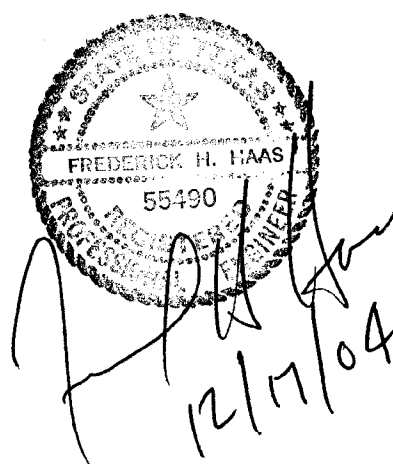




APPENDIX A

DRAINAGE CALCULATIONS



500 YEAR STORM CALCULATIONS

REF: DEPTH-DURATION FREQUENCY OF PRECIPITATION FOR TEXAS, W.H. ASQUITH,
WATER RESOURCES INVESTIGATIONS REPORT 98-4044, U.S. GEOLOGICAL
SURVEY, 1998 (98-4044)

GENERALIZED LOGISTIC DISTRIBUTION

$$X_d(F) = \xi + \alpha / \kappa \{1 - [(1 - F) / F]^{\kappa}\} \quad \text{EQ 10, 98-4044}$$

WHERE: $X_d(F)$ = PRECIPITATION DEPTH FOR A GIVEN
FREQUENCY

$\xi, \alpha, \text{ and } \kappa$ = LOCATION, SCALE AND SHAPE
PARAMETERS FOR THE GLO DIST.

F = ANNUAL NONEXCEEDANCE PROBABILITY

FOR 500 YEAR STORM

$\xi = 1.93$	FIGURE 18, 98-4044
$\alpha = 0.55$	FIGURE 32, 98-4044
$\kappa = -0.22$	FIGURE 46, 98-4044
$F = 0.998$	

$X_d(F) = 9.24$ INCHES

11/15/05

Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extend over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

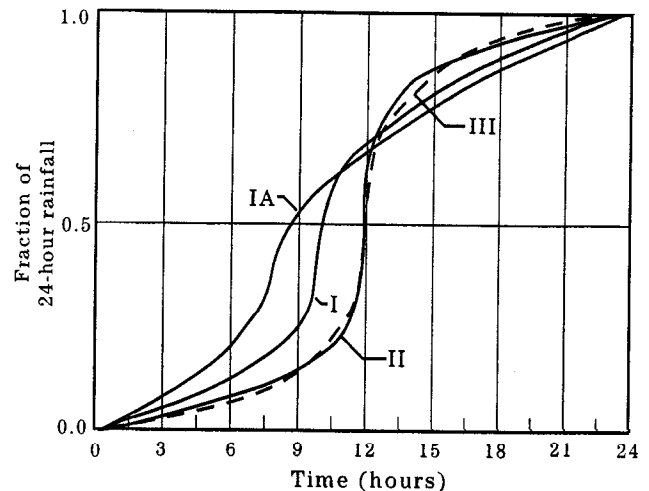
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c . For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c .

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

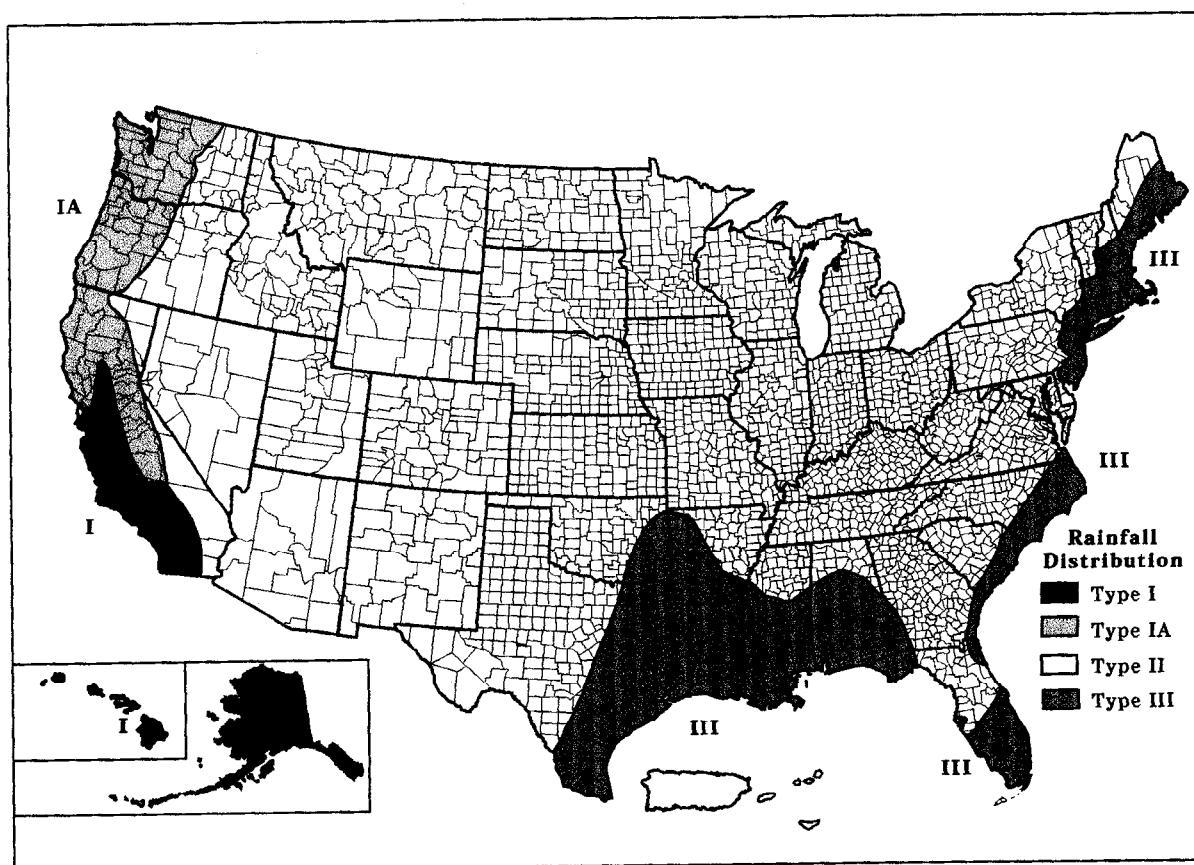
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol. III, Colorado; Vol. IV, New Mexico; Vol. V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of

Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 p.

