How Recent Rainfall Events Compare to Bulletin 70

Megan Elberts, PE, CFM
Christopher B Burke Engineering, Ltd

Presentation Outline

- Background on Precipitation Data Used in Northeastern Illinois
- Recent Rainfall Events
- Analysis Methods
- Analysis Results
- Future Work

Background on Precipitation Data Used in Northeastern Illinois

Technical Paper 40

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

- Period of Record
  - An average of 14-48 years
  - Generally through 1958 (54 years ago!)

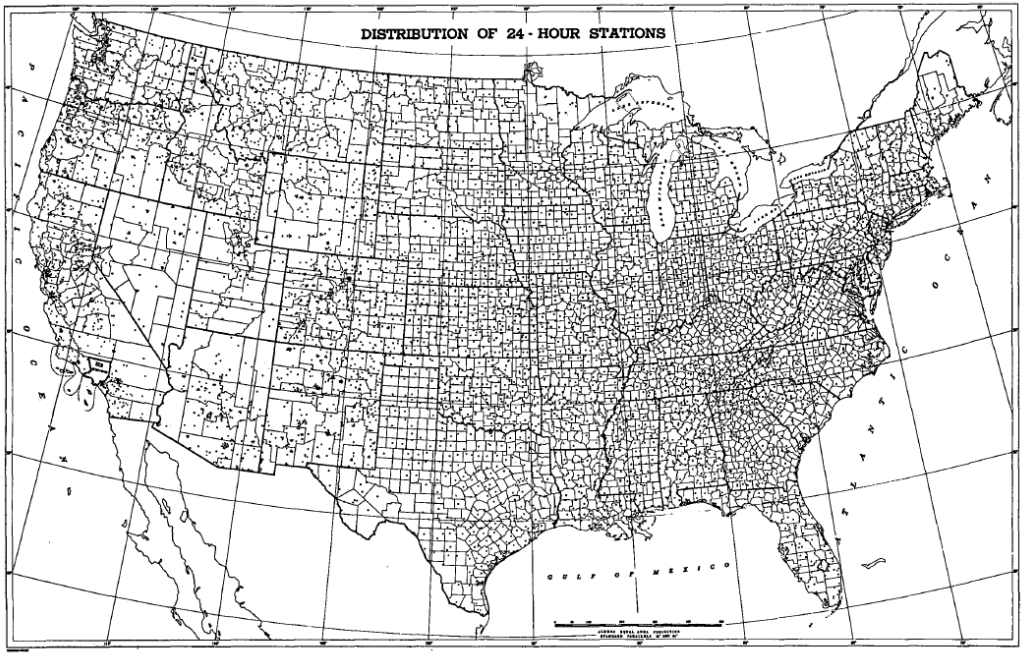

FIGURE 9.—Distribution of 24-hour stations.

TABLE 1.—*Sources of point rainfall data*

Duration	No. of stations	Average length of record (yr.)	Reference No.
30-min. to 24-hr.	200	48	8, 9, 10
Hourly	2081	14	11, 12
Daily (recording)	1350	16	11, 12
Daily (nonrecording)	3409	15	13
Daily (nonrecording)	1426	47	13

