°07'	-117°58'	427	4/19/1952	14	1.18	1.70
13	ALTURAS RS	41°30'	-120°33'	4400	6/6/1952	14	1.13	1.20
14	BIG BEAR LAKE DAM	34°14'	-116°58'	6820	7/24/1952	15	1.17	1.94
15	HARRISON GULCH RS	40°22'	-122°58'	2750	8/1/1952	20	1.29	1.30
16	FLORENCE LAKE	37°16'	-118°58'	7325	8/12/1953	14	1.82	2.07
17	MILFORD LAUFMAN RS	40°08'	-120°21'	4860	6/11/1955	20	1.05	1.05
18	JULIAN	33°05'	-116°36'	4220	8/23/1955	15	2.58	2.83
19	RUNNING SPRINGS RS	34°12'	-117°05'	5970	7/26/1956	17	1.00	1.00
20	SHASTA DAM	40°43'	-122°25'	1075	6/2/1958	2	1.14	3.55
21	THE GEYSERS	38°48'	-122°50'	1668	6/10/1958	16	1.40	1.77
22	SUSANVILLE 1 WNW	40°26'	-120°40'	4555	7/24/1958	17	1.02	1.02
23	MILFORD LAUFMAN RS	34°05'	-116°56'	4860	7/29/1958	15	2.10	2.24
24	CUYAMA RS	34°51'	-119°29'	2750	8/16/1958	16	1.32	2.80
25	HEMET RESERVOIR	33°40'	-116°36'	4360	8/16/1958	12	1.00	1.03
26	FLORENCE LAKE	37°16'	-118°58'	7330	8/9/1959	14	1.18	1.96
27	SLACK CANYON	36°05'	-120°40'	2500	9/12/1959	16	1.14	1.20