Figure B-3 2-year, 24-hr rainfall

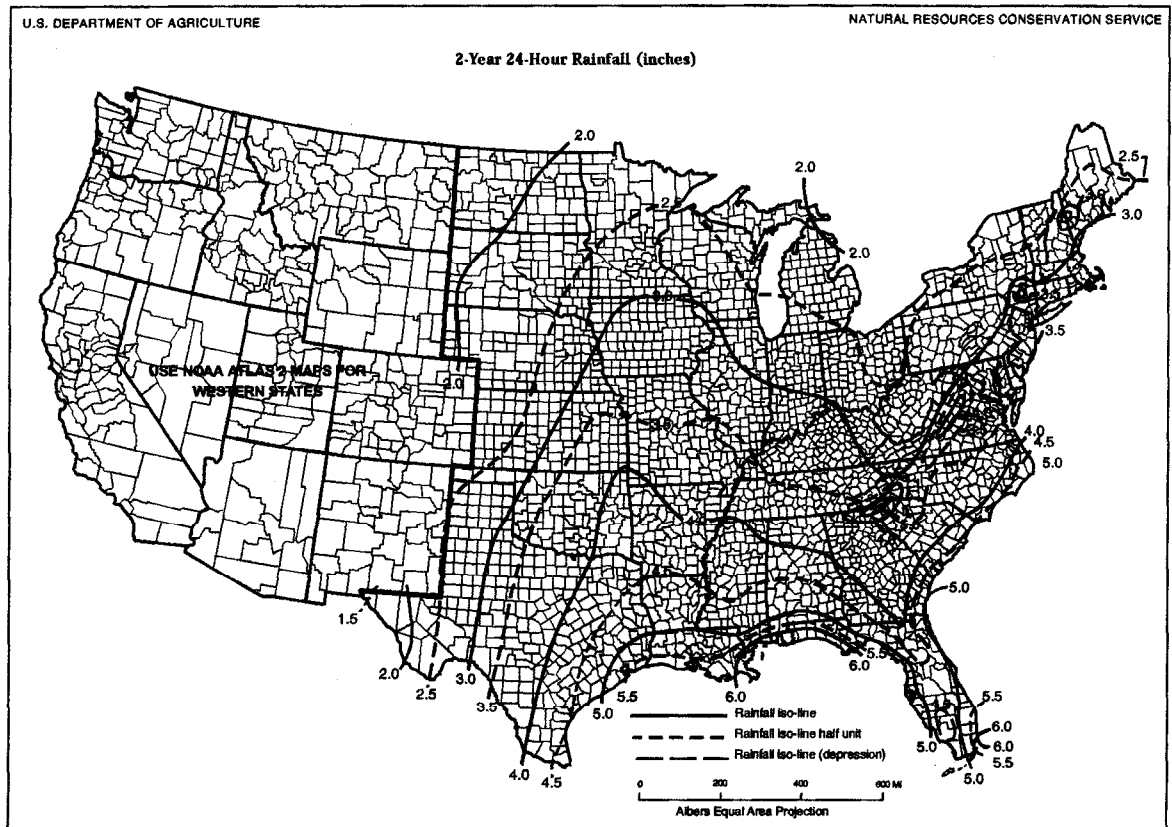


Figure B-4 5-year, 24-hour rainfall

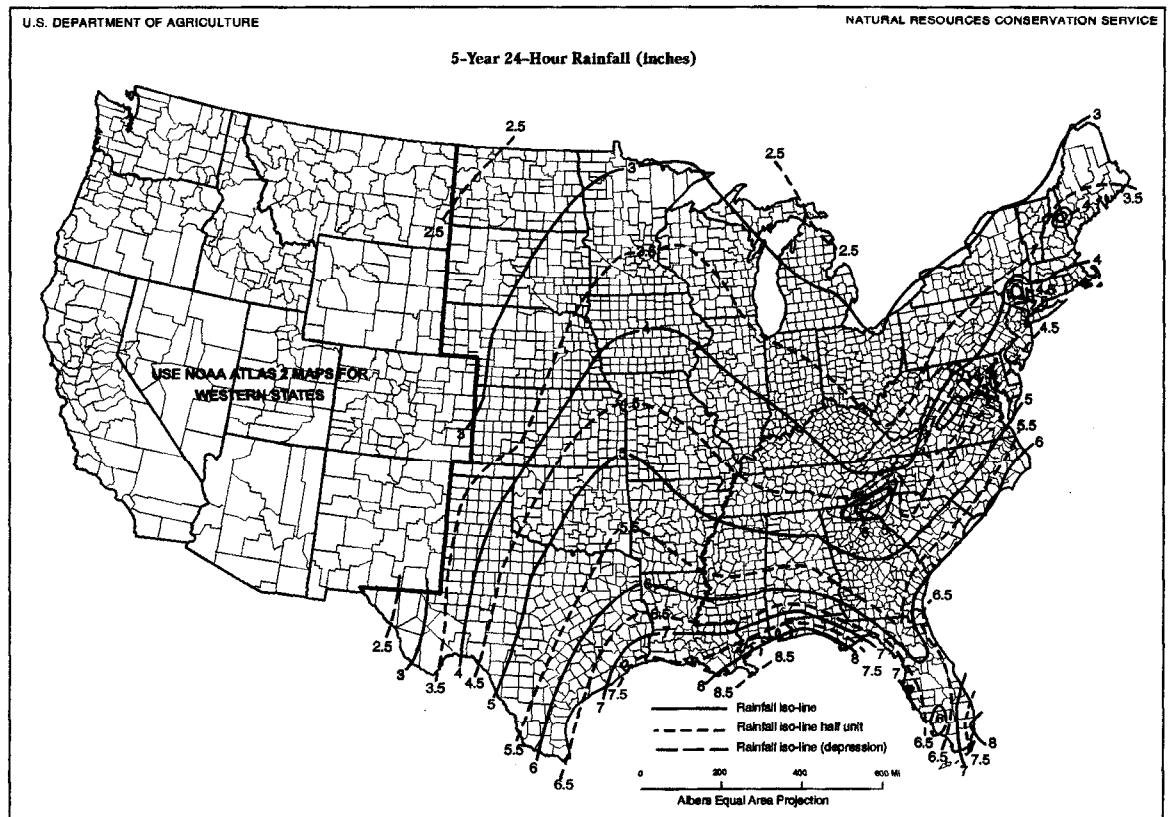


Figure B-5 10-year, 24-hour rainfall

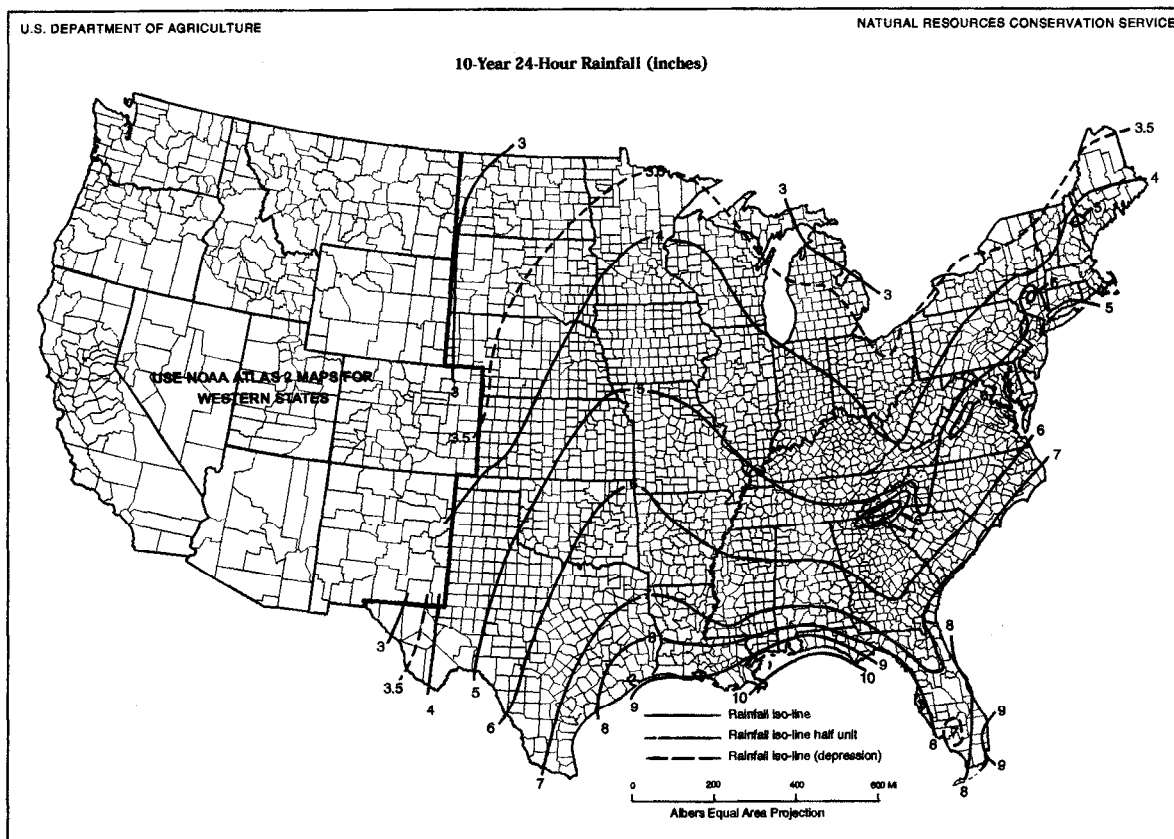


Figure B-6 25-year, 24-hour rainfall

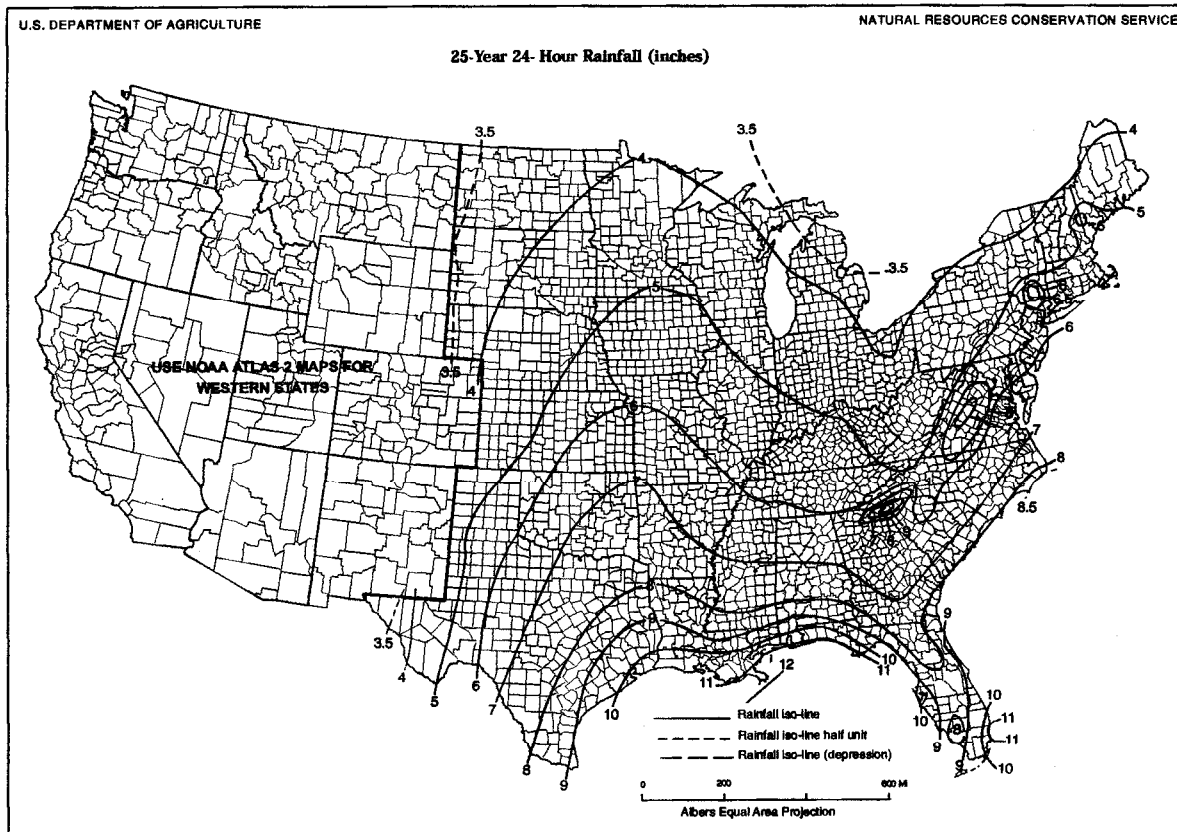


Figure B-7 50-year, 24-hour rainfall

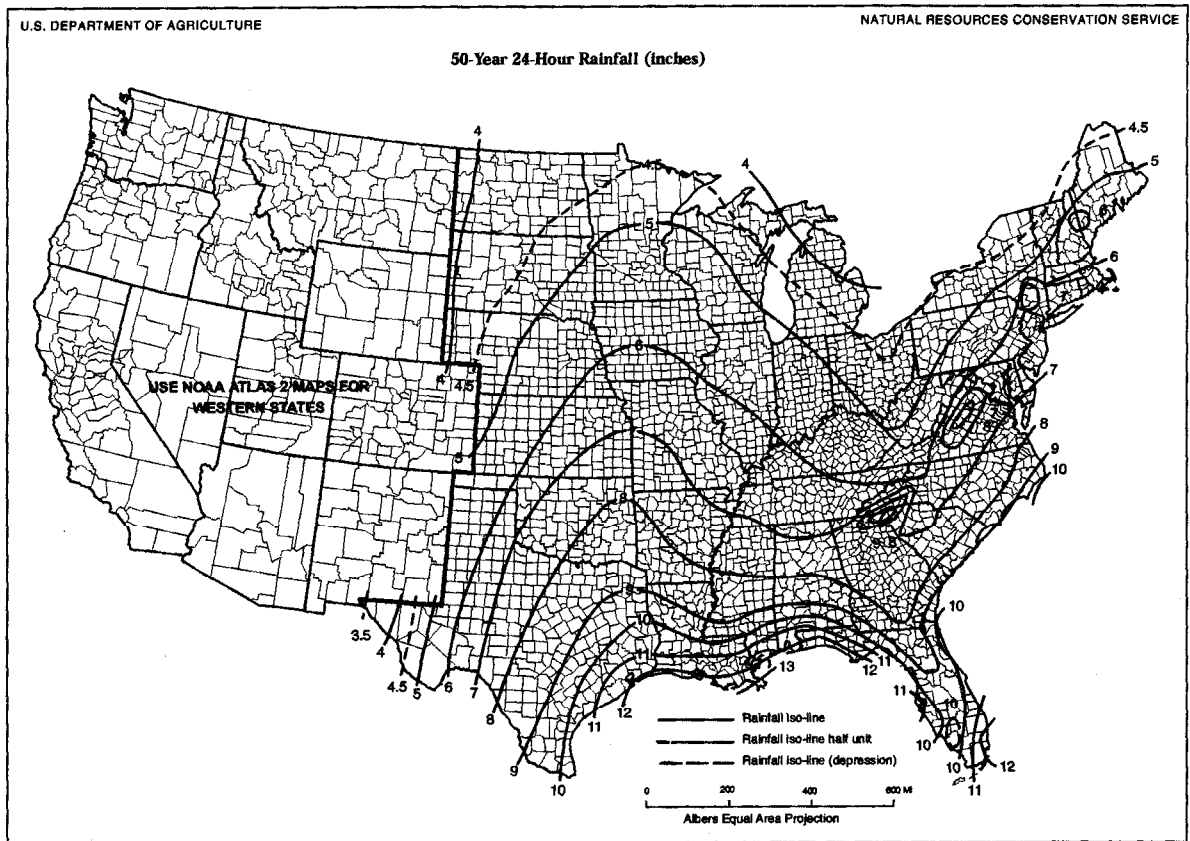
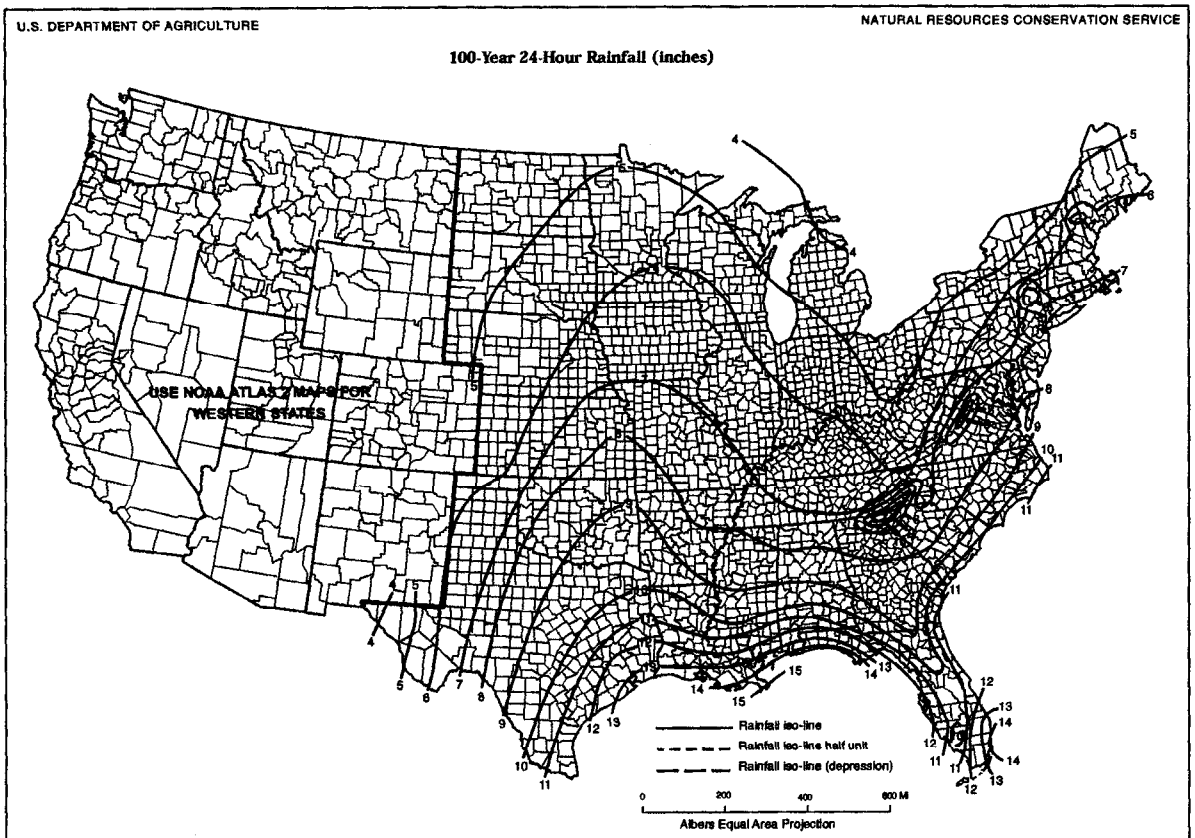


Figure B-8 100-year, 24-hour rainfall



100-YEAR 24-HOUR RAINFALL (INCHES)

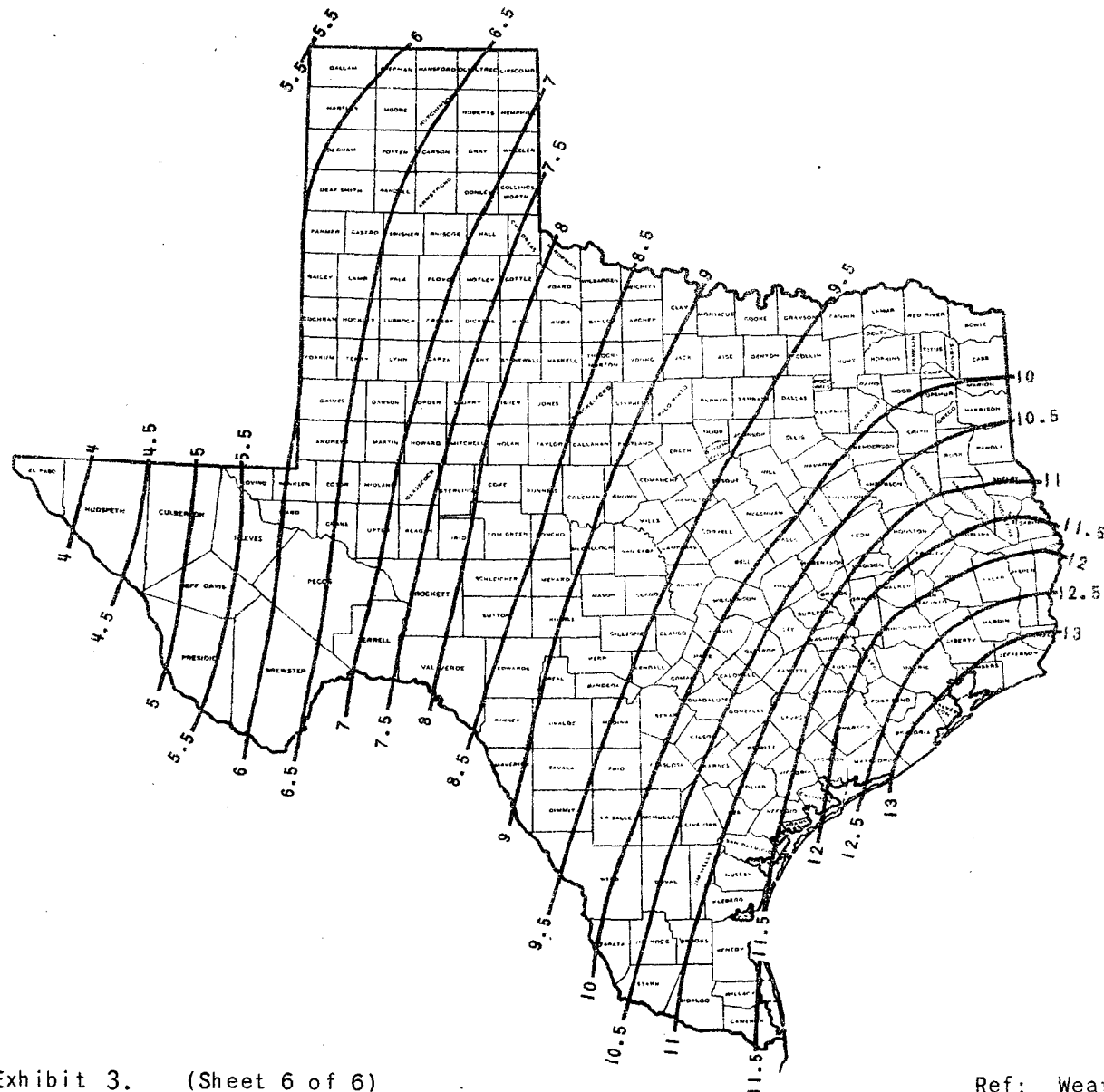


Exhibit 3. (Sheet 6 of 6)

Ref: Weather Bureau TP No. 40

500 YEAR STORM CALCULATIONS

REF: DEPTH-DURATION FREQUENCY OF PRECIPITATION FOR TEXAS, W.H. ASQUITH,
WATER RESOURCES INVESTIGATIONS REPORT 98-4044, U.S. GEOLOGICAL
SURVEY, 1998 (98-4044)

GENERALIZED LOGISTIC DISTRIBUTION

$$X_d(F) = \xi + \alpha / \kappa \{1 - [(1 - F) / F]^{\kappa}\} \quad \text{EQ. 10, 98-4044}$$

WHERE: $X_d(F)$ = PRECIPITATION DEPTH FOR A GIVEN
FREQUENCY

$\xi, \alpha, \text{ and } \kappa$ = LOCATION, SCALE AND SHAPE
PARAMETERS FOR THE GLO DIST.

