

Basic Hydrology – Precipitation and Rainfall Distributions

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SCS Storm Return Periods

- For example, if a flood has a 20 percent chance of being equaled or exceeded each year, over a long period of time the flood will be equaled or exceeded **on an average** of once every five years.
- This is called the return period or recurrence interval (RI).
- The Storm Return Period is the inverse probability of the storm event recurrence interval being equaled or exceeded in any given year.
- For instance a 25 year storm has a 4 % chance of being equaled or exceeded in any given year.
- The probability can be computed by dividing 100 by the return period as follows:

$$\frac{100}{25} = 4 \%$$

SCS Storm Return Periods (Continued)

- Therefore as the precipitation depths get higher, the chance of occurrence gets lower.
- A 1 year storm event has a 100% chance of being equaled or exceeded in any given year:

$$\frac{100}{1} = 100 \%$$

- A 100 Year Storm event has a 1 % chance of being equaled or exceeded in any given year:

$$\frac{100}{100} = 1 \%$$

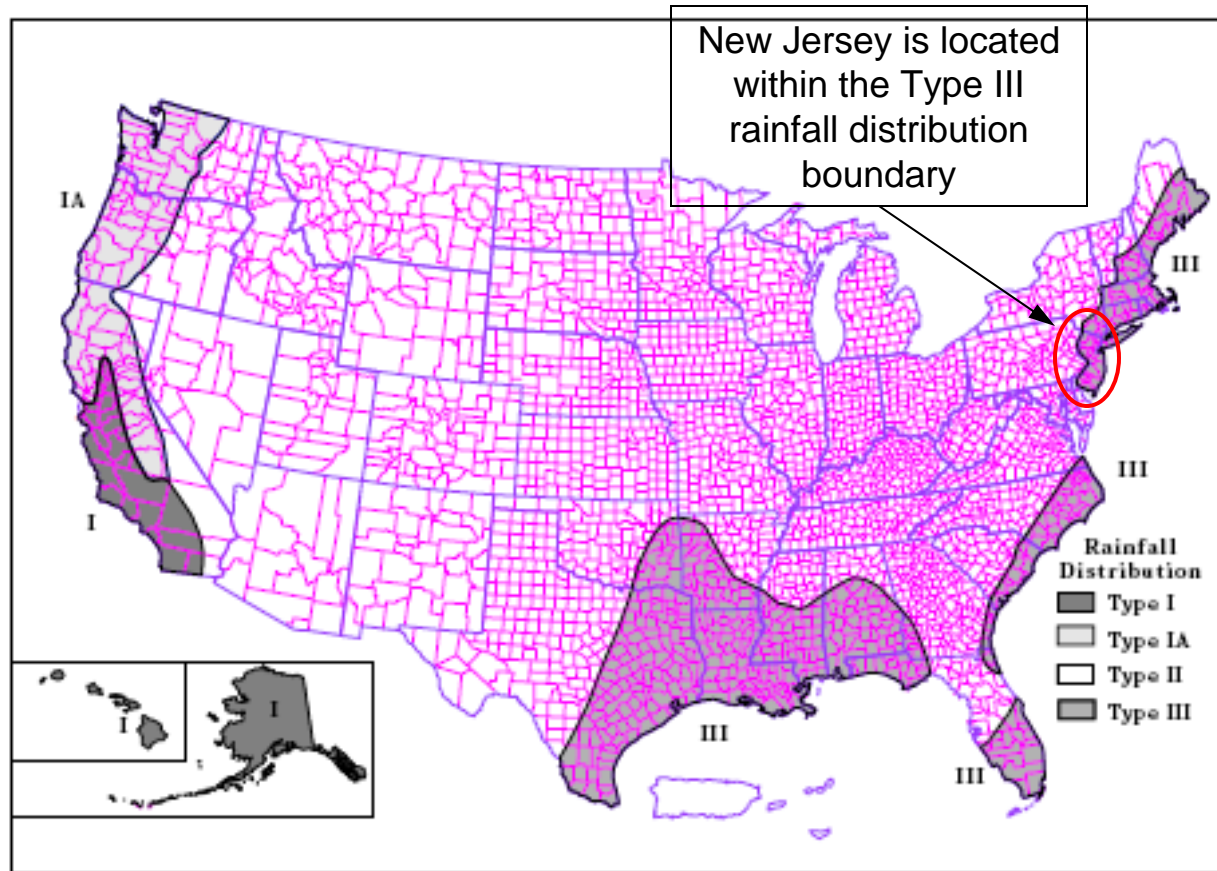
- It really makes sense. The higher the precipitation depths the less frequently storms of that magnitude actually occur.