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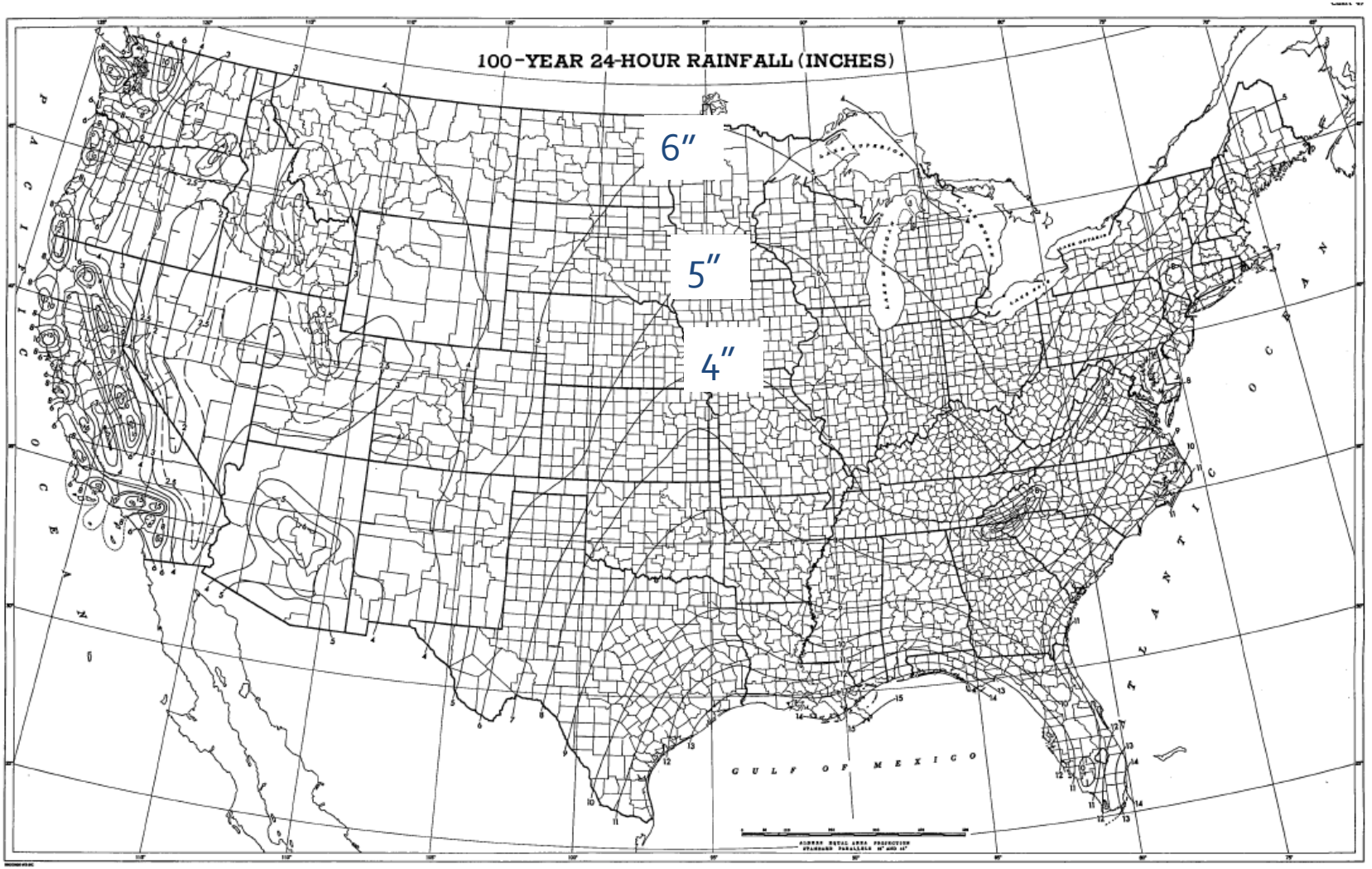