F = ANNUAL NONEXCEEDANCE PROBABILITY

FOR 500 YEAR STORM

$\xi = 1.93$	FIGURE 18, 98-4044
$\alpha = 0.55$	FIGURE 32, 98-4044
$\kappa = -0.20$	FIGURE 46, 98-4044
$F = 0.998$	

$X_d(F) = 8.71$ INCHES

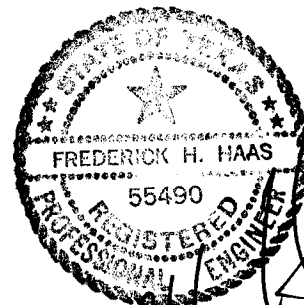


Figure 18

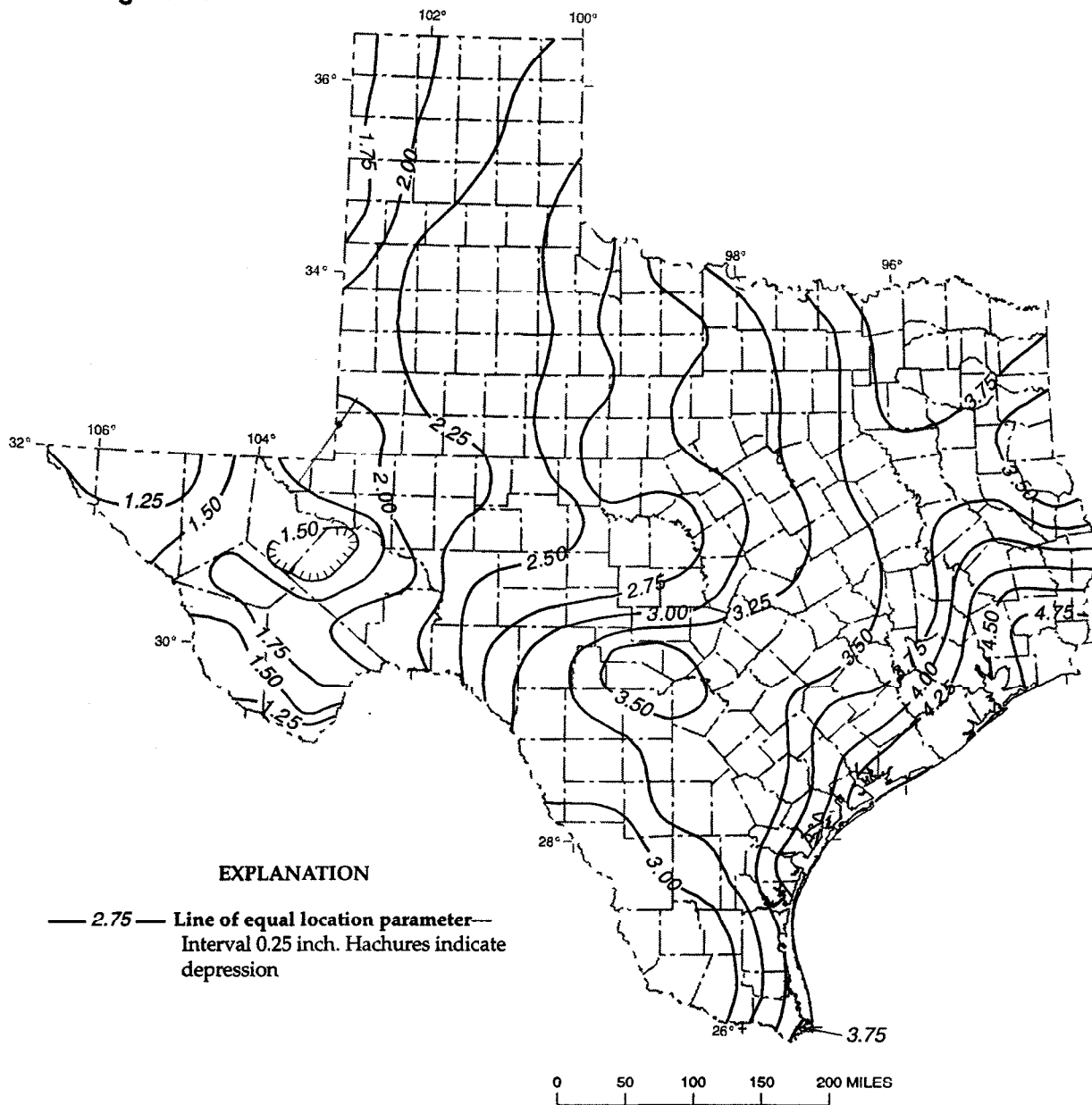


Figure 18. Location (ξ) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

Figure 32

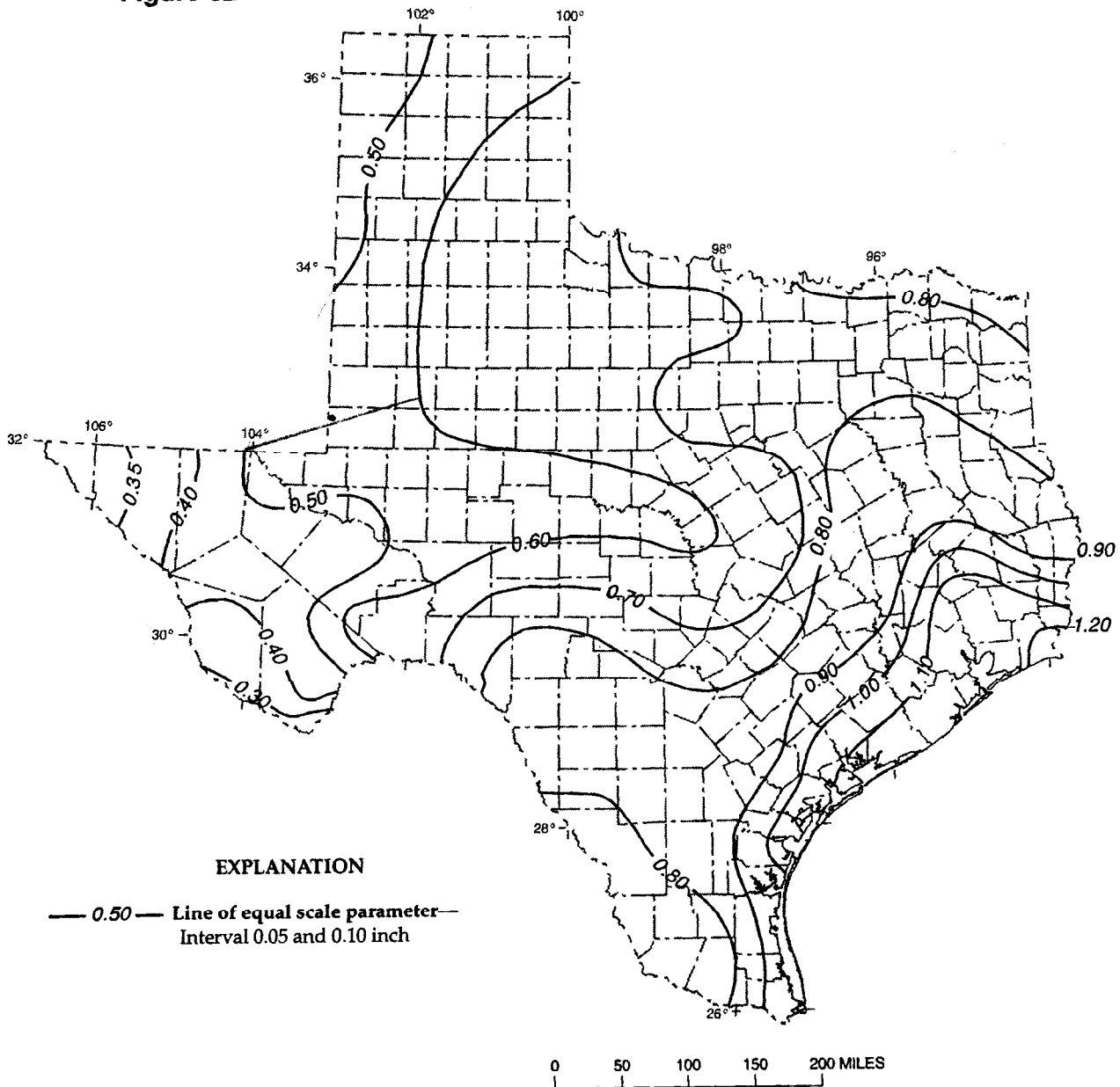


Figure 32. Scale (α) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

Figure 46

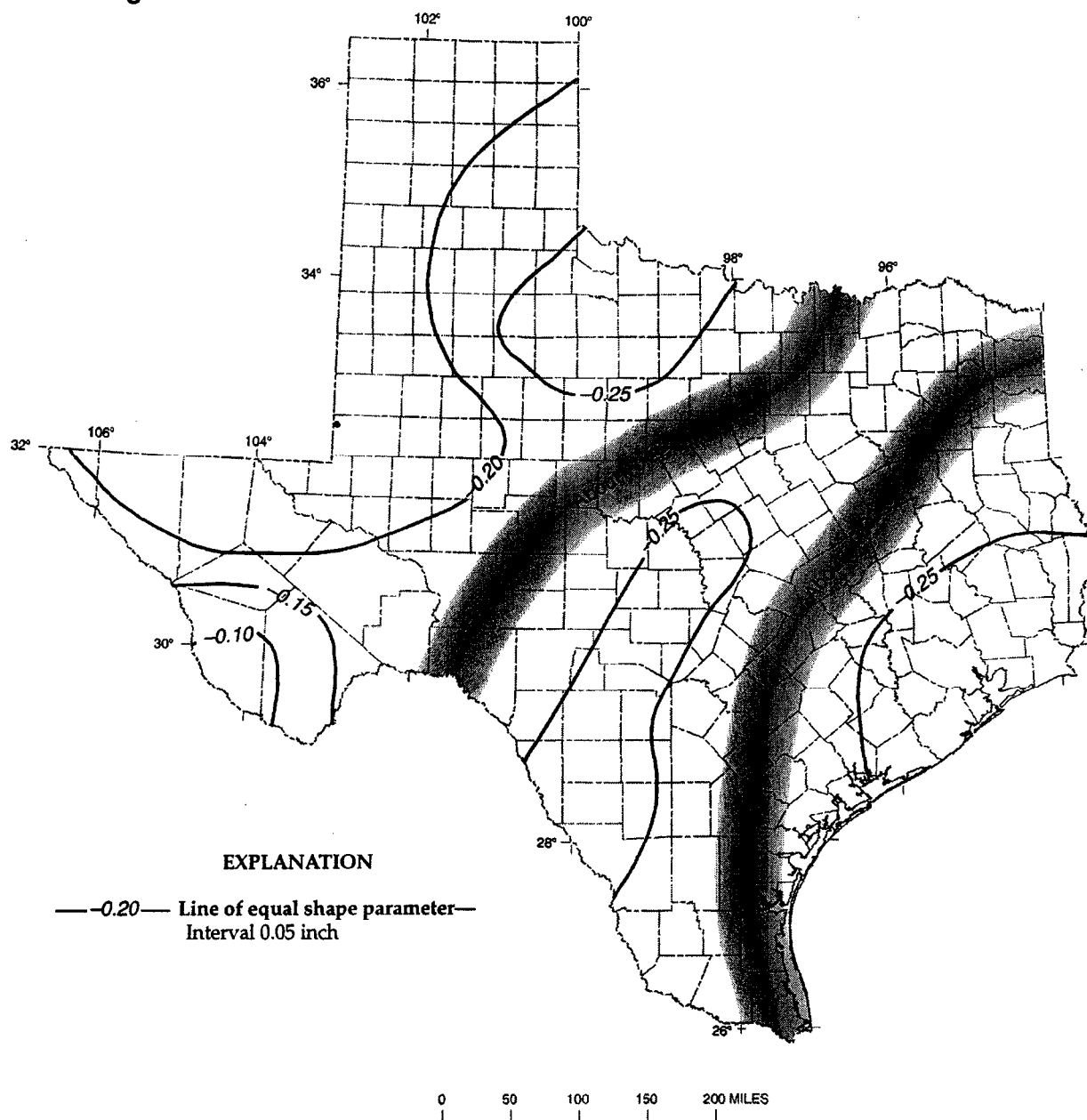


Figure 46. Shape (κ) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

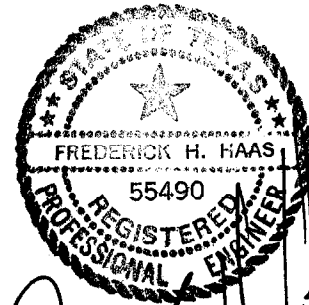
PMP CALCULATIONS

REF: HYDROMETEOROLOGICAL REPORT NO. 51, PROBABLE MAXIMUM
PRECIPITATION ESTIMATES, UNITED STATES EAST OF THE 105TH
MERIDIAN, NATIONAL WEATHER SERVICE, 1978 (HMR 51)

NOAA HYDROMETEOROLOGICAL REPORT NO. 52, APPLICATION
OF PROBABLE MAXIMUM PRECIPITATION ESTIMATES - UNITED
STATES EAST OF THE 105TH MERIDIAN, NATIONAL WEATHER
SERVICE, 1982 (HMR 52)

AREA-DEPTH-DURATION FROM HMR 51

AREA SQ.MI.	DURATION (HR)				
	6	12	24	48	72
10	25.0	30.5	35.0	39.0	40.5
25	23.2	28.1	32.5	36.6	38.2
50	21.9	26.1	30.3	34.5	36.2
100	20.1	24.0	28.1	32.2	34.0
175	18.8	22.3	26.3	30.2	32.3
300	17.1	20.4	24.4	28.2	30.2
450	15.7	19.0	22.9	26.9	28.8
700	14.2	17.4	21.1	25.0	27.0
1000	13.0	16.1	19.6	23.5	25.0



FROM CURVE

AREA SQ.MI.	18 - HR DURATION
10	33.0
25	30.6
50	28.5
100	26.4
175	24.7
300	22.8
450	21.3
700	19.6
1000	18.1

FIRST THREE SIX HOURS

AREA SQ.MI.	1	2	3
10	25.0	5.5	2.5
25	23.2	4.9	2.5
50	21.9	4.2	2.4
100	20.1	3.9	2.4
175	18.8	3.5	2.4
300	17.1	3.3	2.4
450	15.7	3.3	2.3
700	14.2	3.2	2.2
1000	13.0	3.1	2.0

