ENERCON	CALCULATION COVER SHEET	CALC. NO. TXUT-001-FSAR 2.4.2-CALC-019
		REV. 0
		PAGE NO. 1 of 23
Title:	MITS004 - Determination of the Local Intense Precipitation at the Comanche Peak Nuclear Power Plant Units 3 and 4. (HMR 51 & HMR 52)	Client: Luminant
		Project: MITS004 – Comanche Peak COLA

Item	Cover Sheet Items	Yes	No
1	Does this calculation contain any open assumptions that require confirmation? (If YES, identify the assumptions)_____		X
2	Does this calculation serve as an "Alternate Calculation"? (If YES, identify the design verified calculation.) **Design Verified Calculation No.**_____		X
3	Does this calculation supersede an existing calculation? (If YES, identify the superseded calculation.) **Superseded Calculation No.**_____		X

Scope of Revision: N/A

Revision Impact on Results: N/A

Study Calculation	☐	Final Calculation	☒
Safety-Related	☒	Non-safety-Related	☐

(Print Name and Sign)

Originator: Suraj Balan	Date: 6/27/08
Design Verifier: Randall Kolar Kendra Dresback	Date: 6/27/08
Approver: Mike Laggart	Date: 7/2/08

CALCULATION REVISION STATUS

REVISION	DATE	DESCRIPTION
0	June 27, 2008	Original Calculation

PAGE REVISION STATUS

PAGE NO.	REVISION	PAGE NO.	REVISION
All	0		

APPENDIX REVISION STATUS

APPENDIX NO.	PAGE NO.	REVISION NO.	APPENDIX NO.	PAGE NO.	REVISION NO.
N/A					

ENERCON	CALCULATION DESIGN VERIFICATION PLAN AND SUMMARY SHEET	CALC. NO. TXUT-001-FSAR 2.4.2-CALC-019 REV. 0 PAGE NO. 3 of 23

Calculation Design Verification Plan:

Apply CSP Number 3.01 Revision 5 Section 4.5.a. Design Review Method and to include at a minimum:

1. Determine if HMR 51 and 52 is appropriate and applicable in determining the site local intense Probable Maximum Precipitation (PMP).
2. Review HMR 51 and 52 procedures and independently verify that the PMP summary table is accurate (i.e. PMP values for duration of 5, 15, 30 minutes and 1, 6, 12, 24, 48, and 72 hours).
3. Evaluate interpolation of intermediate values.

(Print Name and Sign for Approval – mark "N/A" if not required)

Approver: Mike Laggart Michael Laggart	Date: 7/2/08

Calculation Design Verification Summary:

We have reviewed the local intense PMP calculation for the site and have come to the following conclusions:

1. The cited HMR 51 and 52 reports provide appropriate guidelines for this set of calculations;

2. The calculation procedure correctly follows the cited reports;

3. The Originator has followed the recommendations given during the review process;

4. The calculations were independently verified and all errors have been corrected in the final version of the calculation sheets.

Based on the above summary, the calculation is determined to be acceptable.

(Print Name and Sign)

Design Verifier: Randall Kola Randall Kola Kendra Dresback Kendra Dresback	Date: 6/27/08
Others:	Date:

ENERCON	CALCULATION DESIGN VERIFICATION CHECKLIST	CALC. NO. TXUT-001-FSAR 2.4.2-CALC-019 REV. 0 PAGE NO. 4 of 23

Item	Cover Sheet Items	Yes	No	N/A
1	**Design Inputs** - Were the design inputs correctly selected, referenced (latest revision), consistent with the design basis and incorporated in the calculation?	X		
2	**Assumptions** – Were the assumptions reasonable and adequately described, justified and/or verified, and documented?	X		
3	**Quality Assurance** – Were the appropriate QA classification and requirements assigned to the calculation?	X		
4	**Codes, Standard and Regulatory Requirements** – Were the applicable codes, standards and regulatory requirements, including issue and addenda, properly identified and their requirements satisfied?	X		
5	**Construction and Operating Experience** – Have applicable construction and operating experience been considered?			X
6	**Interfaces** – Have the design interface requirements been satisfied, including interactions with other calculations?	X		
7	**Methods** – Was the calculation methodology appropriate and properly applied to satisfy the calculation objective?	X		
8	**Design Outputs** – Was the conclusion of the calculation clearly stated, did it correspond directly with the objectives and are the results reasonable compared to the inputs?	X		
9	**Radiation Exposure** – Has the calculation properly considered radiation exposure to the public and plant personnel?			X
10	**Acceptance Criteria** – Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?	X		
11	**Computer Software** – Is a computer program or software used, and if so, are the requirements of CSP 3.02 met?	X		

COMMENTS:

(Print Name and Sign)

Design Verifier: Randall Kolar Randall Kolar **Kendra Dresback** Kendra Dresback	**Date:** 6/27/08
Others:	**Date:**

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1.0 Purpose And Scope

Determine the Probable Maximum Precipitation (PMP) for the local intense precipitation at the CPNPP units 3 and 4 using the current applicable guidance contained in HMR 51 and HMR 52.

2.0 Summary Of Results And Conclusions

A summary of PMP estimates is provided below.

Table 2-1, Local Intense PMP Estimates

	Duration								
	1-mi^2 point rainfall				10-mi^2				
	5-min	15-min	30-min	1-hr	6-hr	12-hr	24-hr	48-hr	72-hr
PMP (in)	6.2	9.7	14.2	19	29.5	36	41	45.6	48

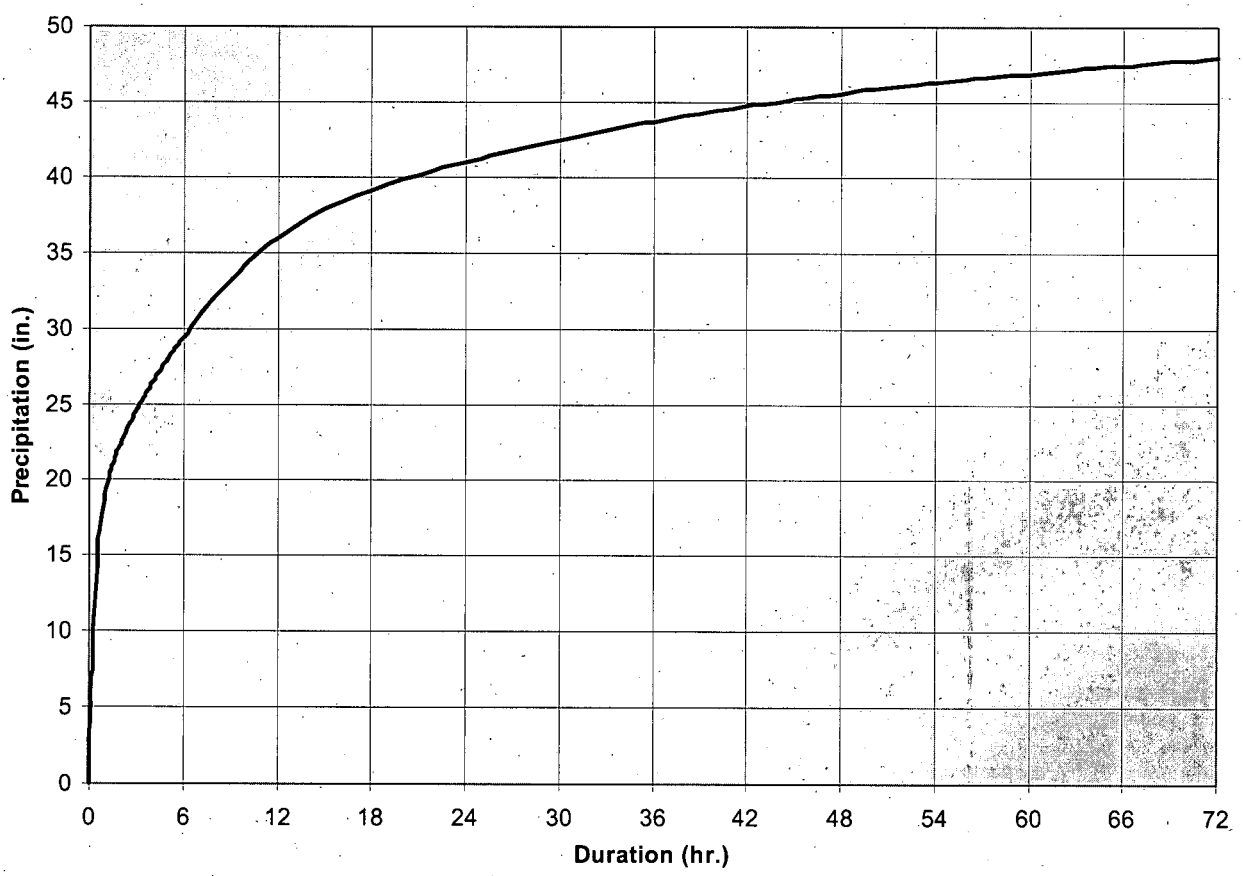

Figure 2-1, PMP Curve

Intermediate values are presented in Section 7.0 Calculations Tables 7-4 and 7-5.