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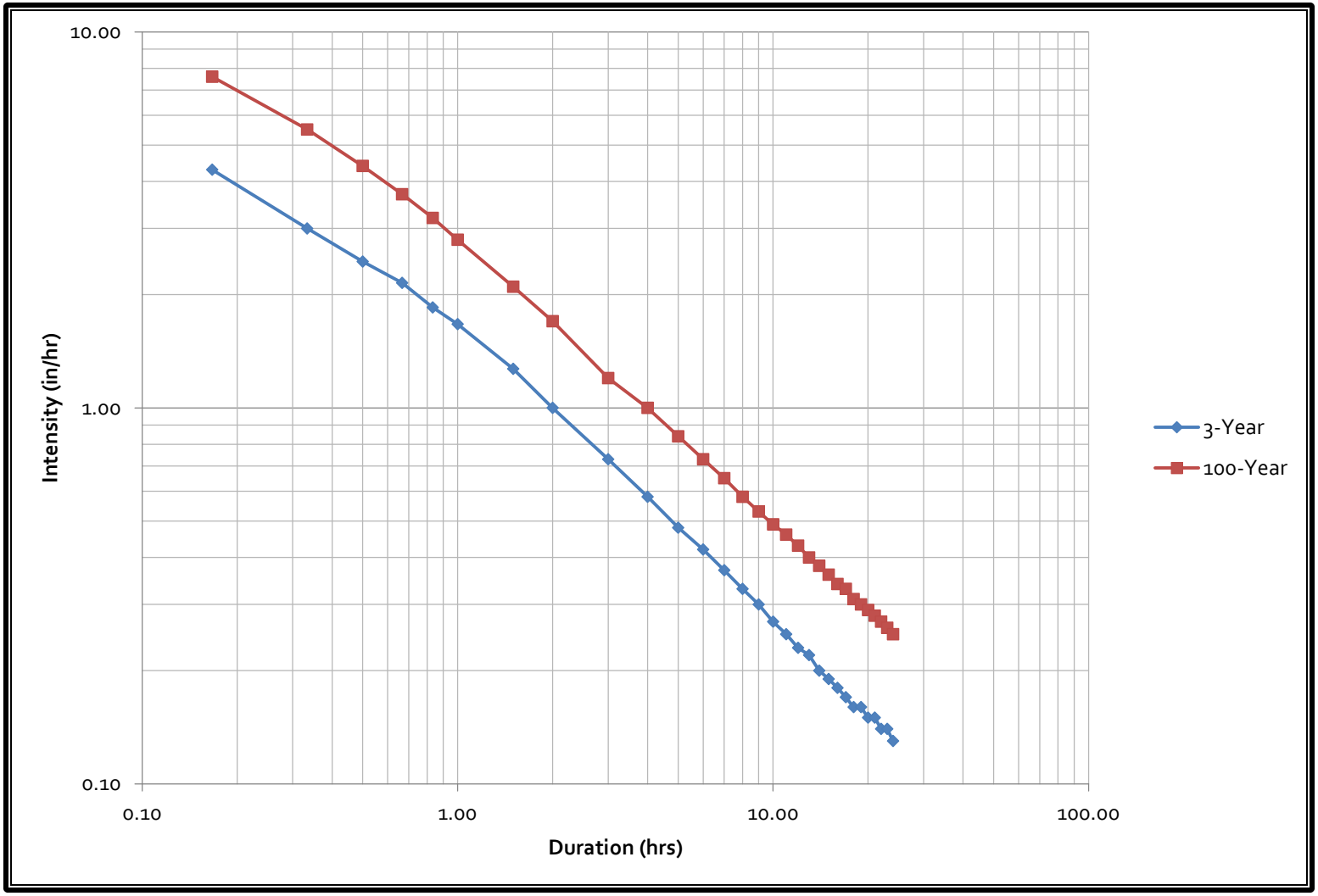
Northeastern Illinois



Technical Letter 13

- Published in 1970 by the Illinois State Water Survey
- Presents rainfall frequency data presented in Technical Letter 1 (February 1959) & Technical Letter 4 (March 1960)