FROM GRAPH

AREA SQ.MI.	1	2	3
10	24.99	5.50	2.53
25	23.50	4.62	2.51
50	21.90	4.20	2.48
100	20.10	3.86	2.44
175	18.60	3.63	2.40
300	17.00	3.42	2.35
450	15.70	3.30	2.29
700	14.20	3.18	2.20
1000	13.00	3.08	2.02

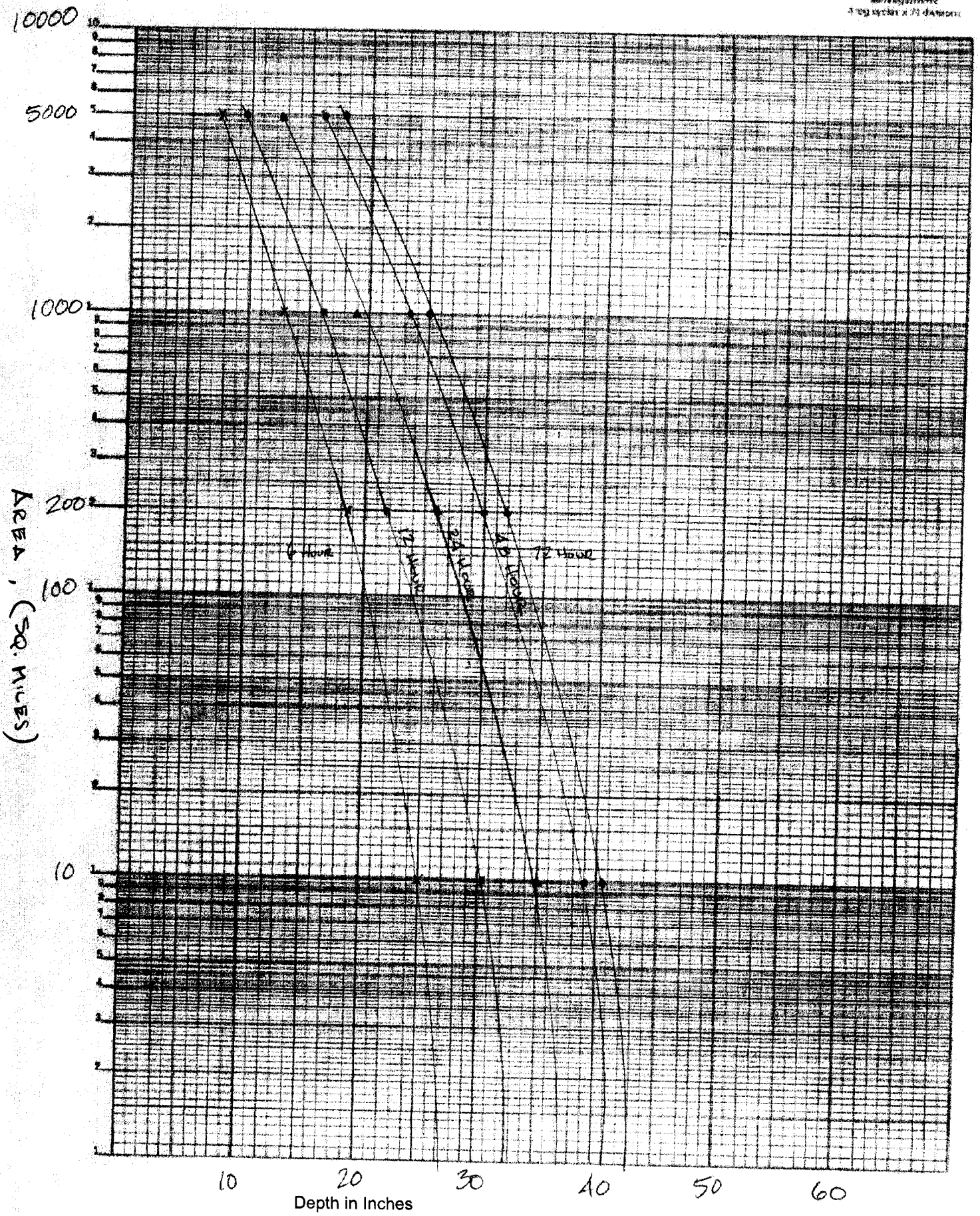
6-HR INC.	PRECIP. (IN.)	DELTA PRECIP (IN.)
1	24.99	24.99
2	30.49	5.50
3	33.02	2.53
4	35.00	1.98
5	36.00	1.00
6	37.00	1.00
7	38.00	1.00
8	39.00	1.00
9	39.50	0.50
10	40.00	0.50
11	40.30	0.30
12	40.50	0.20

TEMPORAL DISTRIBUTION

INTERVAL	SEQUENCE A	SEQUENCE B
(HR)		
0 to 6	0.20	0.30
6 to 12	0.30	0.50
12 to 18	0.50	1.00
18 to 24	0.50	1.00
24 to 30	1.00	24.99
30 to 36	1.00	5.50
36 to 42	1.00	2.53
42 to 48	2.53	1.98
48 to 54	24.99	1.00
54 to 60	5.50	1.00
60 to 66	1.98	0.50
66 to 72	1.00	0.20

7111 12/04

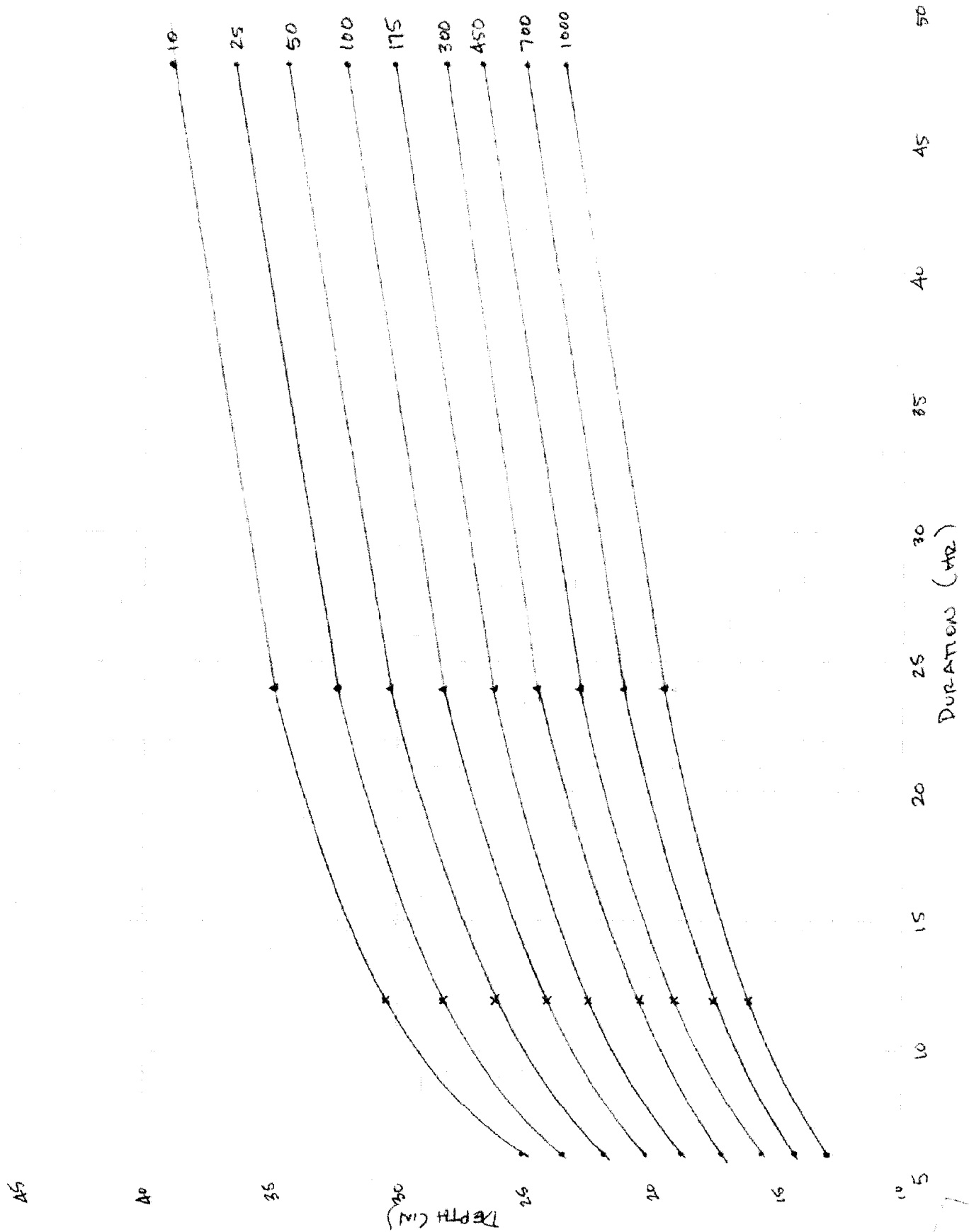
Revised by: [illegible]
Date: 12/04



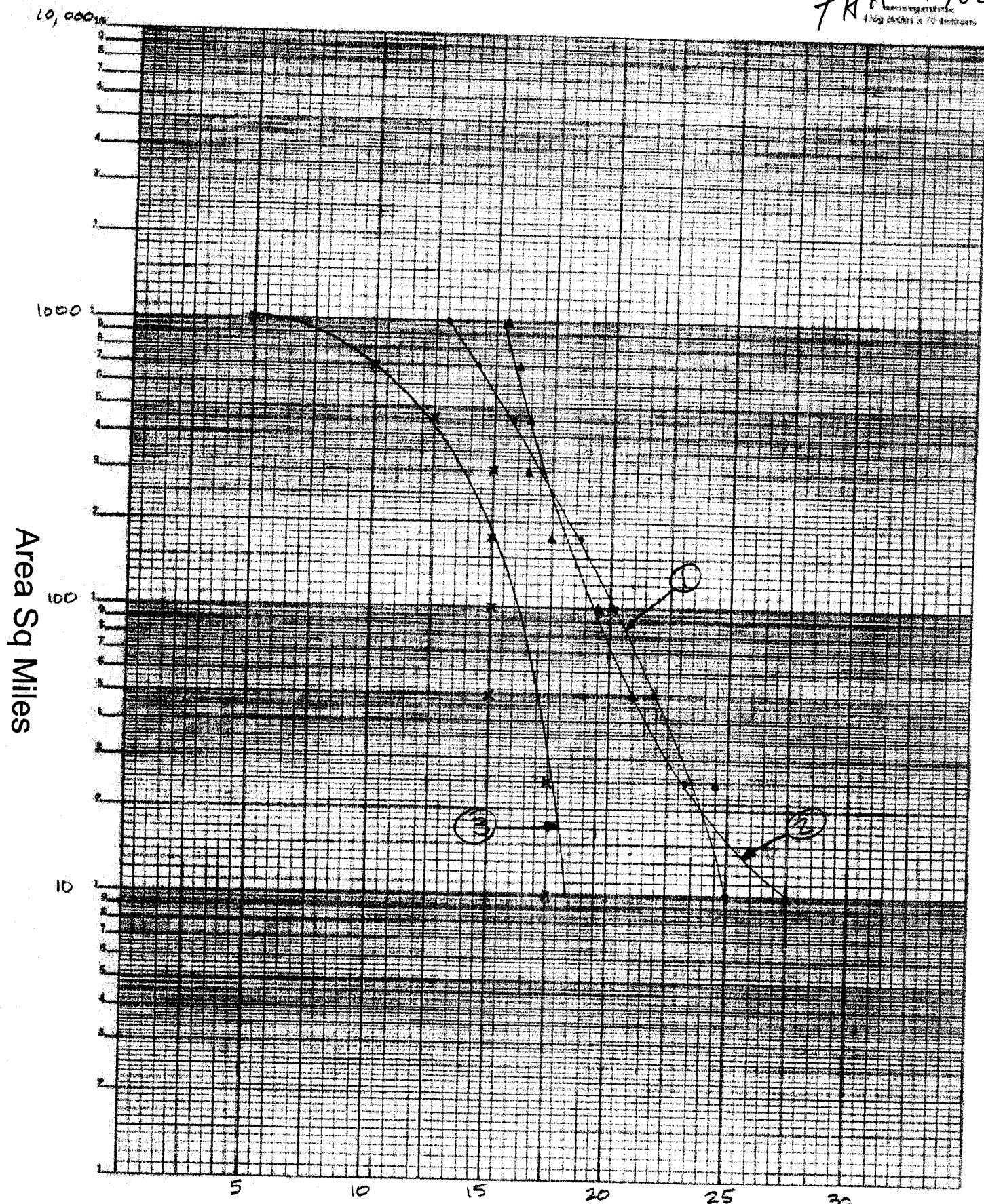


HAESTAD METHODS
37 BROOKSIDE ROAD
WATERBURY, CT 06708 USA
PHONE: +1-203-755-1666 • FAX: +1-203-597-1488
INTERNET: www.haestad.com & www.civilprojects.com

Project _____
Project # _____
Date _____
Engineer *7/11/04*



7HH 12/64



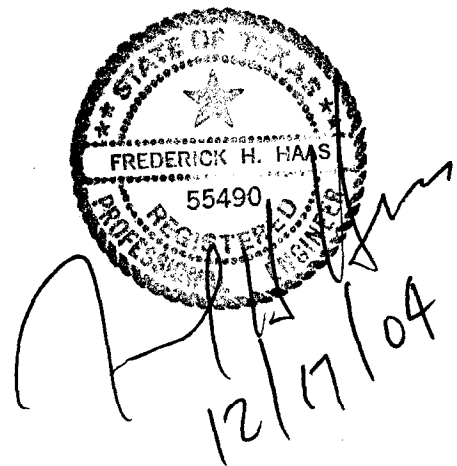
1st 6-Hr Avg. Depths (in.)

1 2 3 4 5 6
2ND 6-Hr Avg. Depths (in.)



APPENDIX B

**HEC-HMS MODEL FOR THE CALCULATION OF
THE 100-YEAR PEAK DISCHARGES**



PLAYA ELEVATION, STORAGE, OUTFLOW

ELEVATION AND STORAGE

ELEV.	AREA	DELTA E	AVERAGE AREA	STORAGE VOLUME	CUMULATIVE STORAGE
MSL	SQ. FT.	FT.	SQ. FT.	CU. FT.	AC.-FT
3478	402878			0	0
		2	517775		
3480	632672			1035550	24
		2	811324.5		
3482	989977			1622649	61
		2	2375467		
3484	3760957			4750934	170
		2	6247779.5		
3486	8734602			12495559	457
		2	10261979		
3488	11789356			20523958	928

OUTFLOW

WEIR EQUATION

$$Q = C * L * H^{3/2}$$

WHERE:

Q= FLOW, CFS

C= WEIR COEFFICIENT

L= HORIZONTAL LENGTH, FT

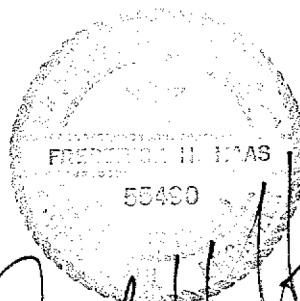
H= HEAD ON WEIR, FT

ASSUME TOP OF PLAYA IS ELEVATION 3486

LENGTH OF 3486 CONTOUR IS 241 FT.