NRCS Rainfall Distributions

- Rainfall Distribution is the variability of the intensity throughout a storm..... although the overall depth for a storm will be the same for a given duration no matter which Distribution is chosen.
- There are four (4) different types of rainfall distributions throughout the U.S. – Type I, Type 1A, Type II and Type III

NRCS Rainfall Distributions

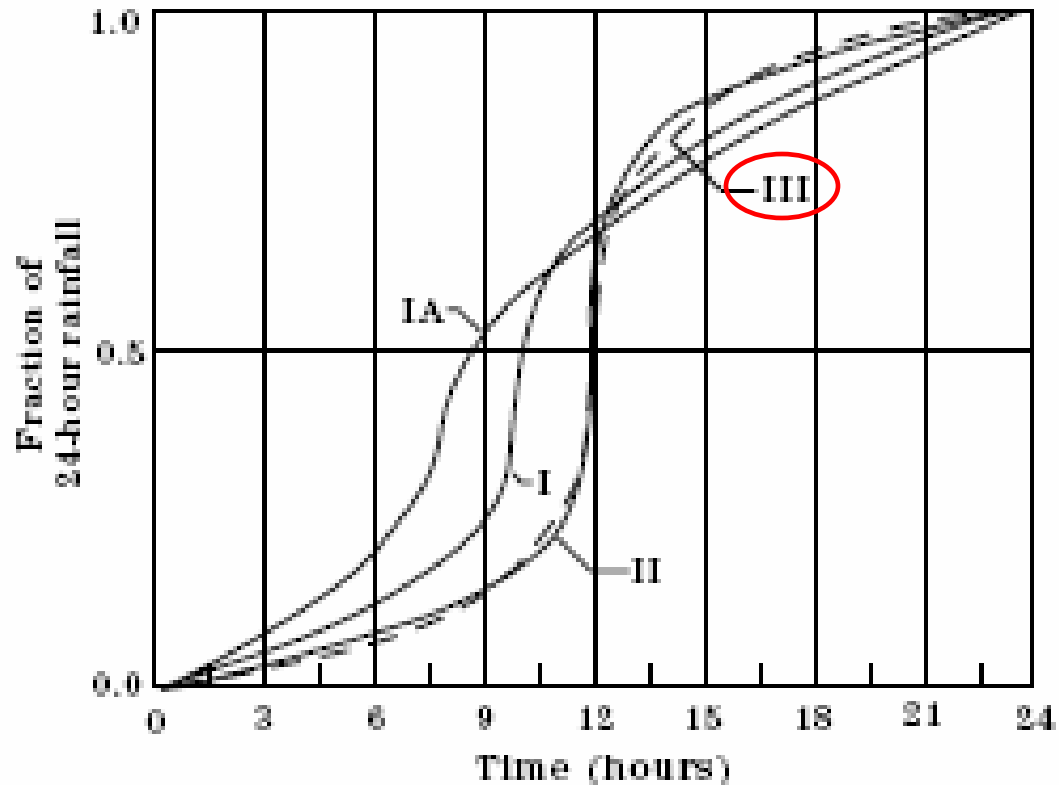
Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



The entire State of New Jersey is located within the Type III Rainfall Distribution.

Comparison of the different rainfall distributions

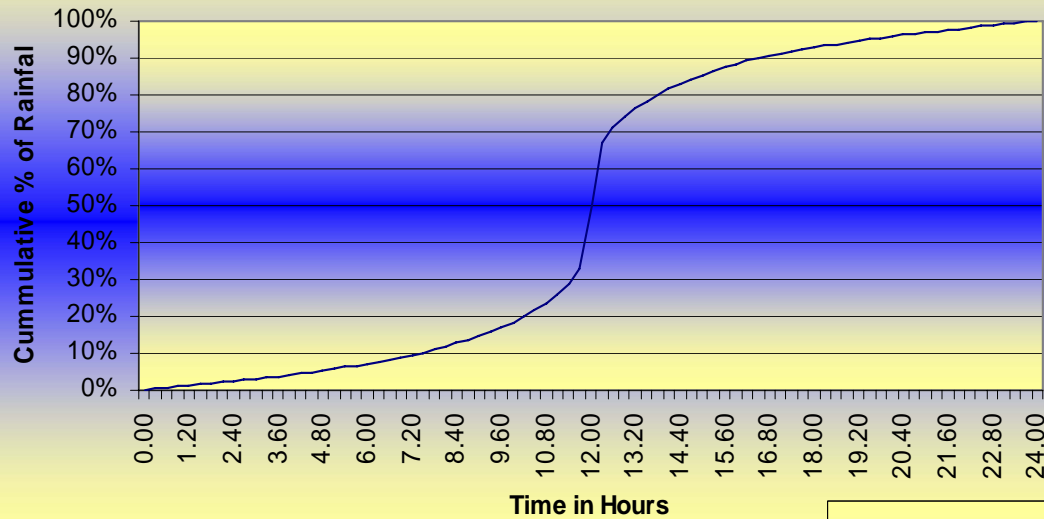
Figure B-1 SCS 24-hour rainfall distributions



Note that approximately 50% of the rainfall occurs between the 11th and 13th hour.
Ever notice that the peak flow rate from a TR-55 generated runoff hydrograph occurs at around the 12th hour?