Table A3.1. *Extreme local storms in California.*

#	Location	Latitude (degrees)	Longitude (degrees)	Elevation (feet)	Date	Hour of maximum rainfall	Max 1-hour rainfall (inches)	Max 6-hour rainfall (inches)
28	JULIAN	33°05'	-116°36'	4220	9/13/1959	14	1.68	1.94
29	MILL CREEK INTAKE	34°05'	-116°56'	4945	9/13/1959	13	1.14	1.68
30	MILL CREEK INTAKE	34°05'	-116°56'	4945	7/22/1960	15	1.80	1.84
31	CRAWFORD RANCH	32°53'	-116°17'	1500	8/21/1960	17	1.00	1.06
32	MILL CREEK INTAKE	34°05'	-116°56'	4945	9/10/1960	16	1.15	1.55
33	OROVILLE RS	39°32'	-121°34'	300	5/30/1961	16	2.08	2.32
34	SANTA ANA RIVER PH	34°06'	-117°06'	1970	8/4/1961	17	1.30	1.35
35	JULIAN	33°05'	-116°36'	4220	8/4/1961	16	1.27	2.04
36	CRAWFORD RANCH	32°53'	-116°17'	1500	8/18/1961	16	2.19	2.66
37	CAMP ANGELUS	34°09'	-116°59'	5768	8/21/1961	13	1.25	1.37
38	TUJUNGA MILL FC	34°23'	-118°05'	4650	8/22/1961	13	1.28	1.80
39	WELDON 1 WSW	35°40'	-118°18'	2680	8/22/1961	16	1.14	1.37
40	MILL CREEK INTAKE	34°05'	-116°56'	4945	8/23/1961	13	1.74	1.79
41	FINLEY 5 SW	38°58'	-122°57'	1750	8/27/1961	17	1.18	1.28
42	MC CLOUD	41°15'	-122°08'	3280	5/29/1963	18	1.21	1.29
43	ETNA	41°28'	-122°54'	2950	6/13/1963	19	1.20	1.43
44	HENSHAW DAM	33°14'	-116°46'	2700	8/7/1963	13	1.79	1.99
45	TEHACHAPI AIRPORT	35°08'	-118°26'	3960	8/8/1963	12	1.20	2.19
46	MILL CREEK INTAKE	34°05'	-116°56'	4945	8/14/1963	14	1.22	1.90
47	CRESTLINE LAKE GREGORY	34°14'	-117°16'	4530	9/18/1963	6	2.01	2.89
48	LUCIA WILLOW SPRINGS	35°53'	-121°27'	360	3/6/1965	4	1.17	1.79
49	JULIAN	33°05'	-116°36'	4220	7/15/1965	13	1.17	1.26
50	KYBURZ STRAWBERRY	38°48'	-120°09'	5700	7/17/1965	14	1.14	1.23
51	HETCH HETCHY	37°57'	-119°47'	3870	8/14/1965	15	1.58	1.87
52	SODA SPRINGS 1 E	39°19'	-120°22'	6890	8/14/1965	12	1.10	1.10
53	BIG PINES PARK FC	34°23'	-117°41'	6850	8/16/1965	14	1.33	3.35
54	CLEARLAKE 4 SE	38°54'	-123°36'	1350	8/17/1965	14	1.08	1.15
55	LOS ANGELES CIVIC CTR.	34°03'	-118°14'	270	9/18/1965	14	1.28	1.39
56	EL CAPITAN DAM	32°53'	-116°49'	600	3/24/1966	15	1.20	1.70
57	REDDING 5 SSE	40°30'	-122°22'	425	4/9/1966	19	2.40	3.51
58	JULIAN WYNOLA	33°06'	-116°39'	3650	7/30/1966	11	1.03	1.30
59	CHUCHUPATE RS	34°48'	-119°01'	5260	8/2/1966	15	1.25	1.27
60	RUNNING SPRINGS 1 E	34°12'	-117°05'	5970	10/6/1966	8	1.10	1.10
61	FALLBROOK	33°21'	-117°15'	660	4/5/1967	13	1.00	1.00
62	ROBBS PEAK PH	38°54'	-120°22'	5120	5/12/1967	10	1.00	1.00
63	FORT JONES 6 ESE	41°35'	-122°43'	3320	6/20/1967	17	1.58	2.13
64	BIG PINES PARK FC	34°23'	-117°41'	6850	7/13/1967	12	1.02	1.37
65	TUJUNGA MILL FC	34°23'	-118°05'	4650	8/23/1967	16	1.29	1.71
66	WARNER SPRINGS	33°17'	-116°38'	3180	8/31/1967	1	1.09	1.90
67	NEEDLES	34°50'	-114°36'	150	7/22/1968	20	2.07	2.23
68	HURKEY CREEK PARK	33°41'	-116°41'	4390	7/23/1968	11	1.18	1.59
69	SAN JOSE	37°21'	-121°54'	67	8/21/1968	13	1.25	1.92
70	IRON MOUNTAIN	34°08'	-115°08'	922	10/3/1968	17	1.72	2.08
71	MOUNT DANAHER	38°42'	-120°40'	3410	4/2/1969	20	1.10	1.50
72	MILL CREEK INTAKE	34°05'	-116°56'	4945	8/8/1969	15	1.15	1.35

