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STATE OF ILLINOIS



RAINFALL INTENSITY - FREQUENCY DATA  
FOR  
CHAMPAIGN - URBANA, ILLINOIS

BY

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ISSUED BY

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URBANA, ILLINOIS

# RAINFALL INTENSITY - FREQUENCY DATA FOR CHAMPAIGN - URBANA, ILLINOIS

by

FLOYD A. HUFF\*

The purpose of this investigation was to determine the intensity and frequency of excessive precipitation rates at Urbana. Such data have important application in the design of engineering systems, such as municipal storm-sewers, where run-off from storm rainfall must be provided for. Such data are available for only a few stations in Illinois, and have not been determined for a station in the East-Central portion of the State. Frequency-intensity data now available is contained in Yarnell's study (4), which covers the whole nation, and includes Chicago, LaSalle, Peoria, Springfield, and Cairo, in Illinois.

Excessive precipitation rates for short-period, high intensity storms were based upon the U.S. Weather Bureau (1) formula;

$$R = 0.01 (t + 20)$$

where: R is rainfall in inches and t is time in minutes.

Excessive rates then correspond to a minimum of 0.25, 0.30, 0.35, 0.50, 0.80, and 1.40 inches in 5, 10, 15, 30, 60, and 120 minutes respectively.

Tipping bucket records from the weather station at the University of Illinois for the 32-year period, 1916-47, were used in the analysis. This station was operated by the Agronomy Department, College of Agriculture until 1948, when the State Water Survey was given responsibility for the station. Complete records were available only for April through October of each year, the gage normally being disconnected during the November-March period due to freezing weather. However short-period excessive rainfall rates rarely occur at Urbana during

this period, so the intensities and frequencies should be approximately representative of annual occurrences also.

In cases where stick measurements exceeded the automatically recorded amounts, the tipping bucket record was corrected by distributing the difference in proportion to the recorded intensities. Sometimes, due to the dense packing of the tipping bucket recorder impulses during short periods of exceptionally high intensities, the actual intensity could be determined only by subtracting the totals for the periods of lower, readable intensities from the total measured by stick gage.

Tables 1-4 and Figure 1 summarize the results of this analysis. Maximum point rainfall for other stations in Illinois used in Table 4 was obtained from published data (2).

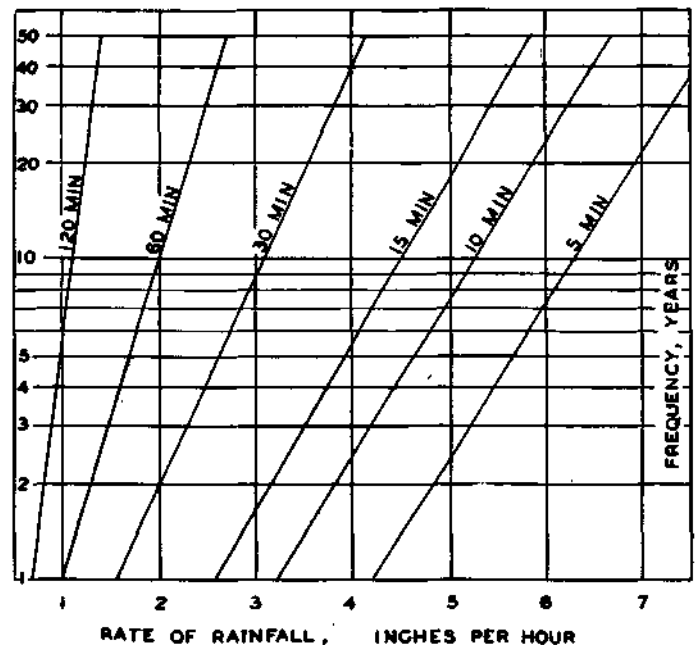


Fig. 1 Frequency of excessive precipitation rates.

(Based on 1916-1947 records)

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Tables 5-7 show the results of a second analysis using another U.S. Weather Bureau classification of excessive precipitation (3), namely, 1.0 inch or more in one hour and 2.5 inches or more in 24 hours. Tables 5 and 6 are based on the 1916-47 tipping bucket records. In Table 7, the classification of 2.5 inches per 24 hours is extended through a 60-year period, 1889-1948, by utilizing 12-hour stick gage measurements. The two highest consecutive 12-hour amounts were taken as the 24-hour maximum amount. Study of the data indicated any error introduced by this method would be relatively small. Most of the heavy storms were spanned by two consecutive 12-hour measurements. When the storms were not completely enclosed by two consecutive 12-hour measurements, the amounts beyond this period were usually insufficient to materially affect the results. Table 8, showing the frequency of various 24-hour amounts, was obtained in the same manner as Table 7.

The data show that short-period excessive rainfall rates occur with the greatest frequency from June through August, when thunderstorm activity is normally most frequent (Table 1). Durations of excessive rates beyond one hour were relatively infrequent during the 32 years studied. Two hour excessive rates averaged less than one per year.

The greatest number of excessive rates in any one month was four (Table 2). These occurred for 10, 15, and 30 minute periods

in August, 1918, July, 1938 and June, 1940. In two other years, 1924 and 1931, there were four occurrences of excessive 10 and 15-minute rates in June. The greatest number of excessive rates in a single year took place in 1938 (Table 3), when eleven excessive 15-minute rates were recorded. Three of these were in June, four in July, and three in August. Ten of these storms gave excessive rates for 30 minutes, two for one hour, and one for two hours. In 1926 there were eight cases of excessive one-hour rates from May through October. Four of these exceeded one inch in one hour, but in only one case did the excessive rate continue for two hours.