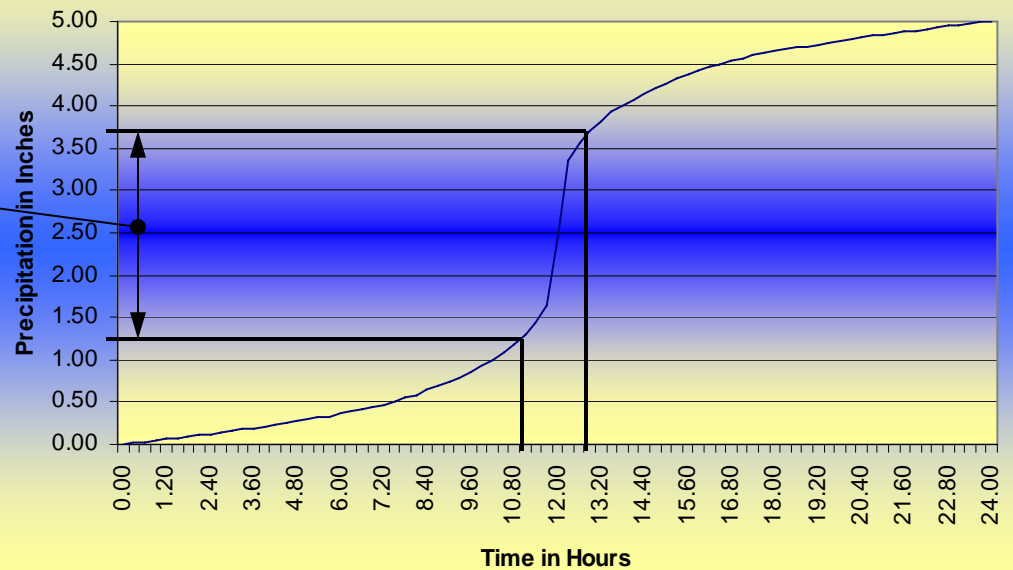
5.00 Inch Precipitation Distribution

SCS Type III Rainfall Distribution



Approximately 2.50 Inches or 50% of the 5.00 Inch Rainfall falls within a 2 hour period from the 11th to the 13th hour.

5.00 Inch Precipitation Distribution



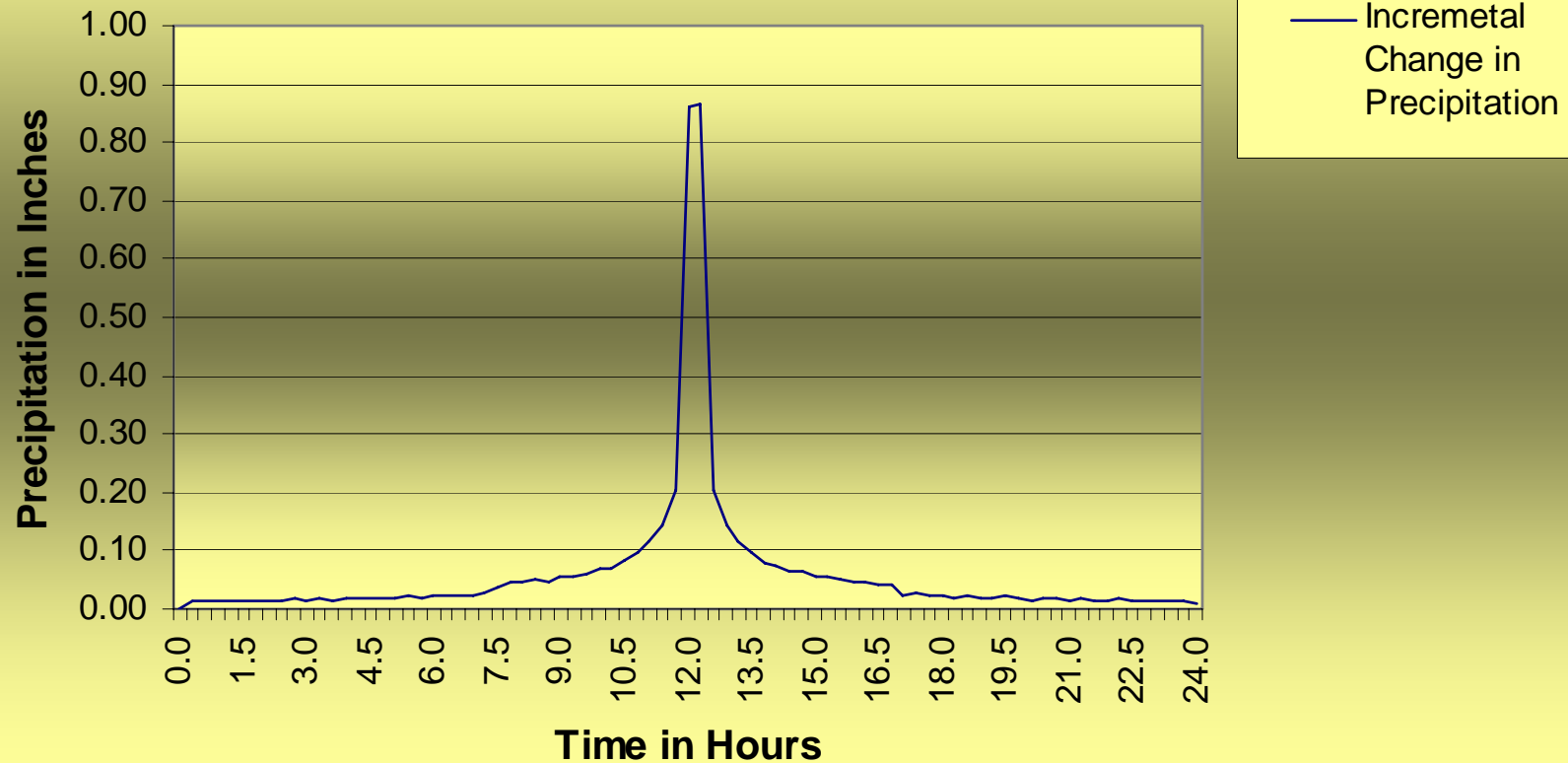
SCS Type 3 Distribution Cumulative Rainfall Table 0.3 hour time interval