Table A3.1. *Extreme local storms in California.*

#	Location	Latitude (degrees)	Longitude (degrees)	Elevation (feet)	Date	Hour of maximum rainfall	Max 1-hour rainfall (inches)	Max 6-hour rainfall (inches)
73	IDYLLWILD FIRE DEPT.	33°45'	-116°43'	5380	8/15/1970	10	1.10	1.60
74	BRIDGEPORT RS	38°15'	-119°14'	6441	7/20/1971	15	1.05	1.25
75	WARNER SPRINGS	33°17'	-116°38'	3180	8/4/1971	14	1.40	1.42
76	MARKLEEVILLE	38°42'	-119°47'	5530	8/12/1971	15	1.12	1.12
77	PALOMAR MTN. OBSY	33°21'	-116°52'	5550	6/5/1972	14	1.00	1.09
78	HUNTINGTON LAKE	37°14'	-119°13'	7020	6/7/1972	15	2.00	2.90
79	LORAINE	35°18'	-118°26'	2720	5/14/1973	16	1.39	1.55
80	NEEDLES	34°50'	-114°36'	150	7/19/1974	19	1.72	2.33
81	CUYAMACA	32°59'	-116°35'	4640	7/19/1974	13	1.10	1.30
82	TUJUNGA MILL FC	34°23'	-118°05'	4650	7/23/1974	14	1.14	1.24
83	WELDON 1 WSW	35°40'	-118°18'	2680	7/24/1974	18	1.65	1.80
84	FORT JONES 6 ESE	41°35'	-122°43'	3320	7/12/1975	15	1.00	1.40
85	FERGUSON RANCH	40°21'	-122°27'	800	8/18/1975	23	1.10	1.50
86	WARNER SPRINGS	33°17'	-116°38'	3180	9/3/1975	13	1.40	1.40
87	CUYAMACA	32°59'	-116°35'	4640	9/4/1975	14	1.00	1.10
88	HURKEY CREEK PARK	33°41'	-116°41'	4390	9/7/1975	13	1.10	1.40
89	HENSHAW DAM	33°14'	-116°46'	2700	7/25/1976	16	1.10	1.70
90	ETNA	41°28'	-122°54'	2950	6/7/1977	16	1.40	1.80
91	MILL CREEK INTAKE	34°05'	-116°56'	4945	8/22/1977	15	1.30	1.30
92	SANTA MARGARITA BOOSTE.	35°22'	-120°38'	1100	9/4/1977	24	1.30	1.30
93	MILL CREEK INTAKE	34°05'	-116°56'	4945	8/6/1979	12	1.20	1.60
94	BLYTHE 7 W	33°37'	-114°43'	390	8/11/1979	18	1.34	1.74
95	HAYFIELD PUMPING PLANT	33°42'	-115°38'	1370	8/12/1979	4	1.30	2.10
96	REDDING 5 SSE	40°30'	-122°22'	425	8/28/1979	19	1.40	1.80
97	DEL MONTE	36°36'	-121°52'	45	5/5/1980	13	1.30	2.20
98	BLYTHE 7 W	33°37'	-114°43'	390	8/14/1981	5	1.11	1.71
99	CUYAMACA	32°59'	-116°35'	4640	8/14/1981	13	1.00	1.00
100	CUYAMACA	32°59'	-116°35'	4640	9/7/1981	15	2.30	3.00
101	NORTH BLOOMFIELD	39°22'	-120°54'	3280	6/19/1982	16	1.10	1.60
102	HURKEY CREEK PARK	33°41'	-116°41'	4390	7/25/1982	14	1.20	1.50
103	RUNNING SPRINGS 1 E	34°12'	-117°05'	5970	7/26/1982	9	1.30	1.90
104	SAN JACINTO RS	33°47'	-116°58'	1560	8/25/1982	18	1.20	1.30
105	OAK GROVE RS	33°23'	-116°48'	2750	8/7/1983	15	1.40	1.40
106	FLORENCE LAKE	37°16'	-118°58'	7325	8/8/1983	15	1.80	2.60
107	HENSHAW DAM	33°14'	-116°46'	2700	8/9/1983	14	1.00	1.10
108	SEPULVEDA DAM	34°10'	-118°28'	670	8/16/1983	17	1.20	1.49
109	LYTLE CRK FTHILL BLVD.	34°06'	-117°20'	1160	8/17/1983	15	2.65	5.79
110	BEAUMONT	33°56'	-116°58'	2613	7/13/1984	15	1.20	1.50
111	ELSINORE	33°40'	-117°20'	1285	7/15/1984	18	1.10	1.20
112	HUNTINGTON LAKE	37°14'	-119°13'	7020	7/17/1984	18	1.30	1.40
113	BIG PINES PARK FC	34°23'	-117°41'	6845	7/18/1984	14	1.40	1.50
114	BLYTHE 7 W	33°37'	-114°43'	390	7/21/1984	16	1.06	1.08
115	MORENA DAM	32°41'	-116°31'	3075	7/27/1984	16	1.50	1.60
116	OZENA GUARD STN.	34°41'	-119°21'	3590	7/31/1984	16	1.20	1.40
117	HOLLISTER 9 ENE	36°55'	-121°14'	2600	8/8/1984	14	1.20	1.20