3.0 References

1. Autodesk, AutoCAD LDD software 2006
2. National Oceanic and Atmospheric Administration, National Weather Service, Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, June 1978.
3. National Oceanic and Atmospheric Administration, National Weather Service, Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates – United States East of the 105th Meridian, August 1982.
4. U.S. Geological Survey, USGS Hill City, TX Quadrangle, Website, http://www.topozone.com, accessed December 27, 2007.
5. U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants", NUREG-0800, May 2007.
6. U.S. Nuclear Regulatory Commission, "Combined License Applications for Nuclear Power Plants", Regulatory Guide 1.206, June 2007.
7. American Nuclear Society, "American National Standard for Determining Design Basis Flooding at Power Reactor Sites", ANSI/ANS-2.8-1992, July 28, 1992.
8. U.S. Nuclear Regulatory Commission, "Flood Protection for Nuclear Power Plants", Regulatory Guide 1.102, September 1976.
9. U.S. Nuclear Regulatory Commission, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants", Regulatory Guide 1.70, November 1978.
10. U.S. Nuclear Regulatory Commission, "Design Basis Floods for Nuclear Power Plants", Regulatory Guide 1.59, August 1977.
11. U.S. Nuclear Regulatory Commission, "Early Site Permits; Standard design Certifications; and Combined Licenses for Nuclear Power Plants", 10 CFR Part 52, August 2007.
12. U.S. Nuclear Regulatory Commission, "Industry Guidelines for Combined License Applicants under 10 CFR Part 52", NEI 04-05, October 2005.

4.0 Assumptions

None

5.0 Design Inputs

CPNPP Units 3 and 4 locations from USGS Hill City, TX Quadrangle NAD83 (Reference 4) as accessed from www.topozone.com:

32° 18' 08.9" N
97° 47' 30.1" W

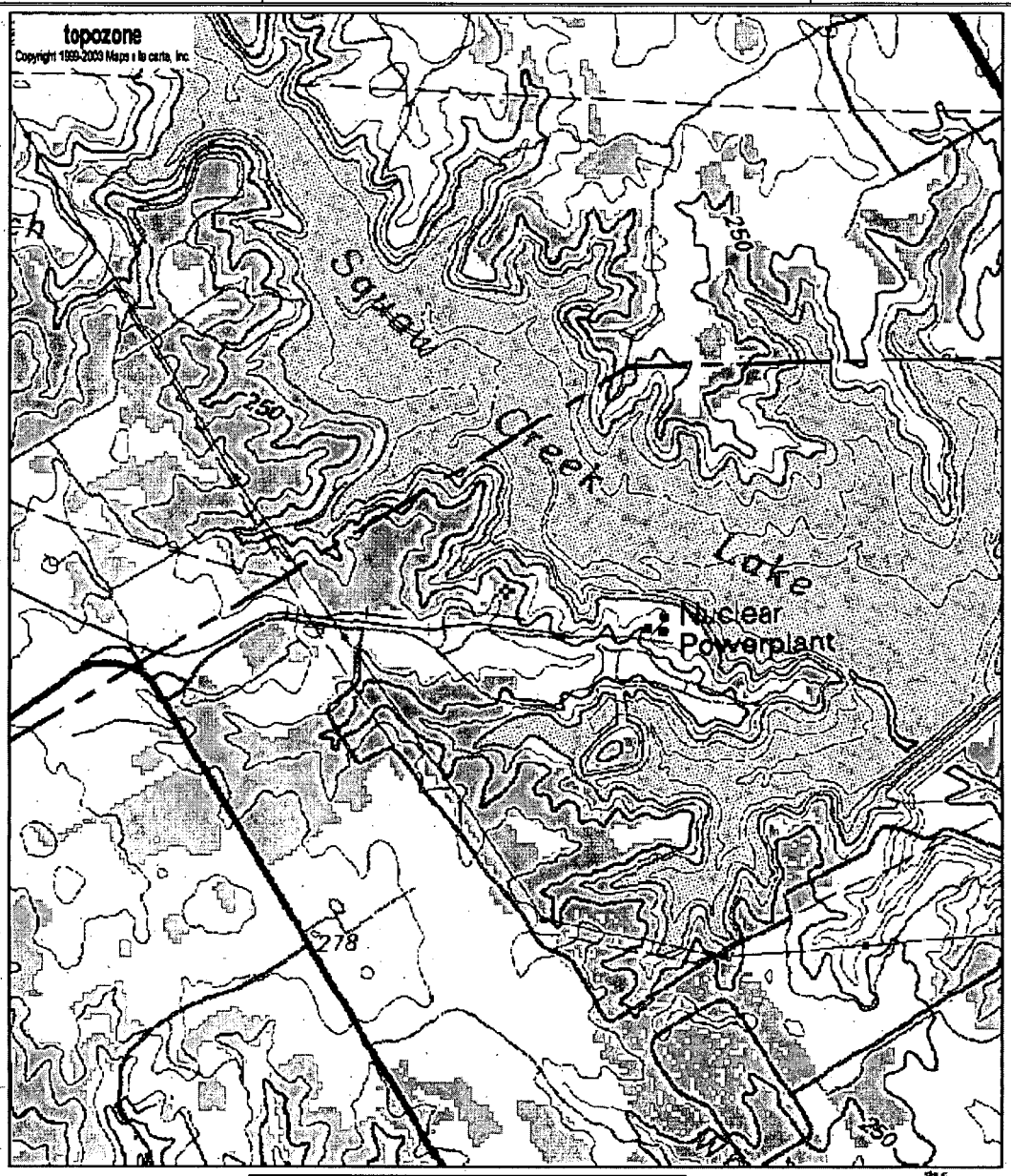

Figure 5-1, CPNPP Units 3 and 4 Site Location

6.0 Methodology

Reference to and compliance with the following listed design guides are considered in evaluating the Probable Maximum Precipitation for local intense precipitation. All other procedures, instructions and design guides listed in section 5.4 of PPD No. TXUT-001, Rev. 2 is not applicable specifically in evaluating the Probable Maximum Precipitation for local intense precipitation.

- American Nuclear Society, "Determining Design Basis Flooding at Power Reactor Sites," ANSI/ANS-2.8-1992, July 28, 1992.
- U.S. Nuclear Regulatory Commission, "Combined License Applications for Nuclear Power Plants (LWR Edition)," Regulatory Guide 1.206, June 2007.
- U.S. Nuclear Regulatory Commission, "Standard Review Plan," NUREG-0800, March 2007.
- U.S. Nuclear Regulatory Commission, "Design Basis Floods for Nuclear Power Plants, Appendix B, Alternative Methods of Estimating Probable Maximum Floods," Regulatory Guide 1.59, August 1977.
- U.S. Nuclear Regulatory Commission, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants", Regulatory Guide 1.70, November 1978.
- U.S. Nuclear Regulatory Commission, "Flood Protection for Nuclear Power Plants", Regulatory Guide 1.102, September 1976.
- U.S. Nuclear Regulatory Commission, "Early Site Permits; Standard design Certifications; and Combined Licenses for Nuclear Power Plants", 10 CFR Part 52, August 2007.
- NEI 04-01 - U.S. Nuclear Regulatory Commission, "Industry Guidelines for Combined License Applicants under 10 CFR Part 52.