0.0000	0.0030	0.0060	0.0090	0.0120
0.0150	0.0180	0.0210	0.0240	0.0280
0.0310	0.0350	0.0380	0.0420	0.0460
0.0500	0.0540	0.0580	0.0630	0.0670
0.0720	0.0770	0.0820	0.0870	0.0930
0.1000	0.1090	0.1180	0.1280	0.1370
0.1480	0.1590	0.1710	0.1850	0.1990
0.2160	0.2350	0.2580	0.2870	0.3280
0.5000	0.6730	0.7140	0.7430	0.7660
0.7850	0.8010	0.8160	0.8290	0.8420
0.8530	0.8640	0.8740	0.8820	0.8920
0.9000	0.9080	0.9150	0.9210	0.9240
0.9290	0.9330	0.9370	0.9400	0.9460
0.9510	0.9550	0.9580	0.9600	0.9660
0.9690	0.9730	0.9760	0.9790	0.9830
0.9860	0.9890	0.9920	0.9950	0.9980
1.0000				

Approximately 50 %
of the total rainfall
occurs within a 1.8
hour time increment
From hour 11.1 to 12.9

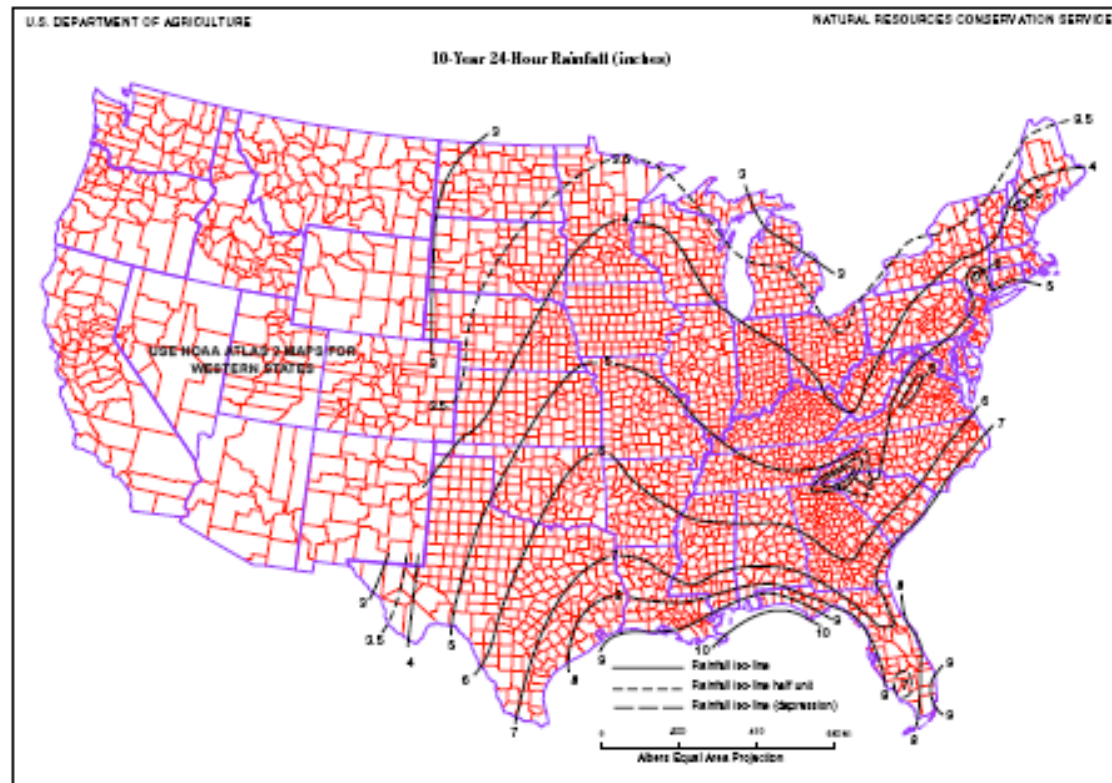
The Majority of the Precipitation Falls between hours 11.00 and 13.00