Table A3.1. *Extreme local storms in California.*

#	Location	Latitude (degrees)	Longitude (degrees)	Elevation (feet)	Date	Hour of maximum rainfall	Max 1-hour rainfall (inches)	Max 6-hour rainfall (inches)
118	HAYFIELD PUMPING PLANT	33°42'	-115°38'	1370	8/19/1984	16	1.10	1.70
119	BATTLE CREEK ADR	40°24'	-122°08'	420	5/28/1985	21	1.10	2.50
120	HAYFIELD PUMPING PLANT	33°42'	-115°38'	1370	7/19/1985	17	1.00	1.40
121	PORTOLA	39°48'	-120°28'	4850	7/25/1985	16	1.10	1.41
122	COFFEE CREEK RS	41°05'	-122°42'	2500	7/30/1985	17	1.40	1.80
123	SHASTA DAM	40°43'	-122°25'	1075	5/20/1986	18	1.50	2.70
124	NEEDLES	34°50'	-114°36'	480	8/11/1986	20	1.10	1.90
125	CALAVERAS BIG TREES	38°17'	-120°19'	4695	9/1/1986	7	1.30	1.50
126	DOWNIEVILLE	39°34'	-120°50'	2915	7/26/1988	16	1.40	1.70
127	COVELO EEL RIVER RS	39°50'	-123°05'	1514	8/14/1988	17	1.00	1.60
128	OAK GROVE RS	33°23'	-116°48'	2750	8/23/1988	13	1.30	1.60
129	MILFORD LAUFMAN RS	40°08'	-120°21'	4860	6/7/1989	16	1.40	1.40
130	HAYFIELD PUMPING PLANT	33°42'	-115°38'	1370	7/10/1989	15	1.20	1.30
131	HURKEY CREEK PARK	33°41'	-116°41'	4390	8/24/1988	2	1.70	1.80
132	BOWMAN DAM	39°27'	-120°39'	5385	7/14/1990	15	1.00	1.20
133	SUSANVILLE 1 WNW	40°26'	-120°40'	4555	7/18/1990	18	1.40	2.00
134	OAK GROVE RS	33°23'	-116°48'	2750	4/9/1990	13	1.20	1.40
135	BIEBER	41°10'	-121°08'	4125	7/18/1991	20	1.40	1.40
136	EL CENTRO 2 SSW	32°46'	-115°34'	-30	7/31/1991	15	1.10	1.10
137	IDYLLWILD FIRE DEPT.	33°45'	-116°43'	5380	7/31/1991	7	1.30	1.80