PMP values for durations from 6-hours to 72-hours are determined using the procedures as described in HMR 51 (Reference 2) for areas of 10-mi^2. Point rainfall (1-mi^2) PMP values for duration's 1-hour and less are determined using the procedures as described in HMR 52 (Reference 3). Point PMP is used to evaluate the effects of local intense precipitation in the immediate vicinity of the site. The PMP for the Squaw Creek watershed and the Paluxy River are described in a separate calculation.

7.0 Calculations

HMR 51 provides generalized estimates of the all-season Probable Maximum Precipitation (PMP) for drainage areas from 10 to 20,000 square miles for durations of 6 to 72 hours. HMR 51 applies to areas in the United States east of the 105th Meridian. According to HMR 52 (Reference 3, pg. 20) the HMR 51, 10-mi^2 isohyet is considered the same as point rainfall. Therefore, point rainfall (1-mi^2) is used for the first hour, while 10-mi^2 is used for durations exceeding 1-hour. The areas at the site are less than 10-square-miles (mi^2). Therefore, the 10-mi^2 PMP estimates will be used for the site and vicinity.

PMP charts (Reference 2, Figures 18-22) are used to determine PMP estimates based on the location of the drainage basin. The site location was approximated as previously described.

Using the PMP charts and the site location as shown in Figures 7-5, 7-6, 7-7, 7-8 and 7-9, the all-season PMP estimates for the 10-mi^2 area and varying durations were determined as shown in Table 7-1.

Table 7-1. 10 sq. mi. All-Season PMP Estimates (inches)

	duration (hr) for 10 sq. mi				
	6	12	24	48	72
PMP (in)	29.5	36	41	45.6	48

Generally, for smaller areas, shorter durations are critical. HMR 52 contains guidance to determine PMP estimates for durations less than 6-hours. HMR 52 applies to areas in the United States east of the 105th Meridian.

PMP charts (Reference 3, Figures 24 and 29-35) are used to determine 1-hour duration PMP estimates based on the location and size of the drainage basin. The site location was approximated as described above. Using the PMP chart and the site location, the 1-hour, 1-mi^2 PMP estimate was determined to be 19 in as illustrated in Figure 7-1.

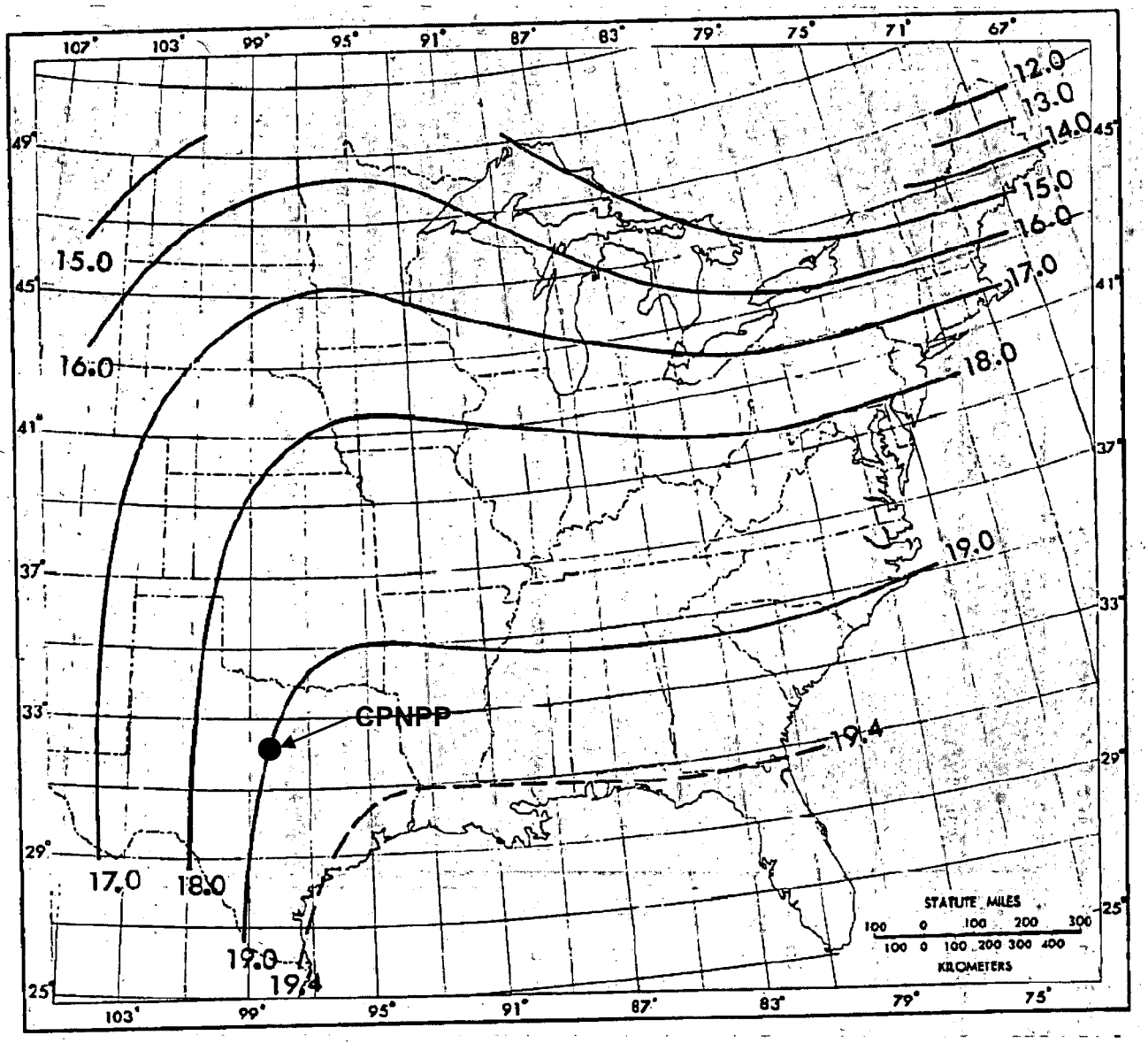

Figure 7-1, HMR 52 Figure 24 – 1-hour 1-mi^2 PMP

For areas less than 200 mi^2, ratios are used to determine the 5, 15, and 30-min duration PMP estimates. The ratios are found using PMP charts (Reference 3, Figures 36-38), included as Figures 7-2 through 7-4.