Incremental Change in Precipitation vs. Time for Type III Distribution and 5.00 Inches Precipitation



Precipitation Rates as shown on Isopluvial Maps

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



These maps are contained within Appendix B of the Tr-55 Manual for Storm Frequencies of 2, 5, 10, 25, 50 and 100 year return periods.

Comparison of Previous vs. Newly Adopted 24 Hour Design Storm Rainfall Depths

NRCS 24 hr Design Storm Rainfall Depths Revised September 2004, 2nd revision

SSCC - NJDA - SCD

Storm Period County	1 yr		2 yr		5yr		10yr		25yr		50yr		100yr	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Atlantic	2.8	2.8	3.5	3.3	4.5	4.3	5.5	5.2	6.2	6.5	6.8	7.6	7.6	8.9
Bergen	2.7	2.8	3.3	3.3	4.3	4.3	5.3	5.1	5.7	6.3	6.5	7.3	7.5	8.4
Burlington	2.8	2.8	3.4	3.4	4.4	4.3	5.3	5.2	6.0	6.4	6.6	7.6	7.4	8.8
Camden	2.8	2.8	3.4	3.3	4.4	4.3	5.3	5.1	5.9	6.3	6.6	7.3	7.4	8.5
Cape May	2.9	2.8	3.5	3.3	4.6	4.2	5.6	5.1	6.3	6.4	6.9	7.5	7.7	8.8
Cumberland	2.8	2.8	3.4	3.3	4.5	4.2	5.4	5.1	6.0	6.4	6.8	7.5	7.5	8.8
Essex	2.7	2.8	3.3	3.4	4.3	4.4	5.3	5.2	5.7	6.4	6.4	7.5	7.5	8.7
Gloucester	2.8	2.8	3.4	3.3	4.4	4.2	5.3	5.0	5.9	6.2	6.6	7.3	7.4	8.5
Hudson	2.7	2.7	3.3	3.3	4.3	4.2	5.3	5.0	5.7	6.2	6.4	7.2	7.5	8.3
Hunterdon	2.6	2.9	3.2	3.4	4.2	4.3	5.0	5.0	5.7	6.1	6.5	7.0	7.3	8.0
Mercer	2.7	2.8	3.3	3.3	4.3	4.2	5.2	5.0	5.8	6.2	6.4	7.2	7.5	8.3
Middlesex	2.7	2.8	3.3	3.3	4.3	4.3	5.2	5.1	5.9	6.4	6.4	7.4	7.5	8.6
Monmouth	2.8	2.9	3.4	3.4	4.4	4.4	5.3	5.2	6.0	6.5	6.5	7.7	7.5	8.9
Morris	2.6	3.0	3.3	3.5	4.3	4.5	5.2	5.2	5.7	6.3	6.5	7.3	7.5	8.3
Ocean	2.8	3.0	3.5	3.4	4.5	4.5	5.4	5.4	6.2	6.7	6.6	7.9	7.5	9.2
Passaic	2.6	3.0	3.3	3.5	4.3	4.4	5.4	5.3	5.7	6.5	6.5	7.5	7.6	8.7
Salem	2.8	2.8	3.3	3.3	4.4	4.2	5.3	5.0	5.9	6.2	6.6	7.3	7.4	8.5
Somerset	2.7	2.8	3.3	3.3	4.3	4.3	5.2	5.0	5.7	6.2	6.5	7.2	7.5	8.2
Sussex	2.6	2.7	3.2	3.2	4.2	4.0	5.0	4.7	5.7	5.7	6.6	6.6	7.5	7.6
Union	2.7	2.8	3.3	3.4	4.3	4.4	5.3	5.2	5.8	6.4	6.4	7.5	7.5	8.7
Warren	2.6	2.8	3.2	3.3	4.1	4.2	4.9	4.9	5.6	5.9	6.5	6.8	7.2	7.8

The values contained within this table correspond to the "contours" on the Isopluvial Maps shown on the previous slide.