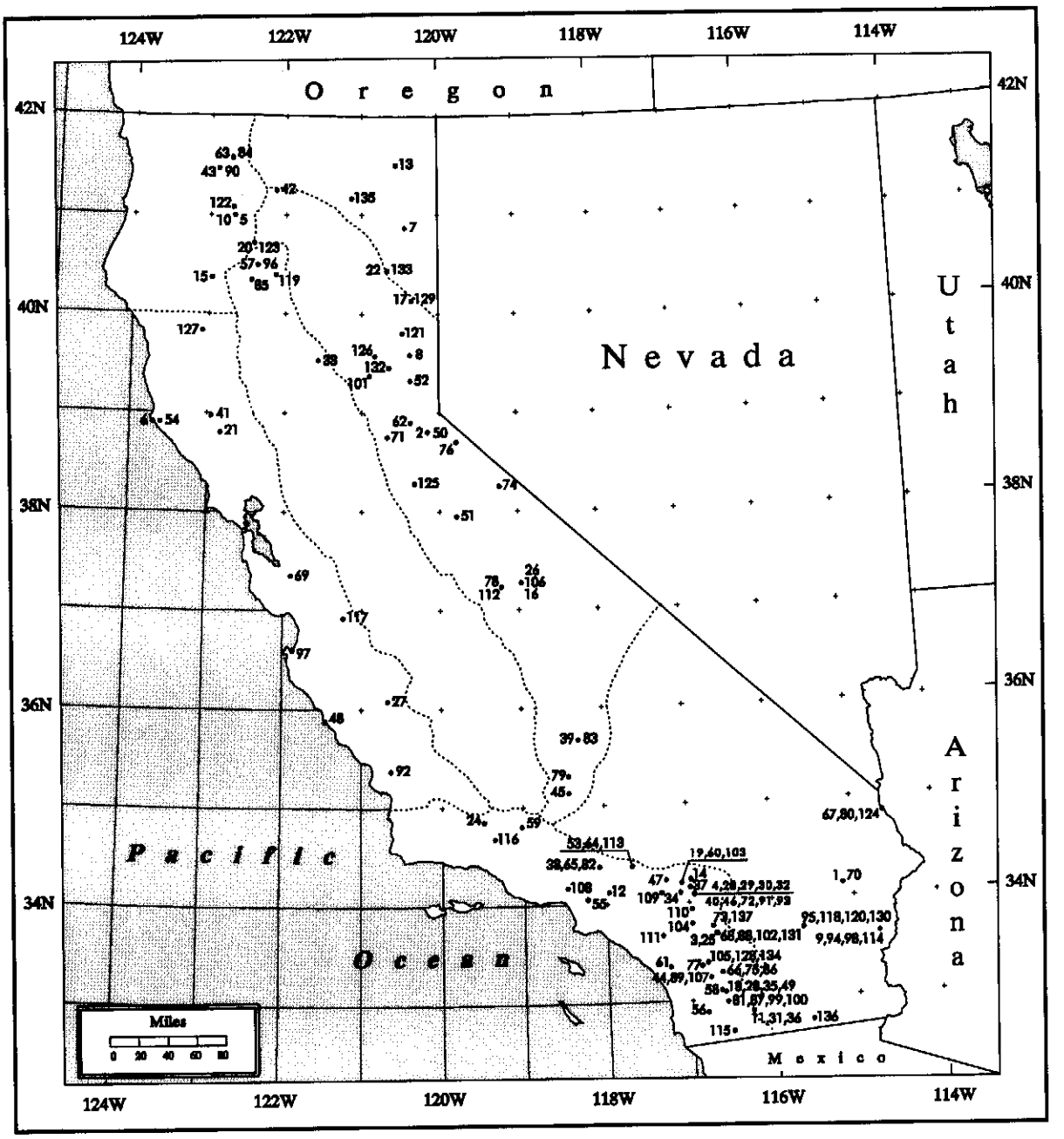

Figure A3.1. *Locations of the 137 local storms from in Table A3.1. The dotted lines indicate the regions specified for depth-area-duration, Chapter 3, Figure 3.3.*

APPENDIX 4

Snowmelt Parameters

In HMR 36 (1961) a snowmelt procedure was provided. Information was included for determination of temperatures, dewpoints, precipitation, and winds during and prior to a PMP storm. The development of new snowmelt parameters was beyond the scope of this report. However, during peer review, inclusion of snowmelt parameter procedures was mentioned by most reviewers as highly desirable. This Appendix is in response to those requests.

The core of the Appendix is a worksheet consisting of five sections (A-E). It is essentially the same worksheet that appeared in HMR 36. An example for the Auburn drainage above Folsom Dam is provided for mid-November. The figures referenced in Chapter X of HMR 36 dealing with variation of precipitable water, temperature/elevation relations, temperature prior to a PMP storm, and winds have not been changed except for new figure numbers. The seasonal variation of maximum moisture table (Table 4-1 in HMR 36) was replaced by Table A4.1. The revision of this table was based on new dewpoint data. The durational variation of maximum moisture, Table A4.2, is unchanged. The seasonal variation of maximum moisture, Table A4.1, is a function of the regional DAD boundaries for Chapter 3, Figure 3.3.

An important part of this methodology is the wind speed expected at the surface of a snow pack; these winds and reduction factors are needed in Steps D.1 and D.2 of the worksheet. The recommended factors for basins not sheltered from the winds by topographic features in advance of a PMP storm are a function of regions.

The factors for the regions are:

Region	Factor
1, 3, 6	.80
2, 5	.75

In cases where basins are sheltered from the winds the reduction factors should reduce the surface winds speeds even more. The amount of the reduction should be decided by the user.

We have assumed that snowmelt is not an important factor for basins in regions 4 and 7. If snowmelt parameters are needed for basins in these regions, use the factor in the above list from the region closest to the basin of concern.

Data values from Figures A4.1 to A4.7 may vary, and there will be some difference from user to user. Figure A4.8 gives the dewpoint temperatures for February over California.

Table A4.1. *Monthly variation of maximum moisture (percent/100 of February maximum). See Chapter 3, Figure 3.11 for region boundaries.*

	Month						
Region	October	November	December	January	February	March	April
3, 4, 6	1.22	1.13	1.08	1.03	1.00	1.03	1.06
7	1.35	1.11	1.03	0.97	1.00	1.03	1.06
1, 2	1.29	1.14	1.12	1.05	1.00	1.00	1.08
5	1.29	1.17	1.11	1.03	1.00	1.03	1.09

Table A4.2. *Durational variation of maximum moisture (percent of 12-hour precipitable water).*

Duration (Hour)	6	12	18	24	30	36	42	48	54	60	66	72
Percent	104	100	97	95	93	91	89	88	86	85	84	83