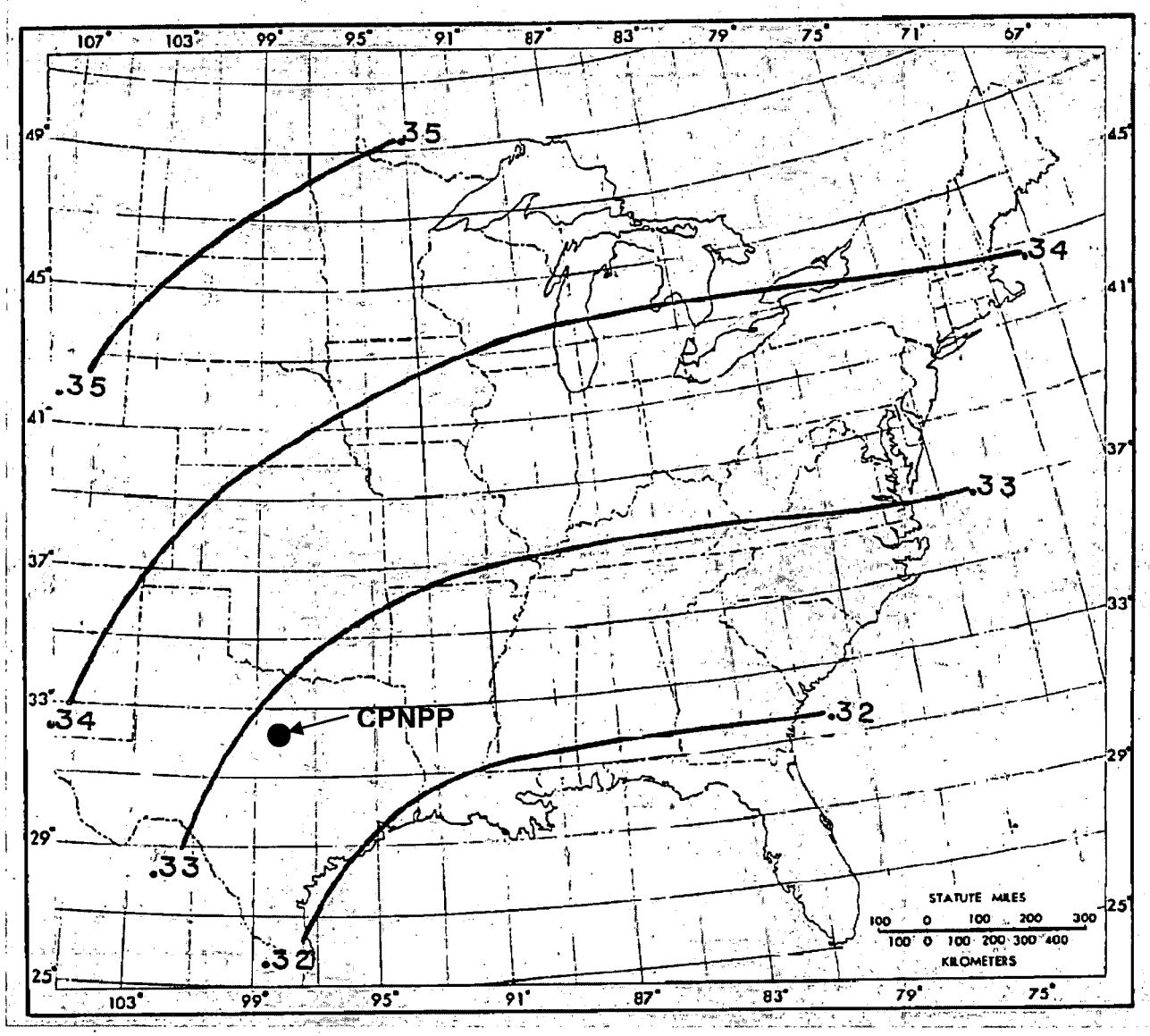

Figure 7-2, HMR 52 Figure 36 – Ratio of 5-min to 60-min PMP

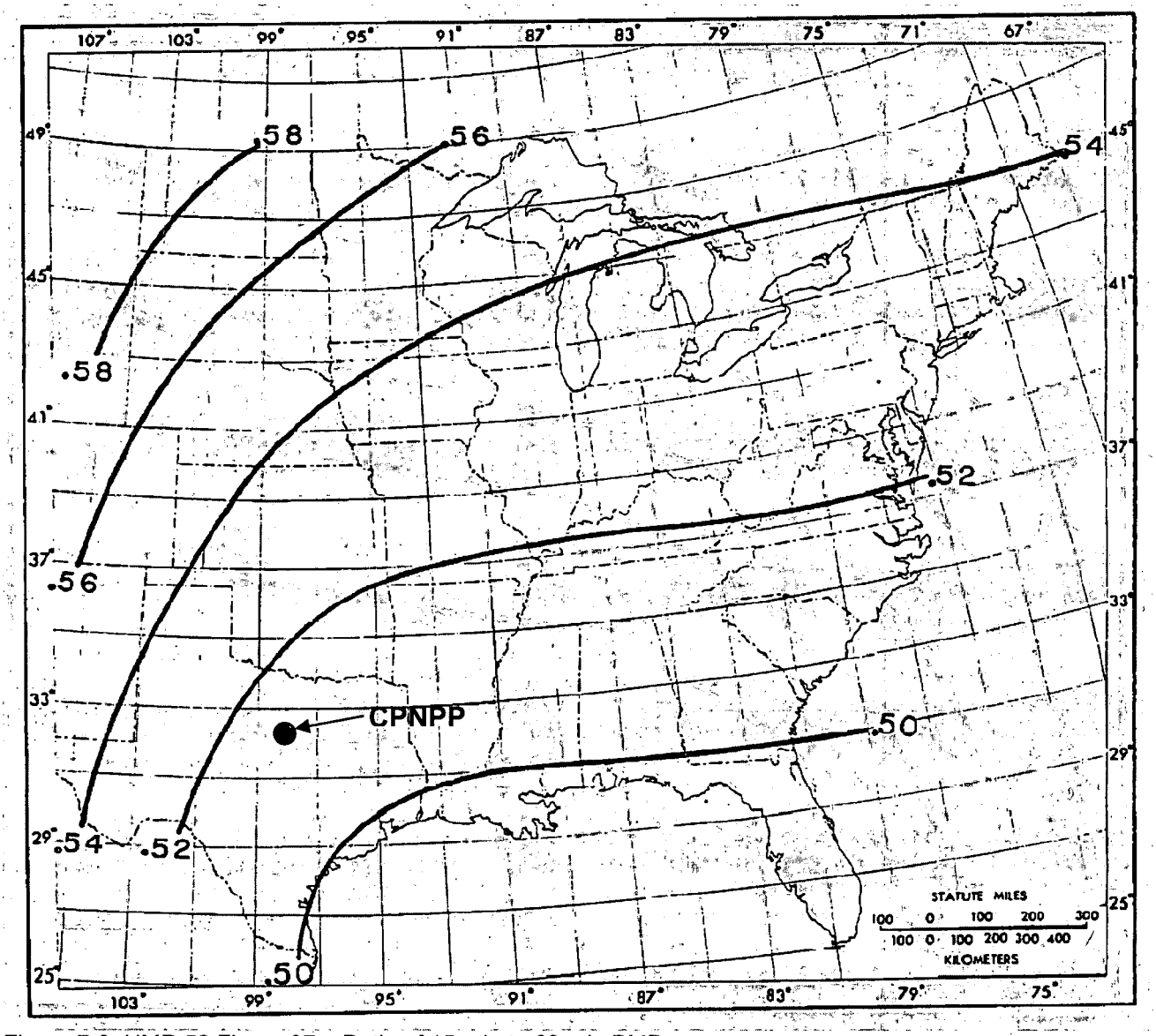

Figure 7-3, HMR 52 Figure 37 – Ratio of 15-min to 60-min PMP

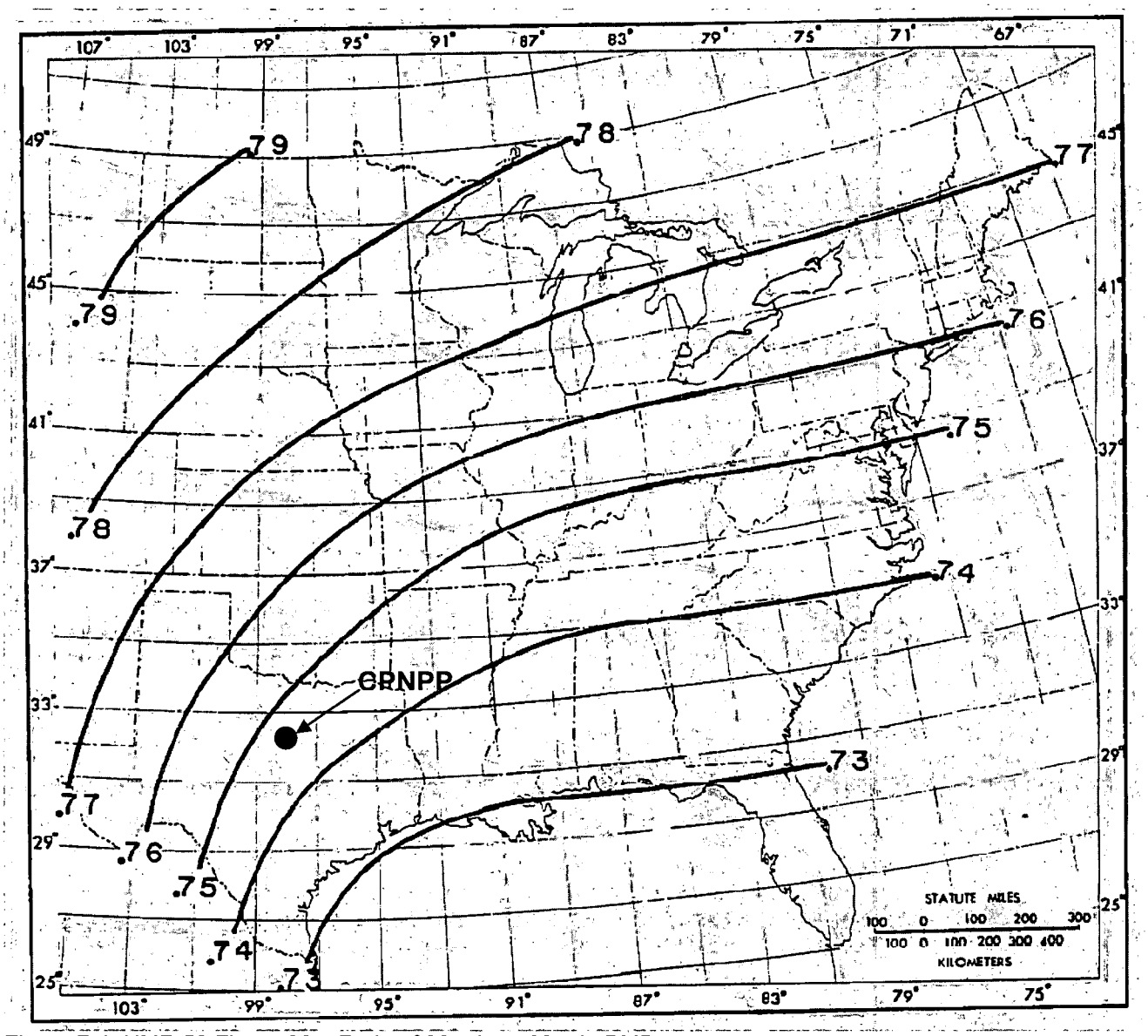

Figure 7-4, HMR 52 Figure 38 – Ratio of 30-min to 60-min PMP

Using the PMP charts and the site location, the ratios and PMP estimates for durations less than 1-hour were determined as shown in Table 7-2. The ratios are applied to the 1-hour, 1-mi^2 PMP estimate of 19 in.

Table 7-2, PMP ratios and estimates (inches) for durations less that 1-hour

	Duration		
	5-min	15-min	30-min
ratio to 1-hour PMP	0.328	0.512	0.746
PMP (in)	6.2	9.7	14.2

The complete local intense 72-hour storm is included in Table 7-3. According to HMR 52 (Reference 3, pg. 20) the HMR 51, 10-mi^2 isohyet is considered the same as point rainfall. Therefore, point rainfall (1-mi^2) is used for the first hour, while 10-mi^2 is used for durations exceeding 1-hour.