Comparison of Runoff Hydrographs between the different Rainfall Distributions

Lets examine an example:

Drainage area = 25.00 Acres

Runoff Curve Number = 74

Time of Concentration = 0.75 Hours

Q_{Peak} Type I = 20.03 cfs @ 10.32 Hours

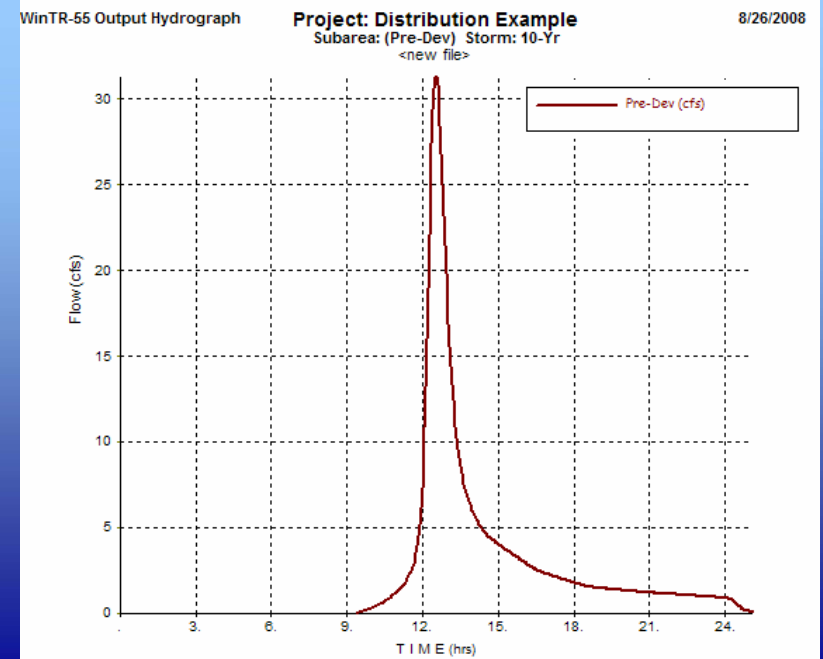
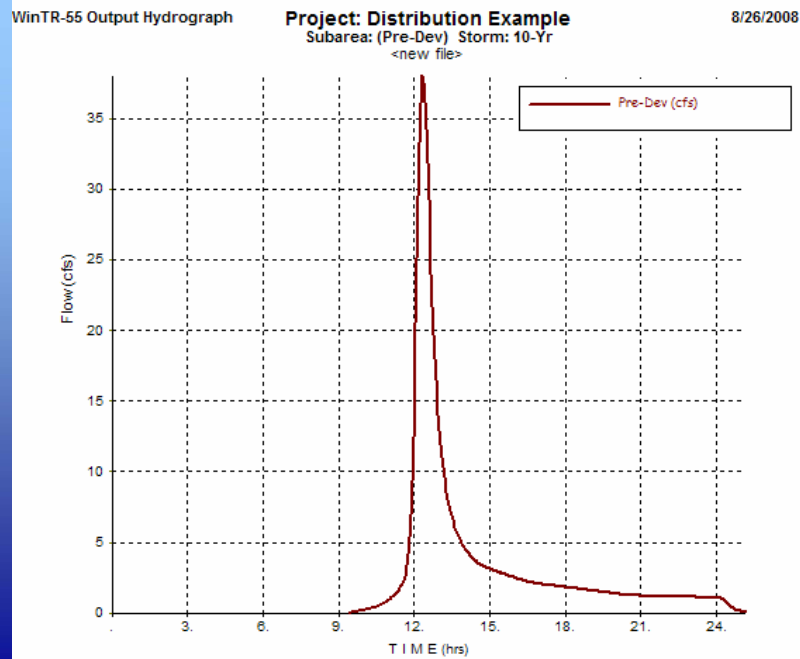
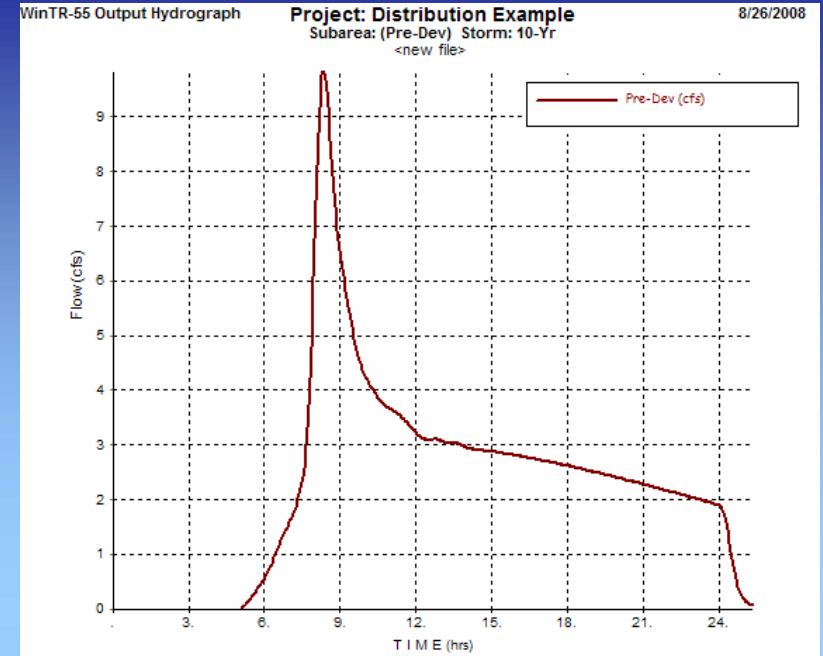
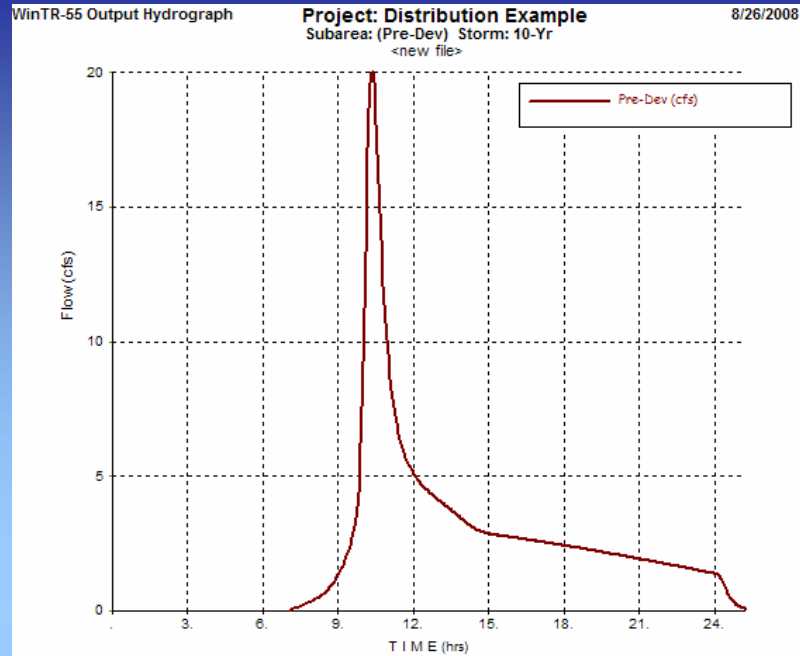
Q_{Peak} Type IA = 9.84 cfs @ 8.33 Hours