HEAD FT.	Cw	Q CU FT /SEC
0.5	3.58	305
1.0	3.58	863
1.5	3.58	1585
2.0	3.56	2427

NOTE: Cw IS FROM WATER-RESOURCES ENGINEERING, LINSLEY AND FRANZINI



Handwritten signature and date: 11/15/05

Meteorologic Model Input

HMS * Meteorologic Model

File Edit Help

Meteorologic Model Met100 Year

Description 100 Year, 24 Hour Storm

Precipitation Evaporation

Method SCS Hypothetical Storm

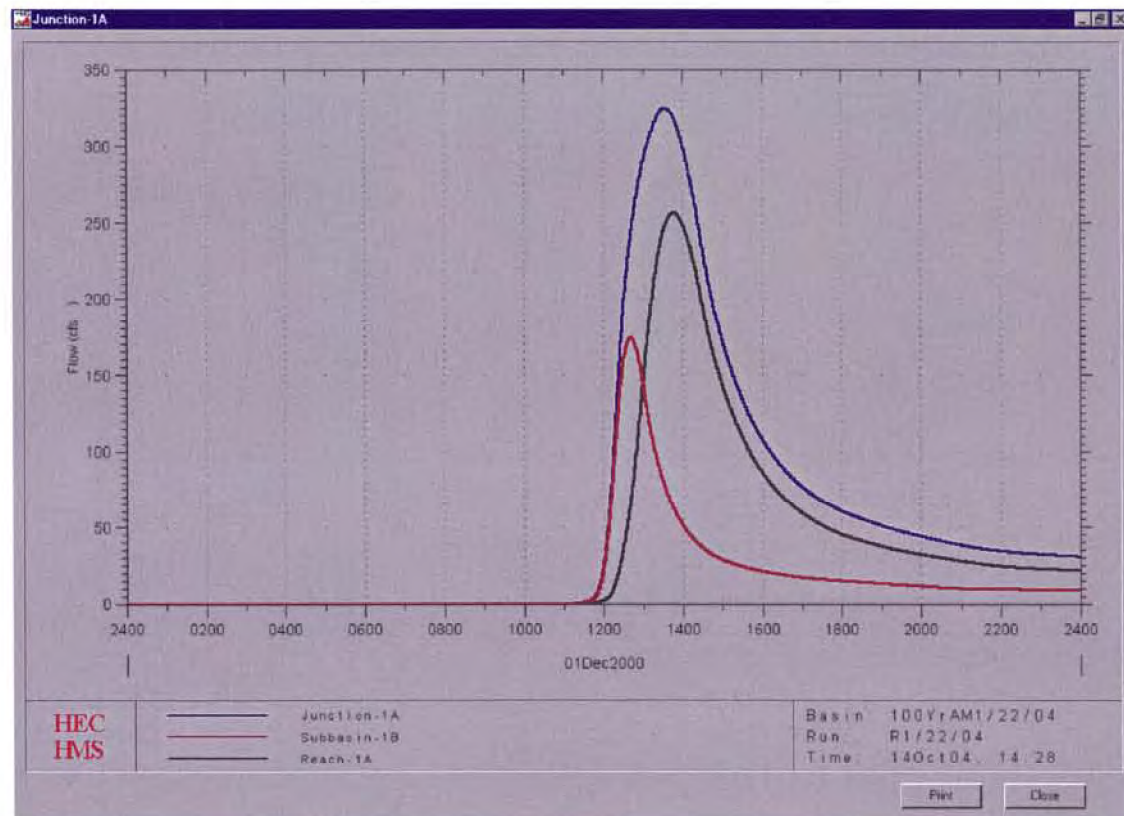
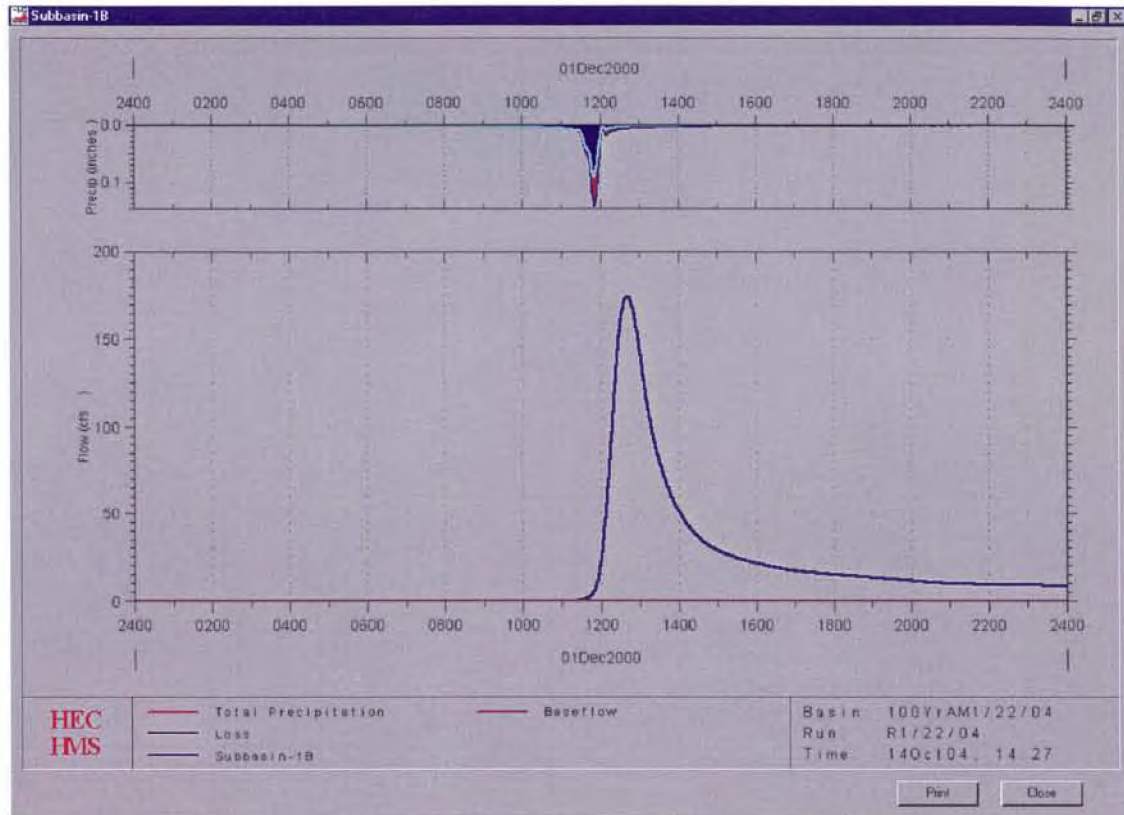
Storm Selection Type II