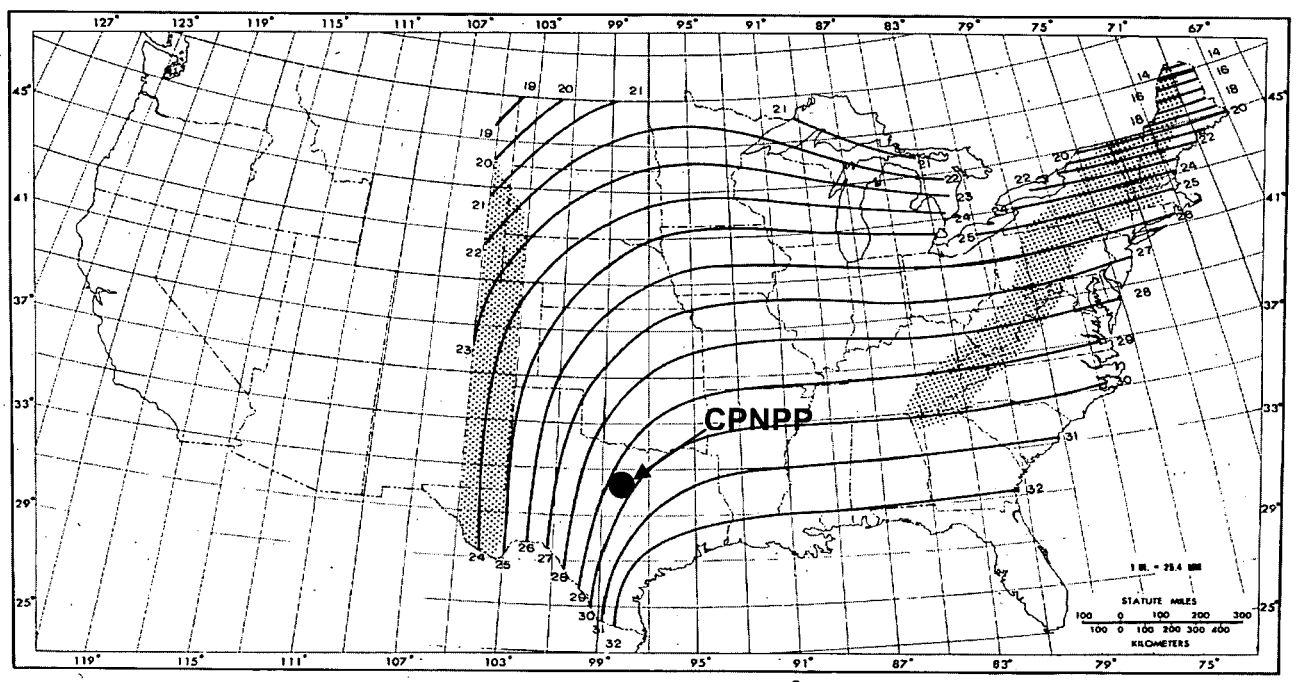

Figure 7-5, HMR 51 Figure 18 – All-season PMP (in.) for 6 hr 10 mi^2

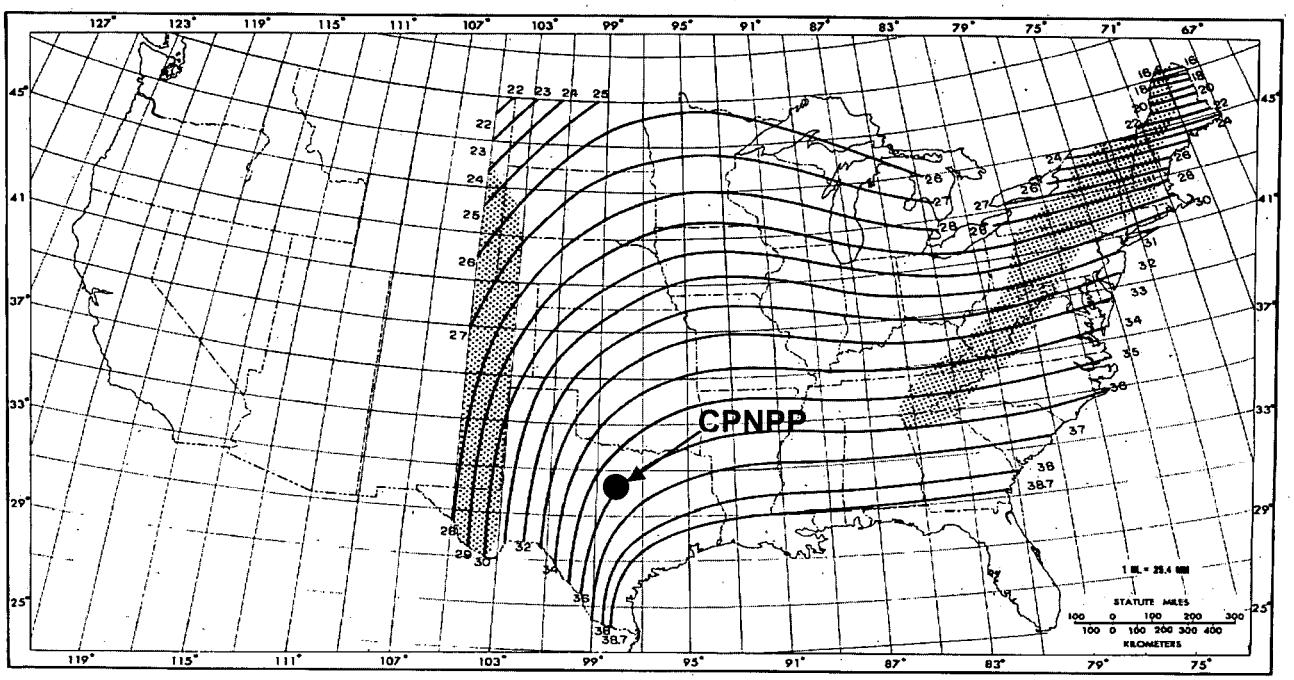

Figure 7-6, HMR 51 Figure 19 – All-season PMP (in.) for 12 hr 10 mi^2

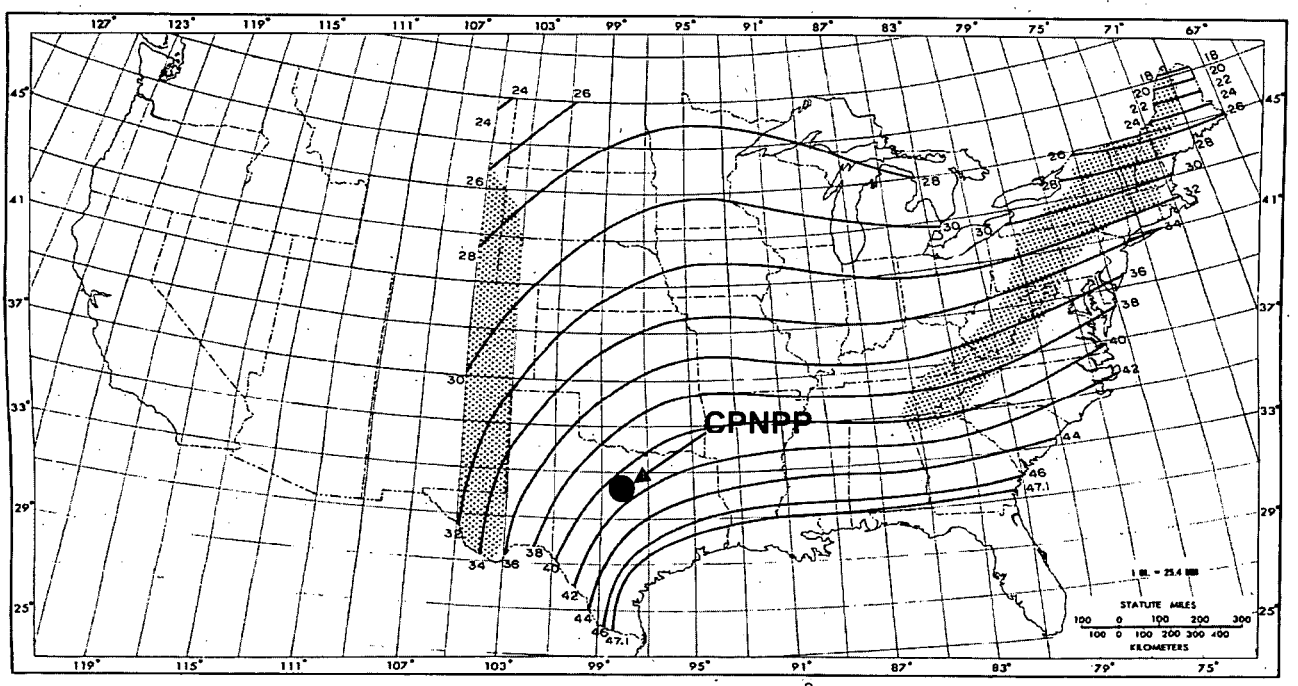

Figure 7-7, HMR 51 Figure 20 – All-season PMP (in.) for 24 hr 10 mi^2

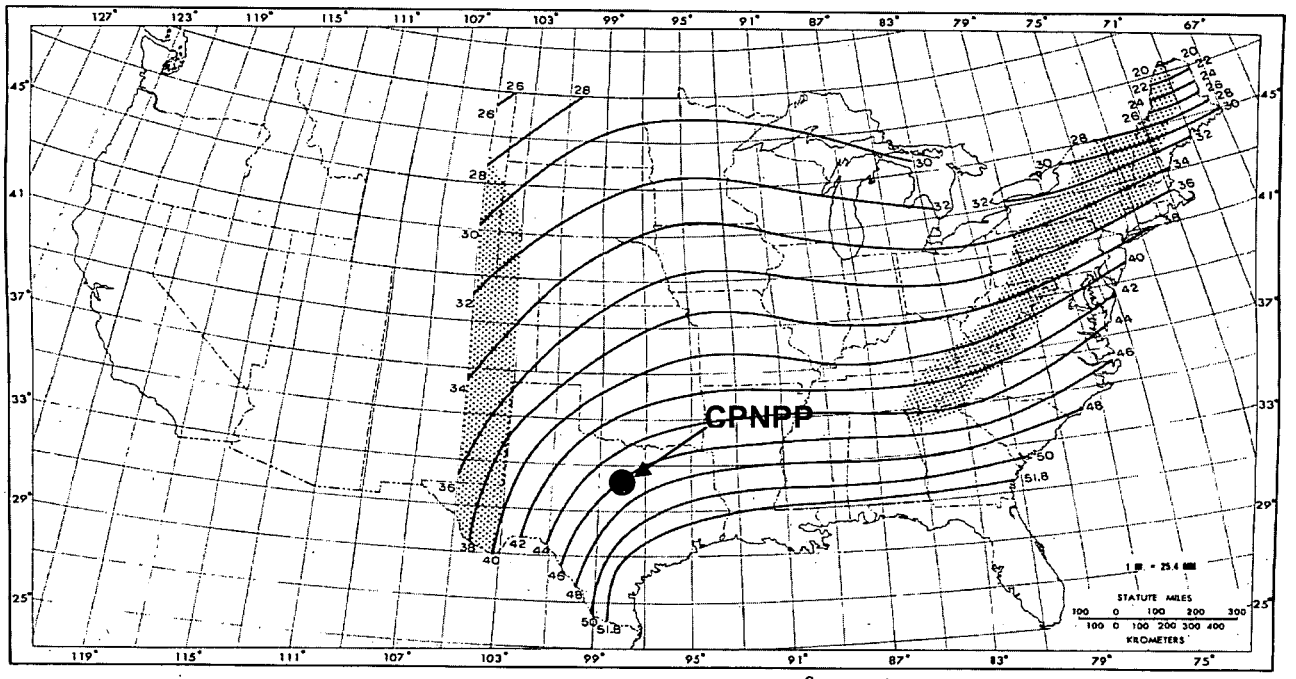

Figure 7-8. HMR 51 Figure 21 – All-season PMP (in.) for 48 hr 10 mi^2

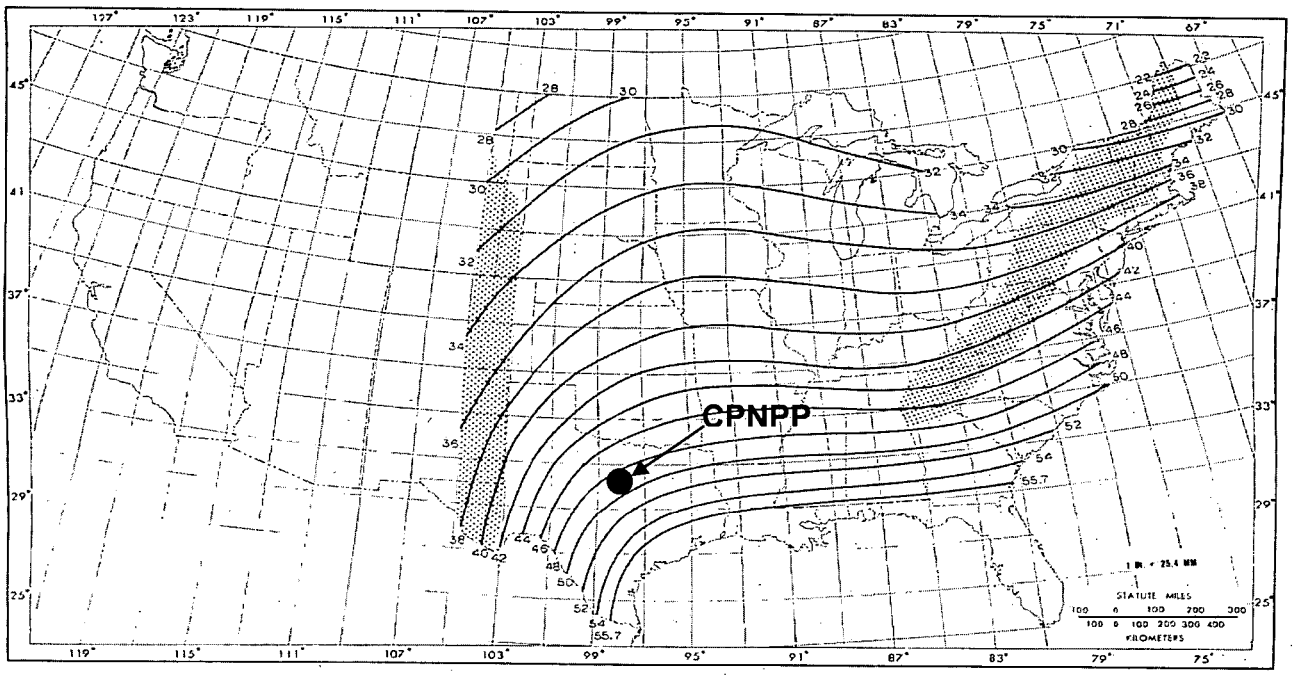

Figure 7-9. HMR 51 Figure 22 – All-season PMP (in.) for 72 hr 10 mi^2

Table 7-3, Local Intense PMP Estimates

	Duration								
	1-mi^2 point rainfall				10-mi^2				
	5-min	15-min	30-min	1-hr	6-hr	12-hr	24-hr	48-hr	72-hr
PMP (in)	6.2	9.7	14.2	19	29.5	36	41	45.6	48

The values from Table 7-3 were plotted in AutoCAD (Reference 1) and fitted with a smooth curve using the AutoCAD spline function. The end points at 0 and 72 hr. were used for the spline tangents. The PMP depth at each hour was then determined using standard AutoCAD