Q_{Peak} Type II = 38.07 cfs @ 12.36 Hours

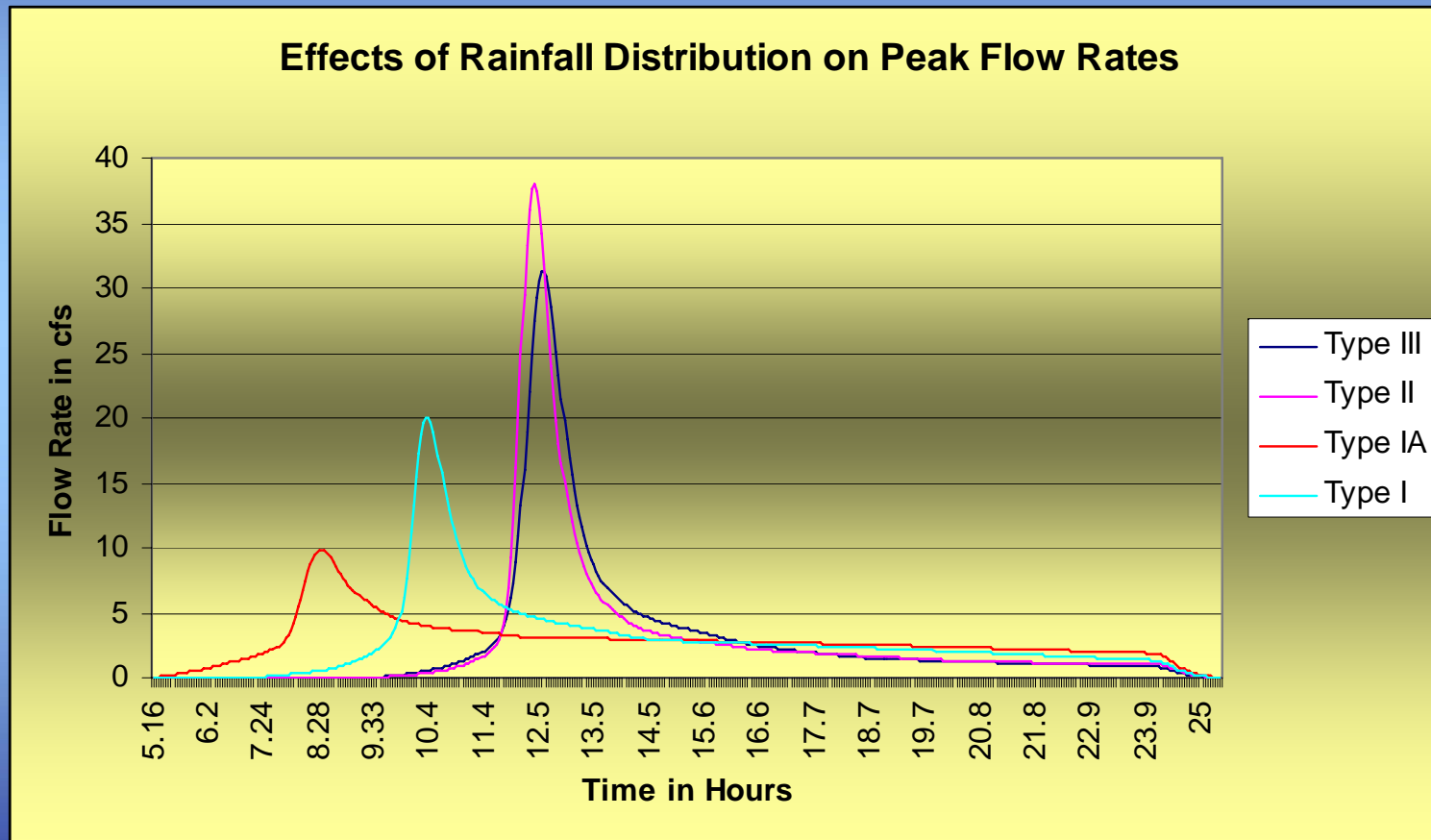
Q_{Peak} Type III = 31.36 cfs @ 12.55 Hours