Values along the frequency curves in Figure 1 are slightly lower than those shown for the local area on Yarnell's U.S. frequency maps (4). In general, the difference is less than 10 per cent, and may be the result of deficient catch due to local turbulence set up by trees and buildings in the vicinity of the raingage.

#### REFERENCES

1. Report of the Chief of the Weather Bureau for 1929, 1930, p. 58.
2. Weather Bureau Technical Paper No. 2, Maximum Recorded U.S. Rainfall, April, 1947.
3. H. D. Dyck and W. A. Mattice, A Study of Excessive Rainfall, Monthly Weather Review, V. 69, October, 1941.
4. D. L. Yarnell, Rainfall Intensity-Frequency Data, U.S. Dept. of Agriculture Misc. Pub. No. 204, August, 1935.

TABLE 1

Excessive Rainfall, Monthly Totals, 1916-47

Month	5 Min.	10 Min.	15 Min.	30 Min.	1 Hour	2 Hours
April	2	3	3	3	2	1
May	9	15	14	13	10	2
June	25	37	37	32	16	8
July	14	29	28	21	15	2
August	20	37	39	35	23	7
September	12	17	20	20	14	5
October	2	5	7	7	4	1
Total	84	143	148	131	84	26
Ave. Number per Year	2.6	4.5	4.7	4.1	2.6	0.8

TABLE 2

Maximum Number Excessive Rainfalls, Any One Month, 1916-47

Month	5 Min.	10 Min.	15 Min.	30 Min.	1 Hour	2 Hours
April	1	1	1	1	1	1
May	2	3	3	3	3	1
June	3	4	4	4	2	1
July	2	4	4	4	3	1
August	2	4	4	4	3	1
September	3	3	3	3	2	1
October	1	1	1	1	1	1

TABLE 3

Maximum Number Excessive Rainfalls, Any One Year, 1916-47

	5 Min.	10 Min.	15 Min.	30 Min.	1 Hour	2 Hours
Number	7	9	11	10	8	3
Year	1927	1938	1938	1938	1926	1927, 1931

TABLE 4

Maximum Recorded Rainfall (Inches)

	5 Min.	10 Min.	15 Min.	30 Min.	1 Hour	2 Hours	3 Hours	6 Hours	12 Hours	24 Hours
Urbana	0.62	1.08	1.39	1.90	2.48	2.55	2.55	3.22	4.10	4.61
Date	7/8/42	6/22/31	6/22/31	6/22/31	6/30/31	6/30/31	6/30/31	11/2/36	5/25/21	5/25/21
Cairo	0.63	1.01	1.33	1.89	3.15	3.67	3.86	5.40	5.40	5.69
Date	7/7/15	7/1/34	7/30/13	8/12/35	6/28/05	6/28/05	6/28/05	3/13/38	3/13/38	10/3/10
Springfield	0.66	1.23	1.41	2.12	2.75	3.01	3.20	3.93	5.94	5.94
Date	7/23/17	7/23/17	7/23/17	7/23/17	7/16/12	9/8/26	9/8/26	6/4/17	6/4/17	6/4/17
Peoria	0.73	0.95	1.26	2.10	2.60	3.18	3.32	4.33	4.33	5.52
Date	8/17/25	8/17/25	7/2/31	7/2/31	7/2/31	9/10/11	9/10/11	5/18/27	5/18/27	5/18/27
Chicago	0.64	1.11	1.31	1.81	2.81	3.67				6.19
Date	7/15/06	9/13/36	9/13/36	9/13/36	7/6/43	7/6/43				8/2/85

TABLE 5

Number of Rainfalls 1.0 Inch or Greater in One Hour.  
1916-47

Month	Number	Maximum (Inches)	Day	Year
April	1	1.40	17	1922
May	4	1.68	17	1943
June	10	2.48	30	1931
July	7	1.97	8	1942
August	10	1.41	20	1924
September	7	1.32	7	1941
October	1	1.06	13	1926

TABLE 6

Number of Rainfalls 2.5 Inches or Greater in 24 Hours.  
1916-47

Month	Number	Maximum (Inches)	Day	Year
April	1	3.07	11	1944
May	2	4.61	25	1921
June	5	3.35	10	1939
July	2	2.68	13	1927
August	6	4.20	20	1924
September	4	4.07	14	1931
October	2	2.58	27	1947

TABLE 7

24-Hour Precipitation of 2.5 Inches or Greater, 1889-1948

Month	Number	Maximum (Inches)	Day	Year
January	0	2.12	7	1937
February	0	1.78	25	1936
March	5	4.09	11	1939
April	1	3.07	11	1944
May	5	4.61	5	1921
June	7	3.35	10	1939
July	5	3.18	10	1897
August	10	4.20	20	1924
September	7	4.07	14	1931
October	2	2.58	27	1947
November	2	4.14	2	1936
December	1	2.97	13	1901
Total	45			

TABLE 8

Frequency of 24-Hour Precipitation  
Equal to or Greater than 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 Inches  
1889-1948

Month	Number of Occurrences					
	2.0"	2.5"	3.0"	3.5"	4.0"	4.5"
January	1	0	0	0	0	0
February	0	0	0	0	0	0
March	11	5	1	1	1	0
April	6	1	1	0	0	0
May	9	5	2	1	1	1
June	16	7	2	0	0	0
July	9	5	3	0	0	0
August	14	10	6	2	1	0
September	15	7	5	1	1	0
October	5	2	0	0	0	0
November	3	2	1	1	1	0
December	2	1	0	0	0	0
Total	91	45	21	6	5	1