Storm Depth 6.0

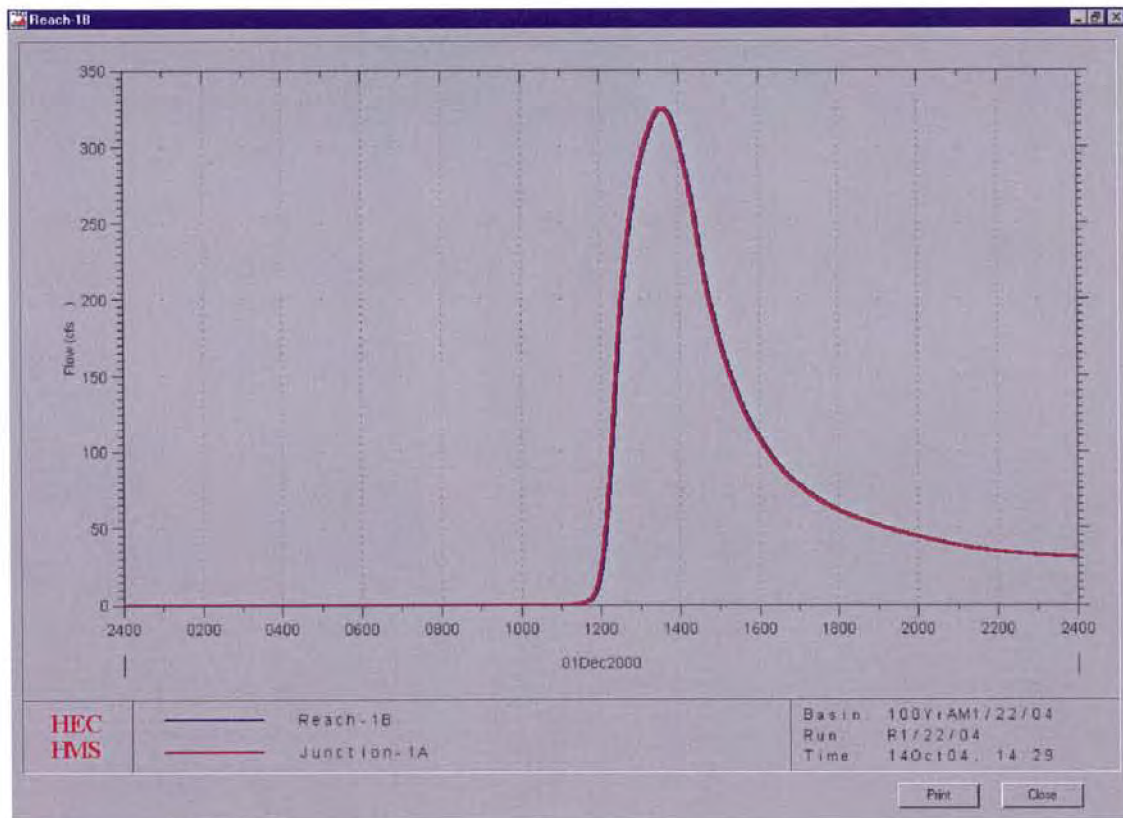
WCS FACILITY FLOOD PLAIN STUDY HYDROGRAPHS



WCS FACILITY FLOOD PLAIN STUDY HYDROGRAPHS



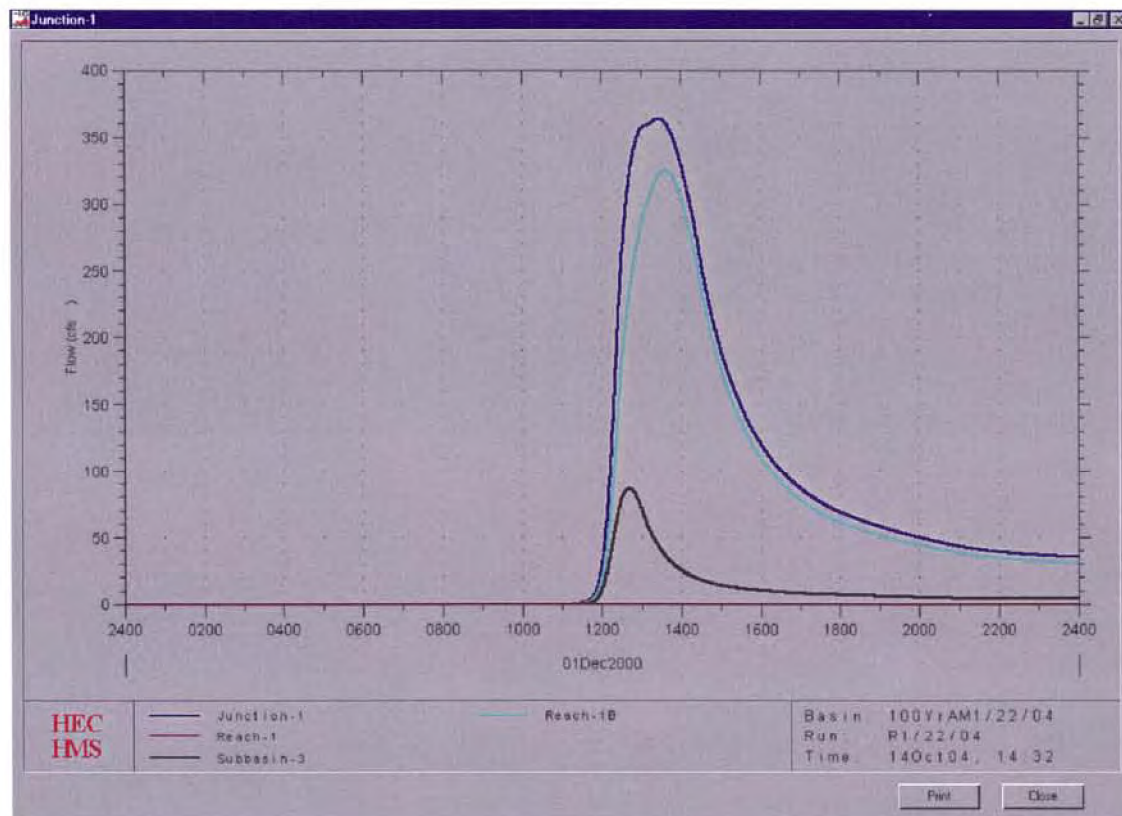
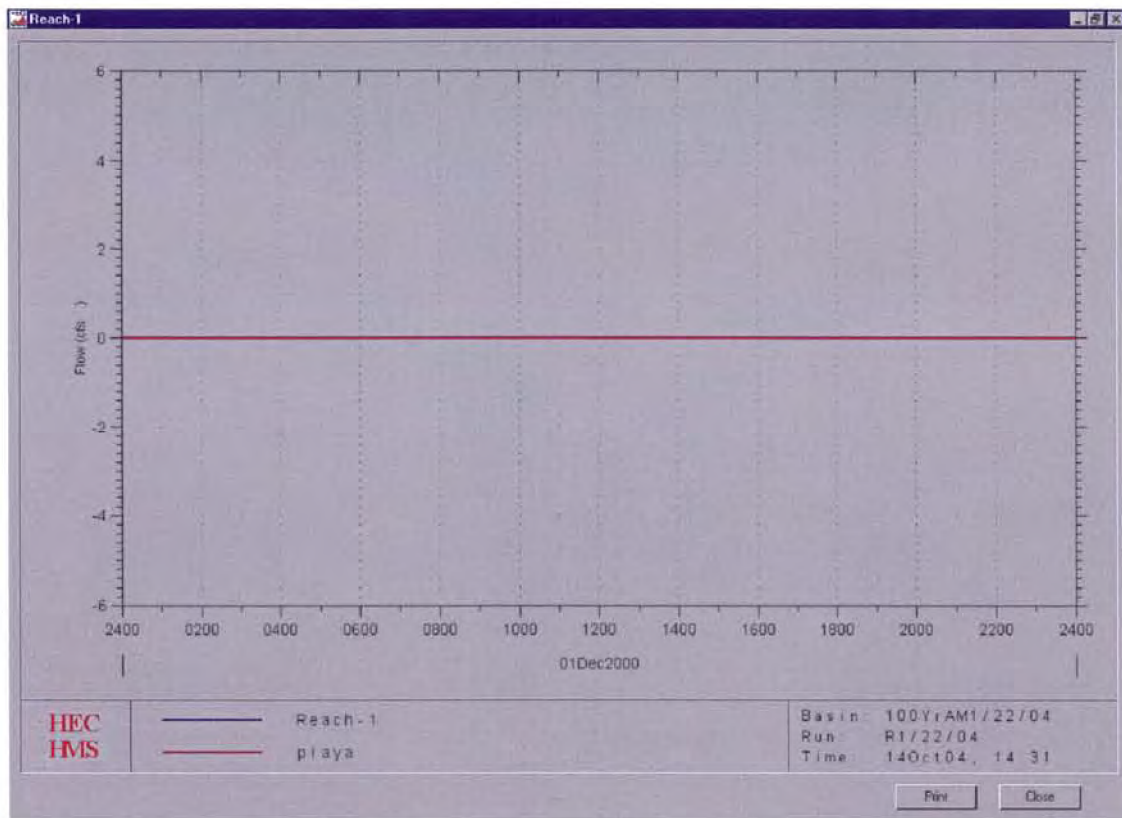
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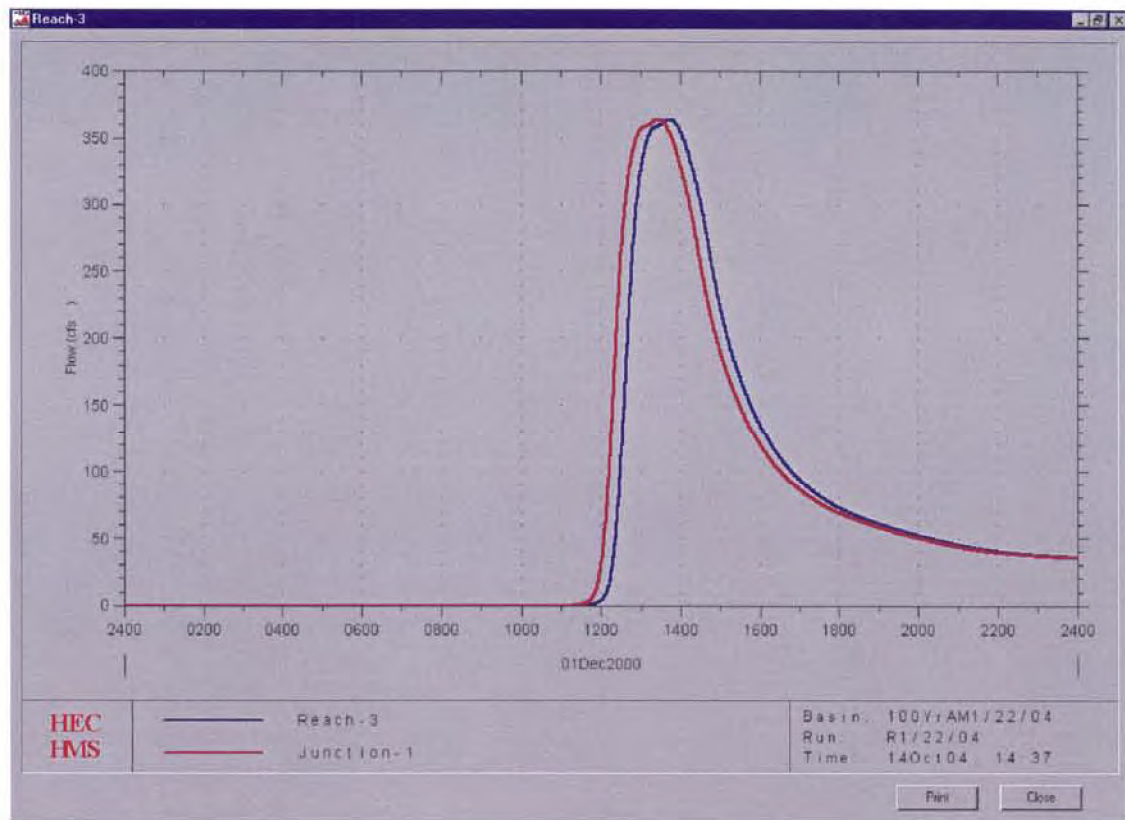
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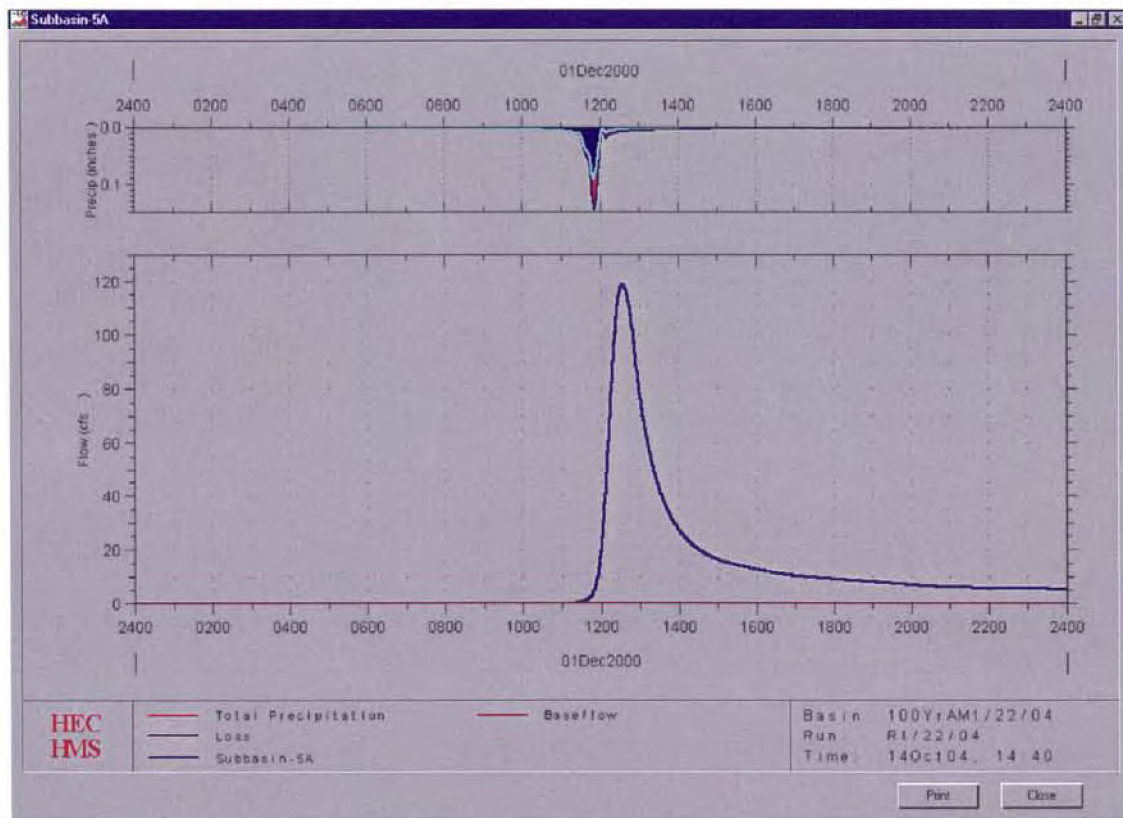
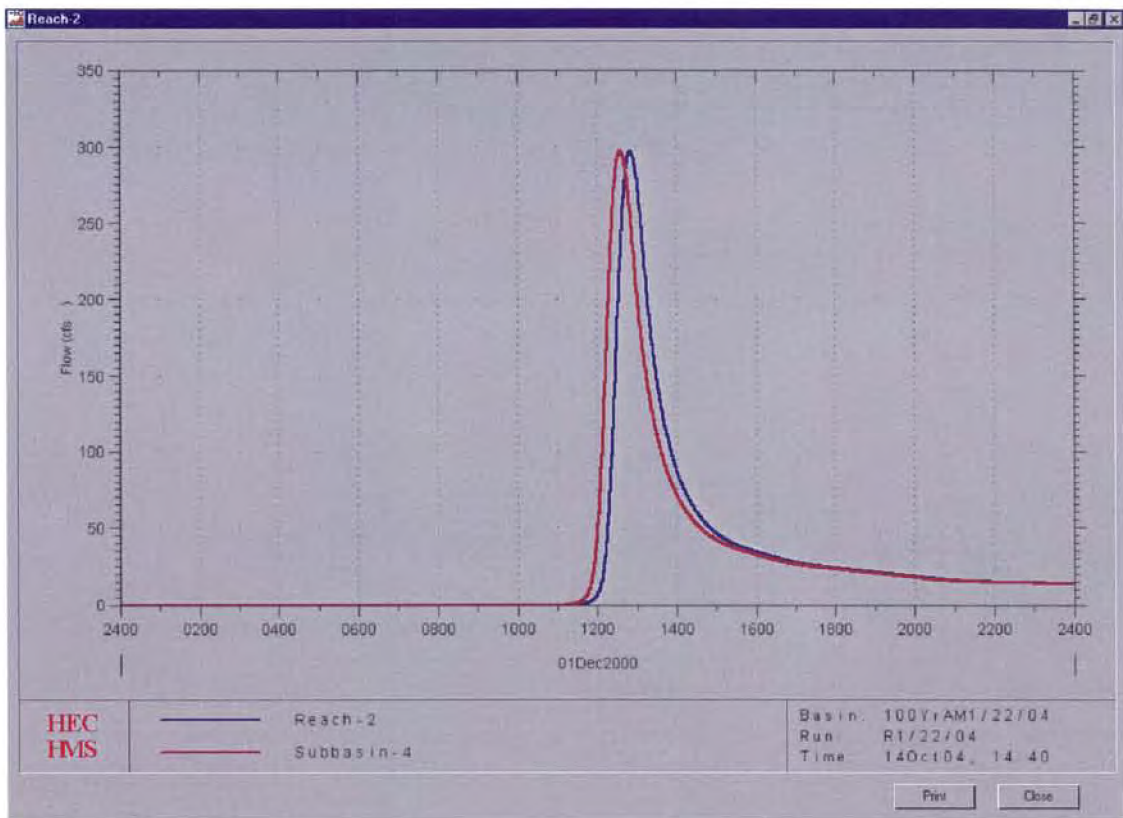
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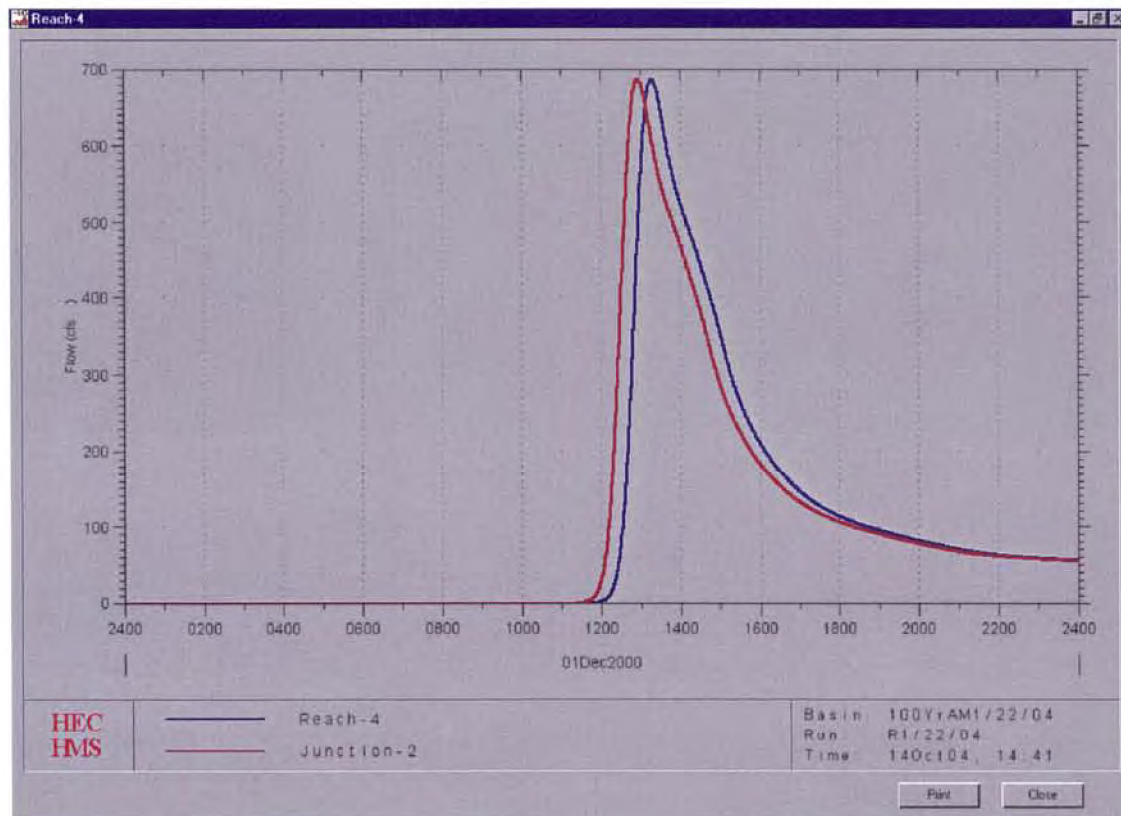