line, polyline, and list functions. The hourly PMP depth duration values are provided in Table 7-4. The values were then graphed in Excel. The resulting smooth depth duration curve is shown in Figure 7-10. Higher precision was used for graphing purposes to ensure a smooth curve was generated.

Table 7-4, Hourly Rainfall Depths, 72-Hour

Hour	Cumulative PMP(in.)	Incremental PMP (in.)	Hour	Cumulative PMP(in.)	Incremental PMP (in.)
1	19.00	19.00	37	43.88	0.19
2	22.39	3.39	38	44.07	0.18
3	24.61	2.23	39	44.24	0.18
4	26.44	1.82	40	44.41	0.17
5	28.04	1.60	41	44.58	0.16
6	29.50	1.46	42	44.74	0.16
7	30.86	1.36	43	44.89	0.16
8	32.12	1.26	44	45.04	0.15
9	33.26	1.14	45	45.19	0.15
10	34.29	1.03	46	45.33	0.14
11	35.20	0.91	47	45.47	0.14
12	36.00	0.80	48	45.60	0.13
13	36.70	0.70	49	45.73	0.13
14	37.30	0.61	50	45.85	0.13
15	37.84	0.54	51	45.98	0.12
16	38.33	0.48	52	46.10	0.12
17	38.76	0.43	53	46.21	0.12
18	39.16	0.39	54	46.32	0.11
19	39.52	0.36	55	46.43	0.11
20	39.85	0.33	56	46.54	0.11
21	40.16	0.31	57	46.64	0.10