The range of the peak rates goes from 9.84 cfs 38.07 cfs or 28.23 cfs. The range in the time to peak goes from 8.33 Hours to 12.55 Hours or 4.22 Hours

Runoff Hydrographs Generated from WinTr-55 Software for Each Distribution

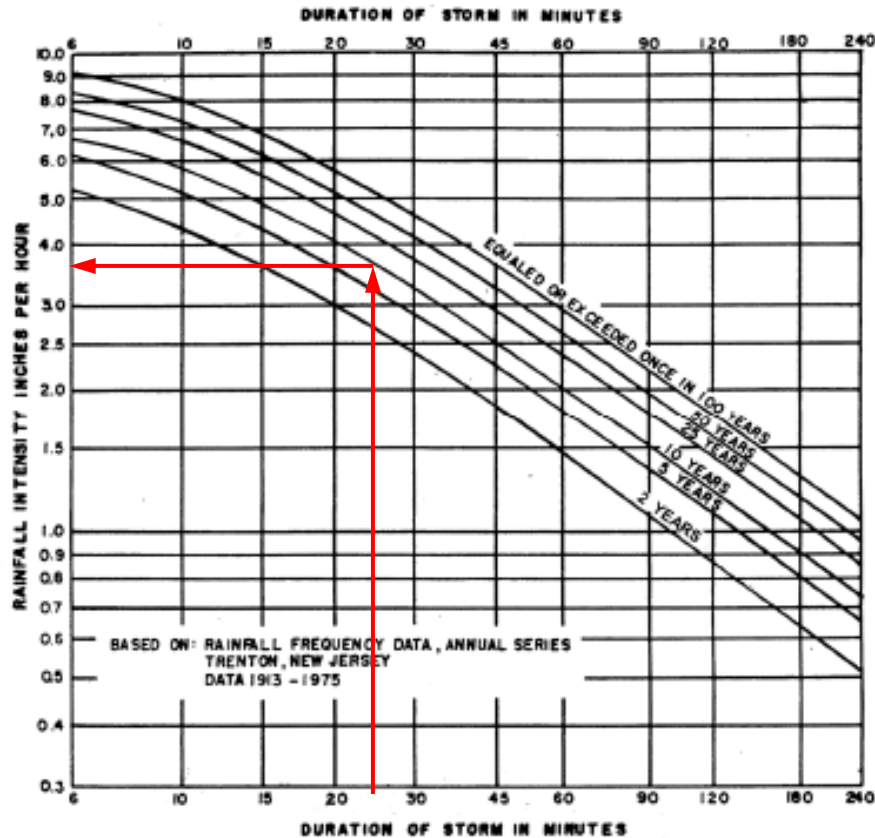


Comparison of Hydrographs generated from different Rainfall Distributions



I-D-F Curves for use with the Rational and Modified Rational Method

Figure 5-4: Rainfall Intensity-Duration-Frequency Curves



Note: Adapted from Figure 2.1-2 in the NJDEP Technical Manual for Stream Encroachment Permits.

Rainfall Intensity is Obtained by:

1. Entering the “Duration of Storm in Minutes” with the computed “Time of Concentration”.
2. Intersecting the Frequency of Recurrence Curve.
3. Drawing a horizontal line to the Rainfall Intensity.

Example: Find the Rainfall Intensity in Inches per Hour for a TC of 25 min. and a 10 Year Storm Frequency.

Answer: 3.6 In/Hr