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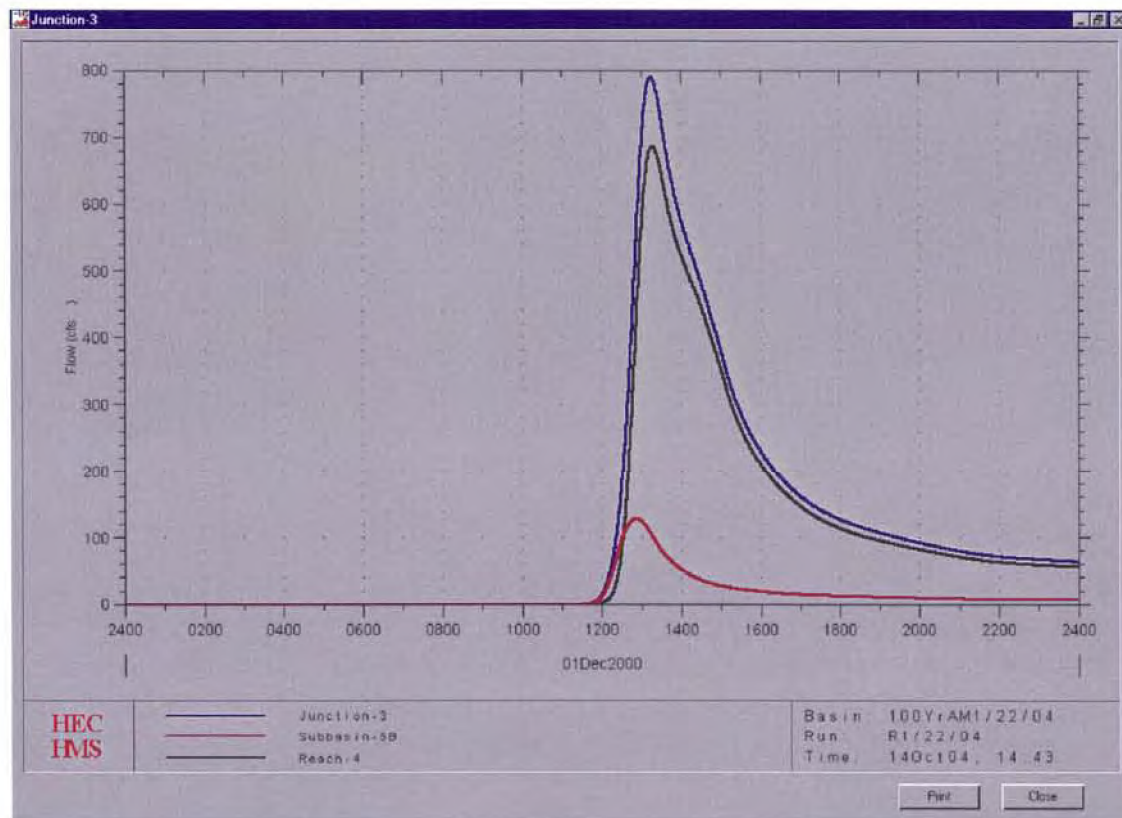
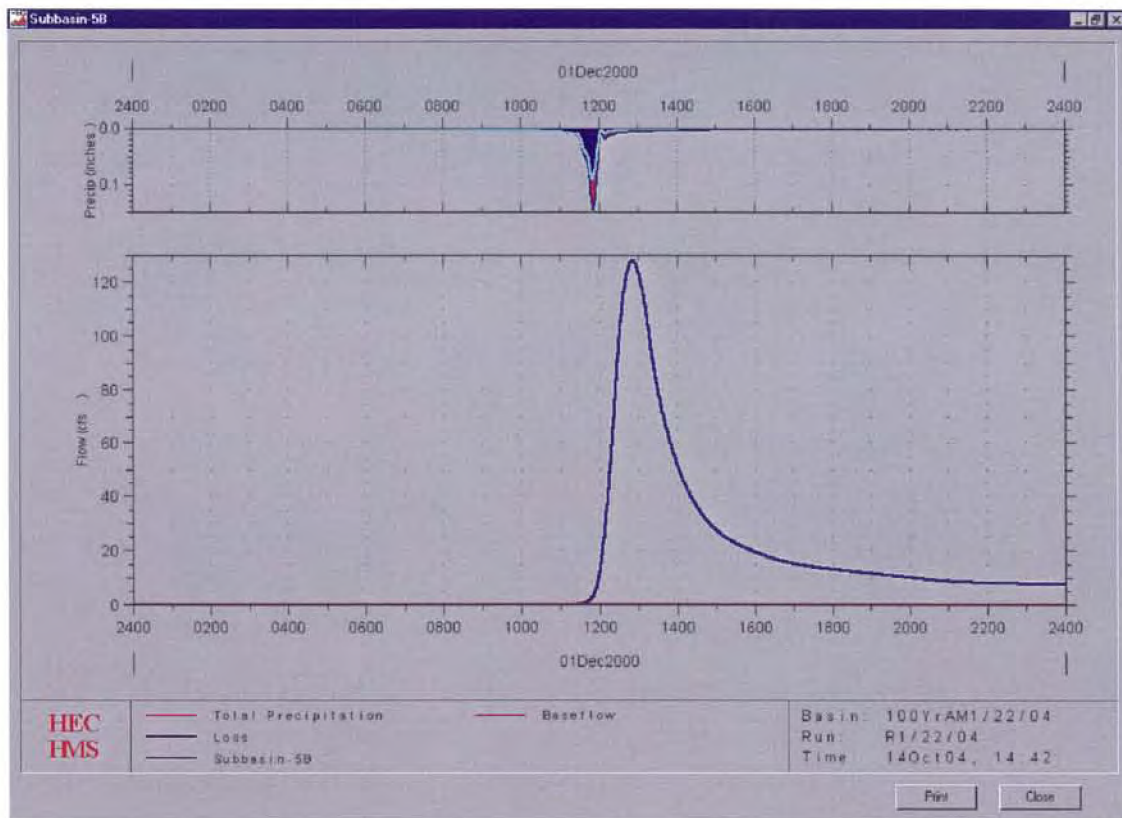
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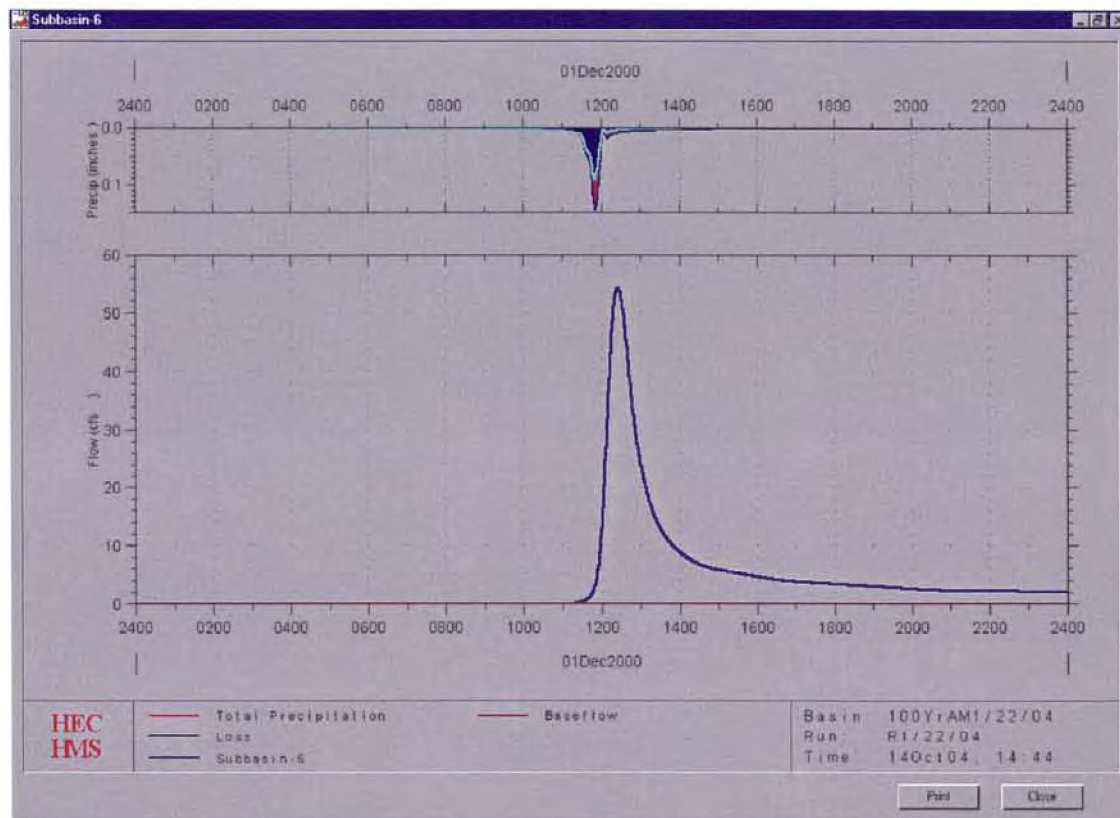
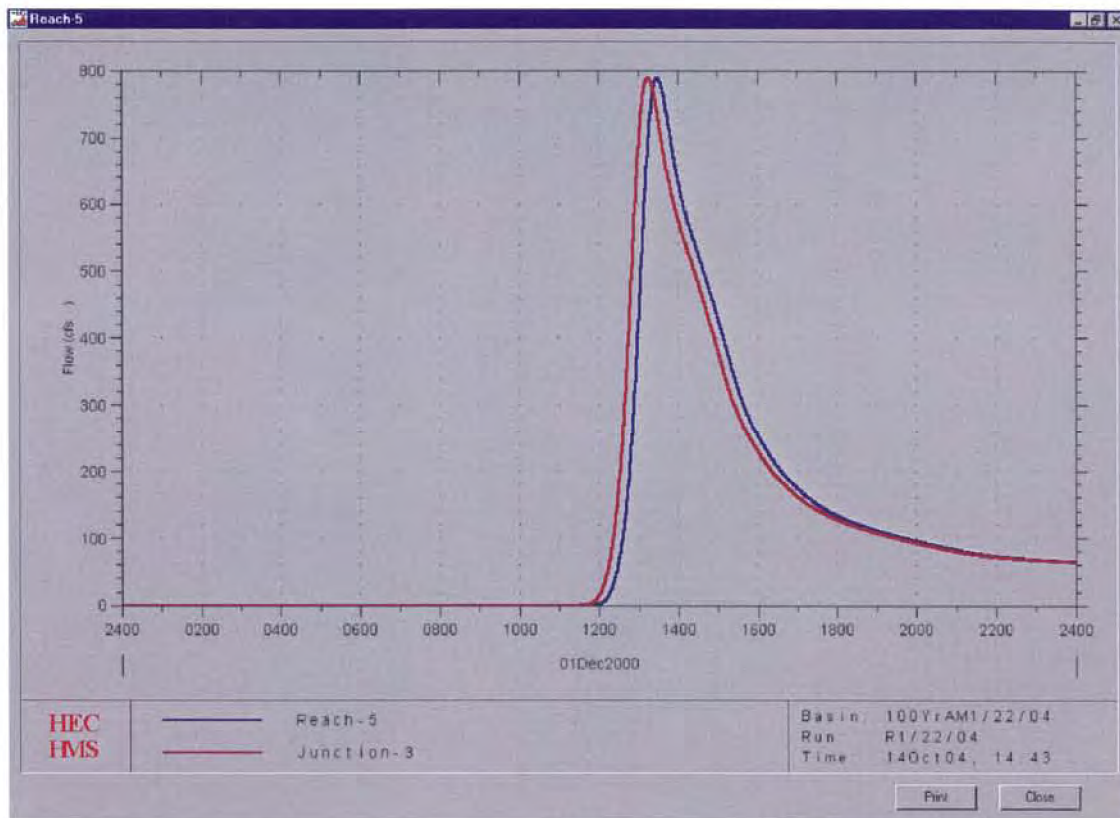
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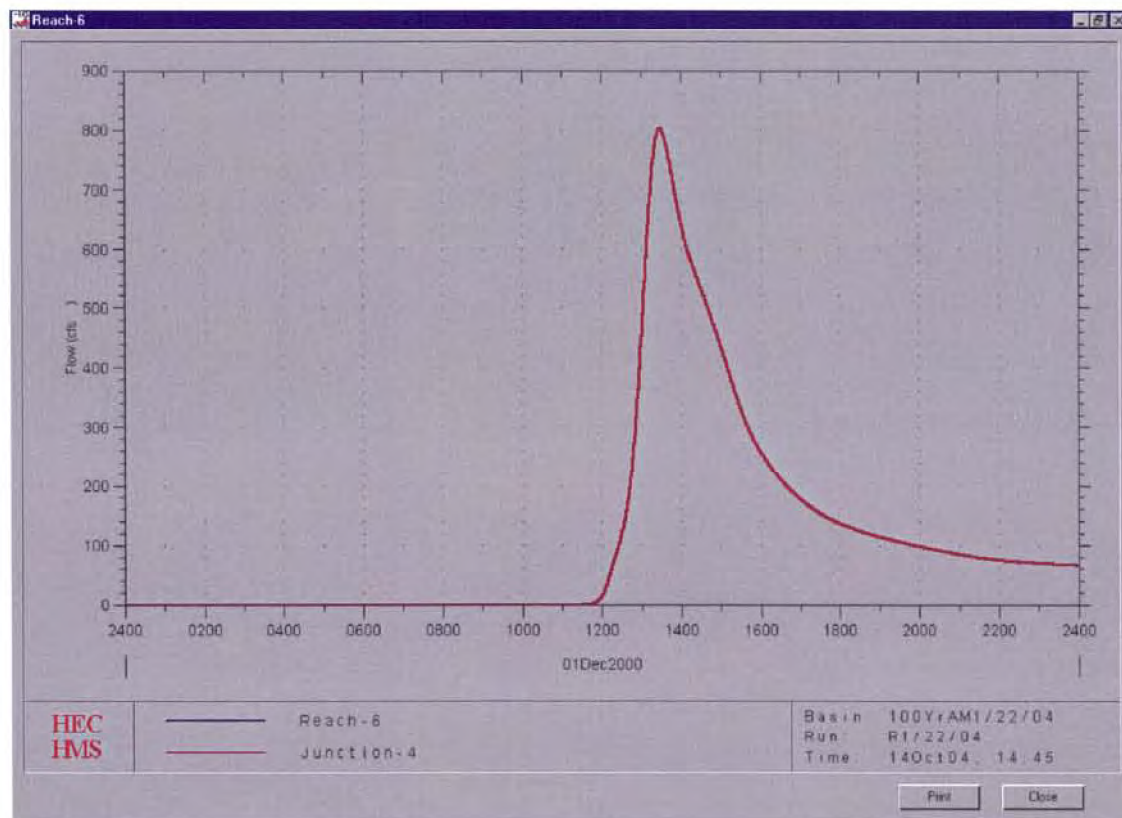
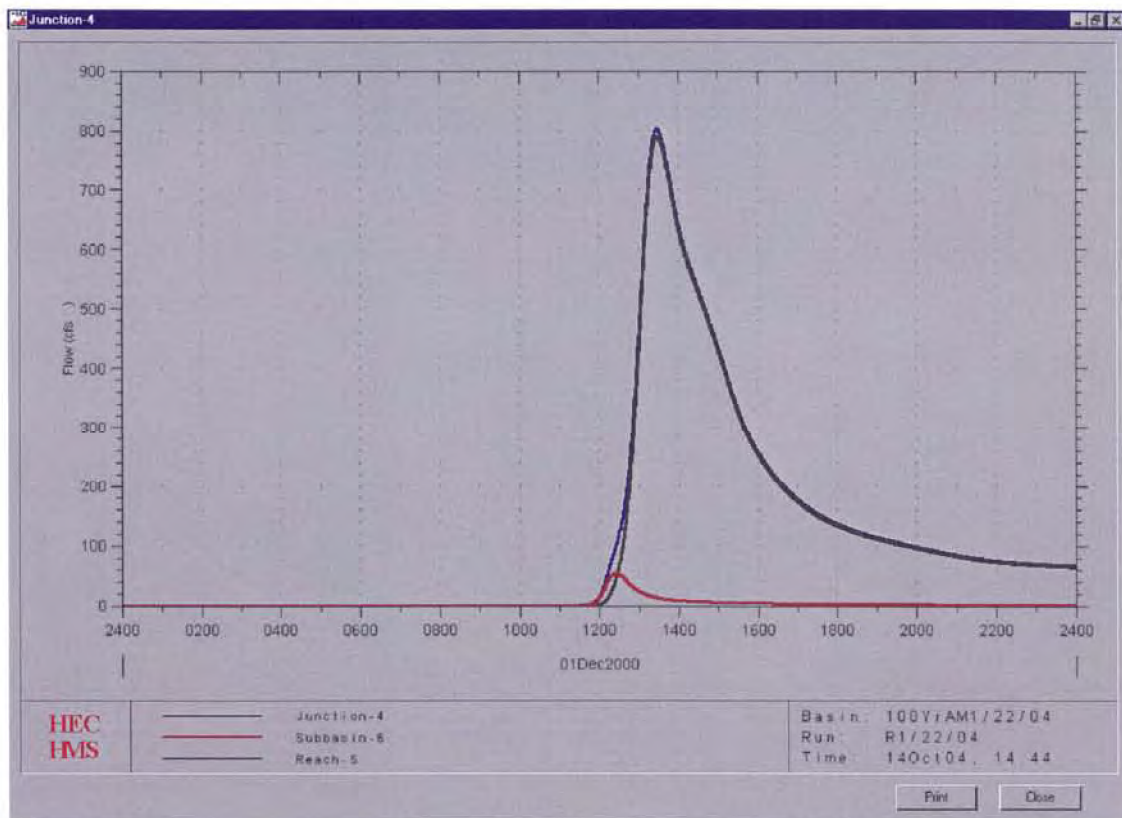
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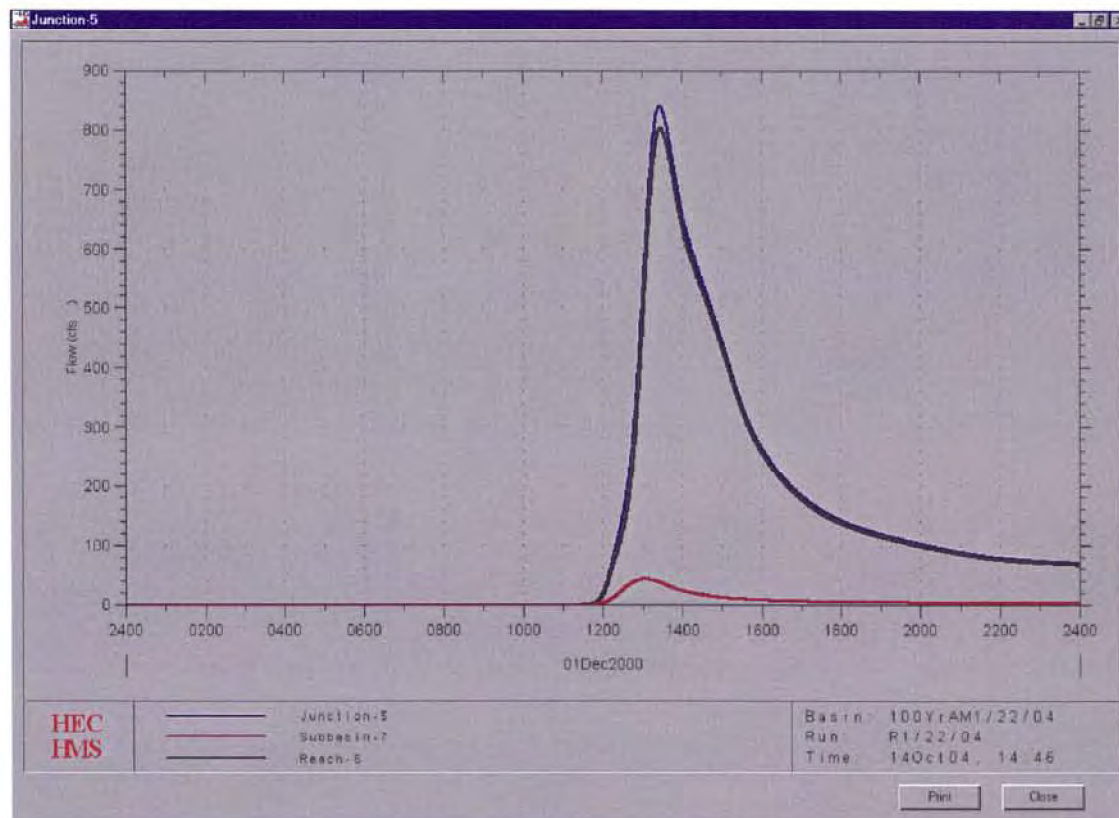
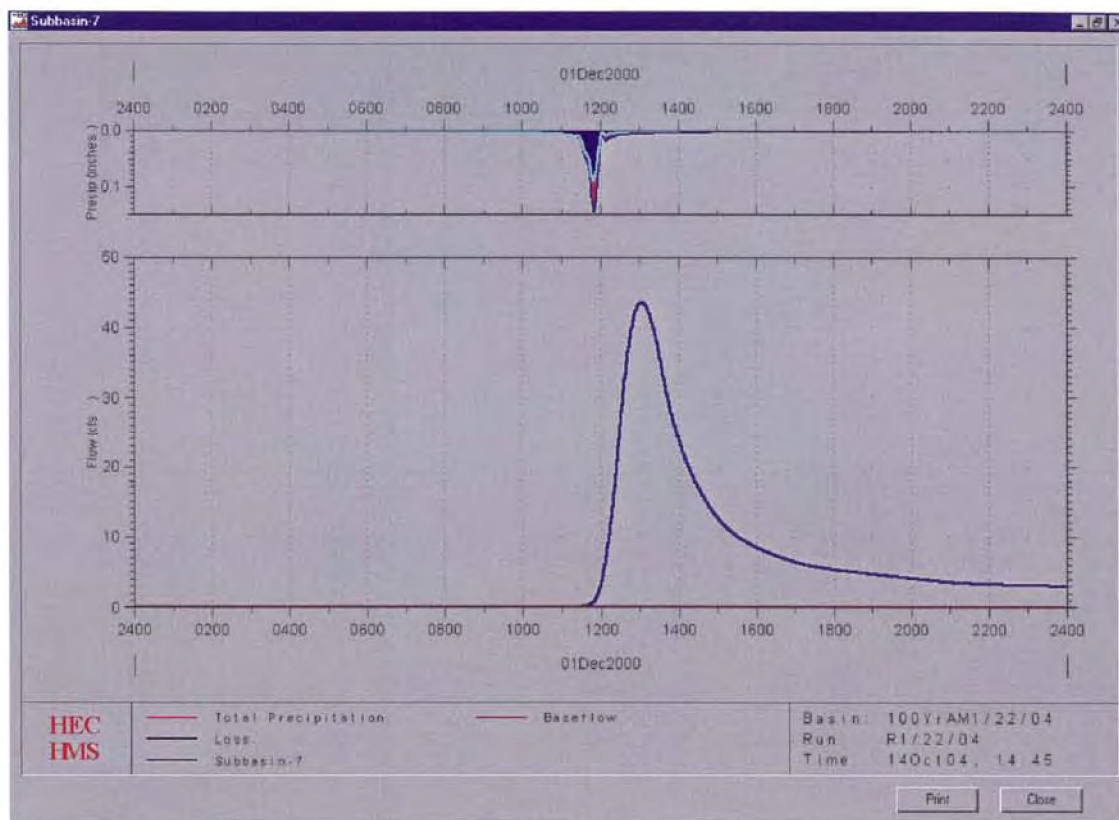
WCS FACILITY FLOOD PLAIN STUDY HYDROGRAPHS