22	40.45	0.29	58	46.74	0.10
23	40.73	0.28	59	46.84	0.10
24	41.00	0.27	60	46.94	0.10
25	41.26	0.26	61	47.03	0.10
26	41.51	0.25	62	47.13	0.09
27	41.76	0.25	63	47.22	0.09
28	42.00	0.24	64	47.31	0.09
29	42.23	0.23	65	47.40	0.09
30	42.46	0.23	66	47.49	0.09
31	42.68	0.22	67	47.57	0.09
32	42.90	0.21	68	47.66	0.09
33	43.11	0.21	69	47.75	0.09
34	43.31	0.20	70	47.83	0.09
35	43.51	0.20	71	47.92	0.08
36	43.70	0.19	72	48.00	0.08

Local Intense Probable Maximum Precipitation Depth-Duration Curve

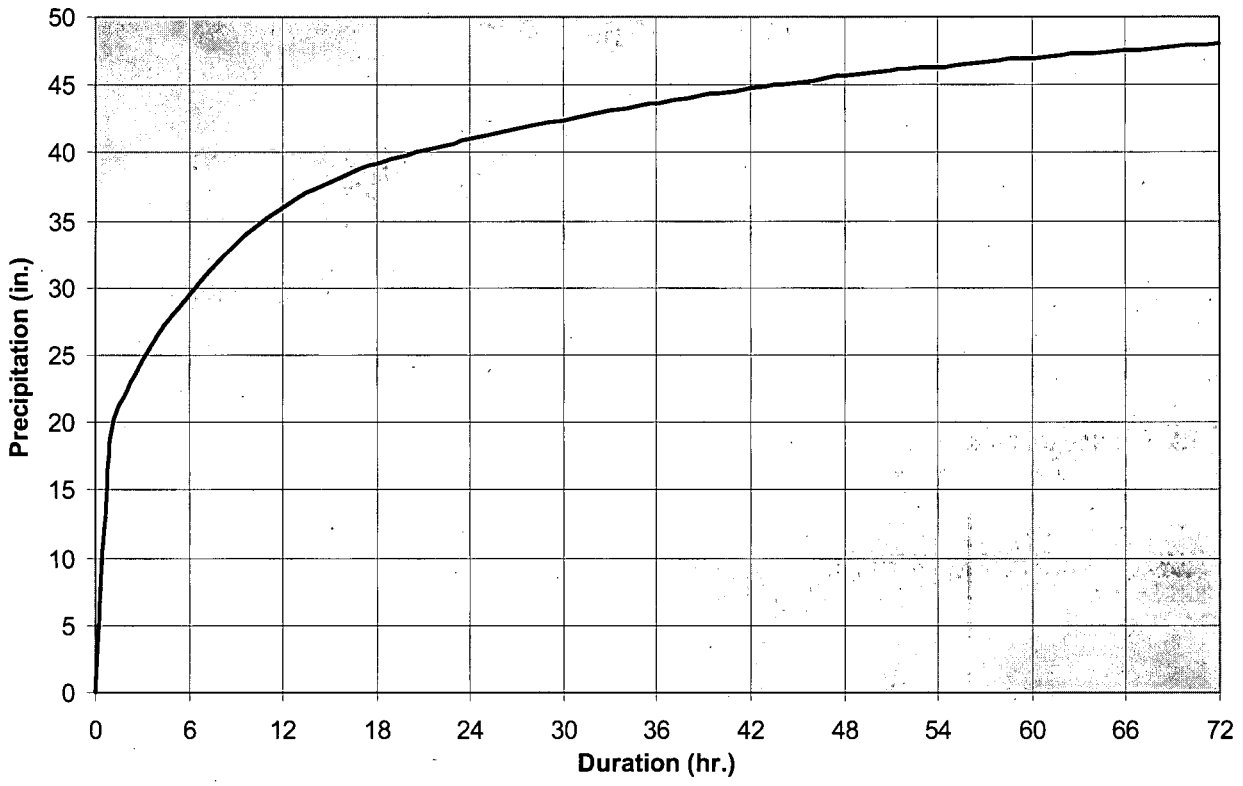

Figure 7-10, CPNPP 72-hour PMP Curve

Recognizing that peak flow for small basins is generally dependent on shorter durations, a similar procedure was used to determine intermediate depths using a 5 min. interval for the first 6 hr. of the curve. The 5 min. PMP depth duration values are provided in Table 7-5. The values were then graphed in Excel. The resulting smooth depth duration curve is shown in Figure 7-11. Higher precision was used for graphing purposes to ensure a smooth curve was generated.

Table 7-5, 5-Minute Rainfall Depths, 6-Hour

Minutes	Cumulative PMP(in.)	Incremental PMP (in.)	Minutes	Cumulative PMP(in.)	Incremental PMP (in.)
5	6.20	6.20	185	24.78	0.16
10	8.12	1.92	190	24.94	0.16
15	9.70	1.58	195	25.10	0.16
20	11.23	1.53	200	25.25	0.16
25	12.73	1.50	205	25.41	0.15
30	14.20	1.47	210	25.56	0.15
35	15.55	1.35	215	25.71	0.15
40	16.59	1.04	220	25.86	0.15
45	17.38	0.79	225	26.01	0.15
50	18.02	0.63	230	26.15	0.15
55	18.55	0.53	235	26.29	0.14
60	19.00	0.45	240	26.44	0.14
65	19.40	0.40	245	26.58	0.14
70	19.76	0.36	250	26.72	0.14
75	20.09	0.33	255	26.85	0.14
80	20.40	0.31	260	26.99	0.14
85	20.69	0.29	265	27.12	0.13
90	20.96	0.27	270	27.26	0.13
95	21.23	0.26	275	27.39	0.13
100	21.48	0.25	280	27.52	0.13
105	21.72	0.24	285	27.65	0.13
110	21.95	0.23	290	27.78	0.13
115	22.17	0.22	295	27.91	0.13
120	22.39	0.22	300	28.04	0.13
125	22.60	0.21	305	28.16	0.13
130	22.80	0.20	310	28.29	0.13
135	23.00	0.20	315	28.41	0.12
140	23.20	0.19	320	28.54	0.12
145	23.39	0.19	325	28.66	0.12
150	23.57	0.19	330	28.78	0.12
155	23.75	0.18	335	28.90	0.12
160	23.93	0.18	340	29.02	0.12
165	24.11	0.18	345	29.14	0.12
170	24.28	0.17	350	29.26	0.12
175	24.45	0.17	355	29.38	0.12
180	24.61	0.17	360	29.50	0.12

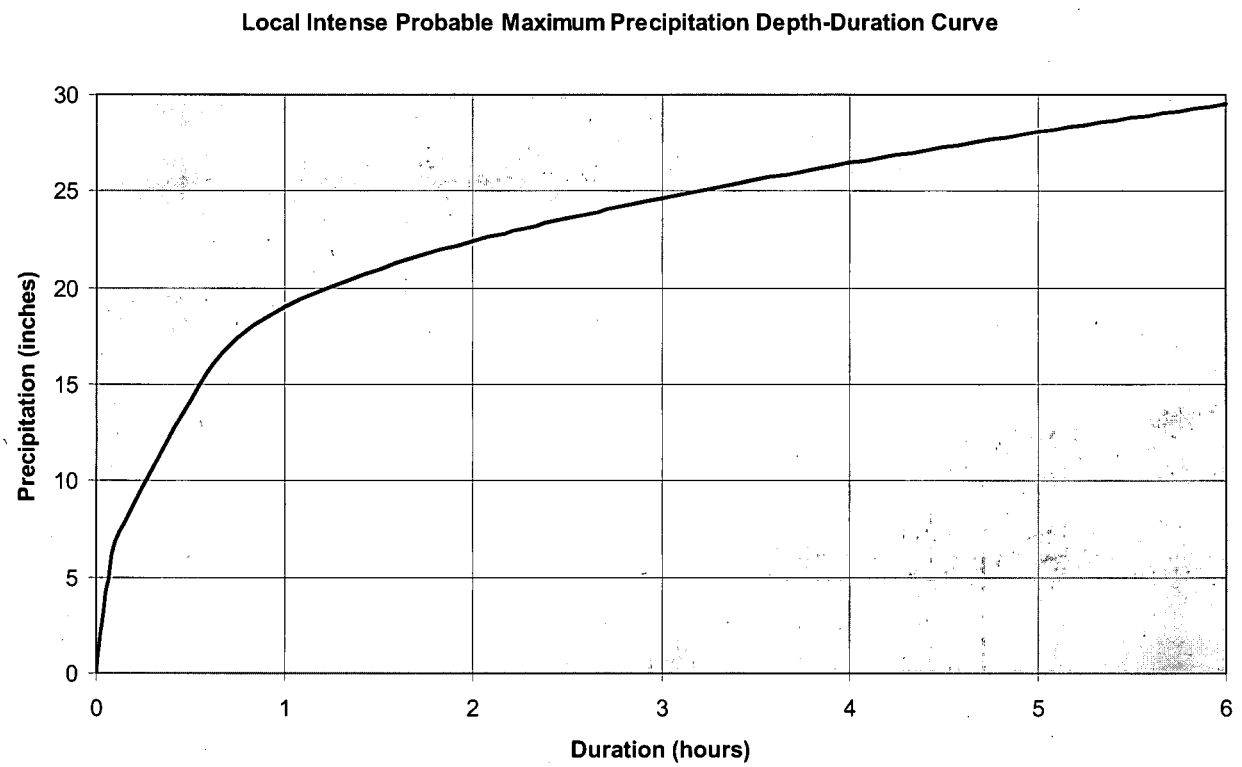

Figure 7-11, CPNPP 6-hour PMP Curve

The values from Tables 7-4 and 7-5 were also plotted in Excel to create a combined, smoother curve. The revised PMP curve is shown in Figure 7-12.

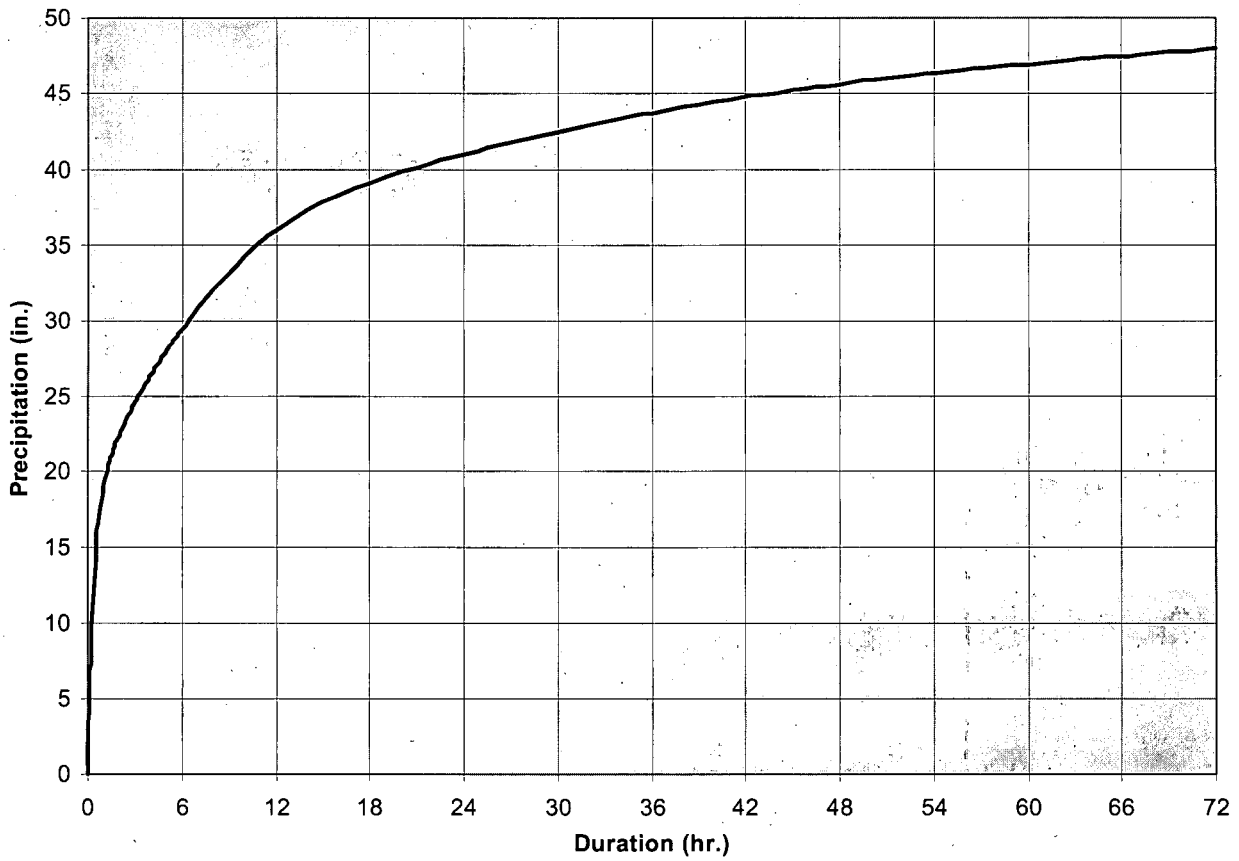

Figure 7-12. CPNPP Revised 72-hour PMP Curve

8.0 Appendices

N/A