WCS FACILITY FLOOD PLAIN STUDY HYDROGRAPHS



WCS FACILITY FLOOD PLAIN STUDY HYDROGRAPHS



HMS * Summary of Results

Project : WCS

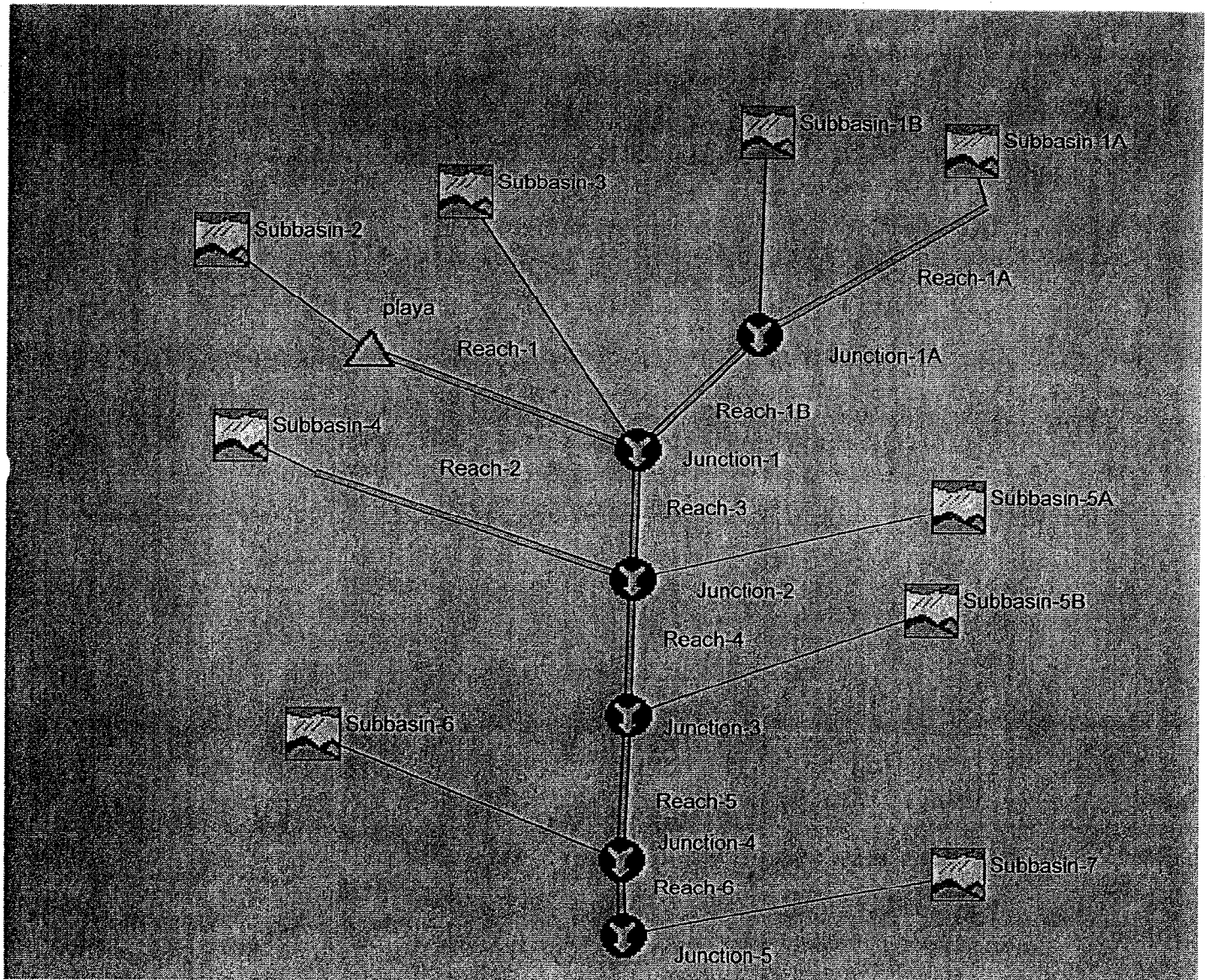
Run Name : R1/22/04

Start of Run : 01Dec00 0000 Basin Model : 100YrAM1/22/04

End of Run : 02Dec00 0000 Met. Model : Met100 Year

Execution Time : 29Jan04 1349 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin-4	297.60	01 Dec 00 1235	49.246	0.490
Reach-2	297.60	01 Dec 00 1250	48.953	0.490
Subbasin-2	440.24	01 Dec 00 1305	105.39	1.063
playa	0.0	30 Nov 00 2400	0.0	1.063
Reach-1	0.0	30 Nov 00 2400	0.0	1.063
Subbasin-1A	256.61	01 Dec 00 1328	73.808	0.691
Reach-1A	256.61	01 Dec 00 1345	73.298	0.691
Subbasin-1B	174.42	01 Dec 00 1241	31.477	0.314
Junction-1A	324.86	01 Dec 00 1332	104.77	1.005
Reach-1B	324.86	01 Dec 00 1335	104.65	1.005
Subbasin-3	86.653	01 Dec 00 1241	15.638	0.156
Junction-1	364.05	01 Dec 00 1326	120.28	2.224
Reach-3	364.05	01 Dec 00 1343	119.45	2.224
Subbasin-5A	118.86	01 Dec 00 1234	19.306	0.192
Junction-2	686.69	01 Dec 00 1255	187.71	2.906
Reach-4	686.69	01 Dec 00 1316	186.08	2.906
Subbasin-5B	128.06	01 Dec 00 1251	26.440	0.265
Junction-3	790.00	01 Dec 00 1314	212.52	3.171
Reach-5	790.00	01 Dec 00 1328	211.28	3.171
Subbasin-6	54.403	01 Dec 00 1225	7.4715	0.074
Junction-4	803.31	01 Dec 00 1328	218.75	3.245
Reach-6	803.31	01 Dec 00 1328	218.75	3.245
Subbasin-7	43.582	01 Dec 00 1304	10.316	0.104
Junction-5	841.14	01 Dec 00 1327	229.07	3.349



HMS * Basin Model * SCS Curve Number

Sort: Hap

Basin Model ID: 1001-AM1/22/04

Subbasin Name	SCS Curve Number	Initial Abstraction (in)	Imperviousness (%)
Subbasin 1A	62		0.0
Subbasin 2	60		0.0
Subbasin 3	60		0.0
Subbasin 4	60		0.0
Subbasin 5B	60		0.0
Subbasin 5	60		0.0
Subbasin 1B	60		0.0
Subbasin 5A	60		0.0
Subbasin 7	60		0.0

HMS * Basin Model * SCS UH

Sort: Hap

Basin Model ID: 1001-AM1/22/04

Time Units: 

Subbasin Name	SCS Lag (min)
Subbasin 1A	86
Subbasin 2	65
Subbasin 3	44
Subbasin 4	39
Subbasin 5B	53
Subbasin 5	30
Subbasin 1B	44
Subbasin 5A	38
Subbasin 7	64

HMS * Basin Model * Lag Routing

Basin Model ID: 1007 AMH/22/04

Interval: Minutes ☐

Reach Name	Lag (min)
Reach-1	35
Reach-2	15
Reach-3	17
Reach-4	21
Reach-5	14
Reach-6A	17
Reach-6B	3
Reach-6C	0

HMS * Basin Model * Reservoir Editor

Reservoir Name: playa

Description:

Method: Elevation-Storage-Outflow

Initial Elevation (ft): 3478

Elevation (ft)	Storage (acre-feet)	Outflow (cfs)
3478.0	0.0	0.0
3480.0	24.0	0.0
3482.0	61.0	0.0
3484.0	170.0	0.0
3486.0	457.0	0.0
3487.0	693.0	863.0
3488.0	928.0	2427.0