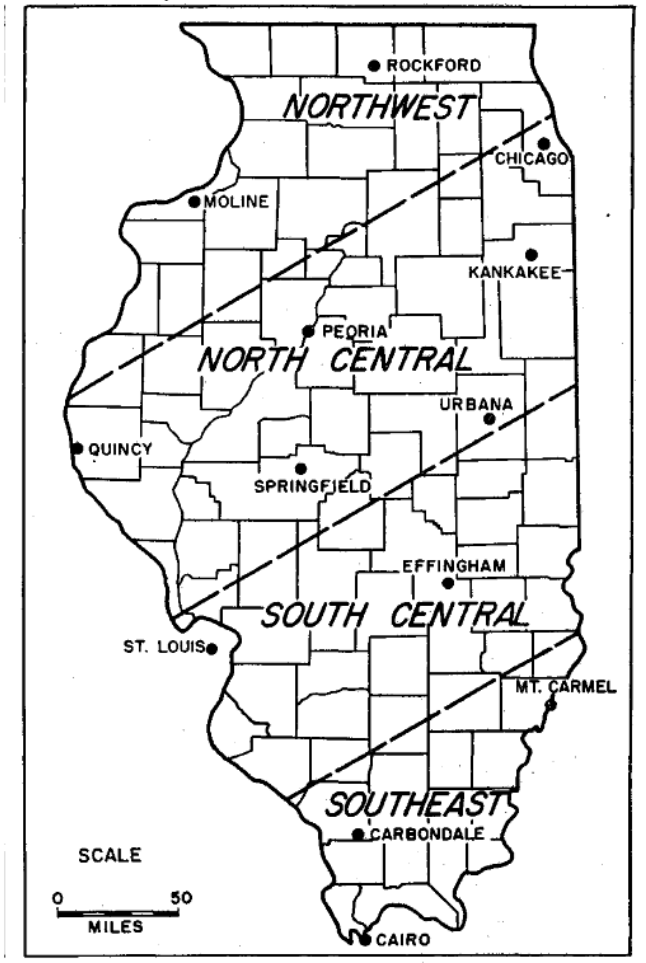


Fig. 1.- Sections of state according to rainfall frequencies

Technical Letter 13

100-year, 24-Hour Rainfall Depths

Section	Rainfall Depth (inches)
Northwest	8.4
North Central	7.2

TABLE 3

AVERAGE RAINFALL FREQUENCY FOR STORM PERIODS OF 1 TO 10 DAYS

Northwest Section

Average Recurrence Interval (years)	Depth (inches) for Given Storm Periods (days) 1	2	3	5	10
2	2.6	2.9	3.1	3.5	4.2
5	3.6	3.9	4.2	4.8	5.8
10	4.4	4.8	5.3	6.0	7.1
25	5.7	6.2	6.9	7.8	9.3
50	7.2	7.5	8.4	9.4	11.4
100	8.4	9.2	10.0	11.2	13.2

North Central Section

	1	2	3	5	10
2	2.6	2.8	3.0	3.4	4.1
5	3.4	3.7	4.0	4.5	5.5
10	4.0	4.4	4.8	5.6	6.7
25	5.1	5.6	6.2	7.0	8.5
50	6.1	6.6	7.3	8.2	9.9
100	7.2	7.9	8.7	9.9	11.8

South Central Section

	1	2	3	5	10
2	2.7	3.0	3.3	3.8	4.5
5	3.7	4.0	4.4	5.2	6.3
10	4.5	4.9	5.5	6.3	7.7
25	5.8	6.3	7.0	8.0	9.8
50	7.0	7.5	8.4	9.5	11.7
100	8.4	9.1	10.0	11.5	13.9

Southeast Section

	1	2	3	5	10
2	3.2	3.4	3.7	4.2	5.2
5	4.2	4.5	4.9	5.7	6.8
10	4.9	5.4	6.0	6.8	8.1
25	6.3	6.8	7.6	8.5	10.3
50	7.3	7.9	8.6	9.7	11.7
100	8.8	9.5	10.4	11.9	14.3

Bulletin 70

- Rainfall Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois
  - Illinois State Water Survey
  - Huff, F. A., and J. R. Angel
- Published in 1989
- 61-stations
- Two 40-year periods of daily (**24-hour**) rainfall
  - 1901-1940
  - 1941-1980

Bulletin 70

Table 11. Average Ratios of X-Hour/ 24-Hour Rainfall for Illinois

Rain period (hours)	*Ratio, x-hr /24-hr*
0.08 (5 min.)	*0.12*
0.17 (10 min.)	*0.21*
0.25	*0.27*
0.50	*0.37*
1	*0.47*
2	*0.58*
3	*0.64*
6	*0.75*
12	*0.87*
18	*0.94*

Storm Duration	Ratio Used to Derive Rainfall Depth
5 Minutes	0.12
10 Minutes	0.22
15 Minutes	0.27
30 Minutes	0.37
1 Hour	0.47
2 Hours	0.59
3 Hours	0.64
6 Hours	0.75
12 Hours	0.87
18 Hours	0.92

Table 13. Sectional Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years

Storm codes

1 – 10 days
2 – 5 days
3 – 72 hours
4 – 48 hours
5 – 24 hours
6 – 18 hours
7 – 12 hours
8 – 6 hours
9 – 3 hours
10 – 2 hours
11 – 1 hour
12 – 30 minutes
13 – 15 minutes
14 – 10 minutes
15 – 5 minutes

Sectional (zone) codes

1 – Northwest
2 – Northeast
3 – West
4 – Central
5 – East
6 – West Southwest
7 – East Southeast
8 – Southwest
9 – Southeast
10 – South

Rainfall (inches) for given recurrence interval

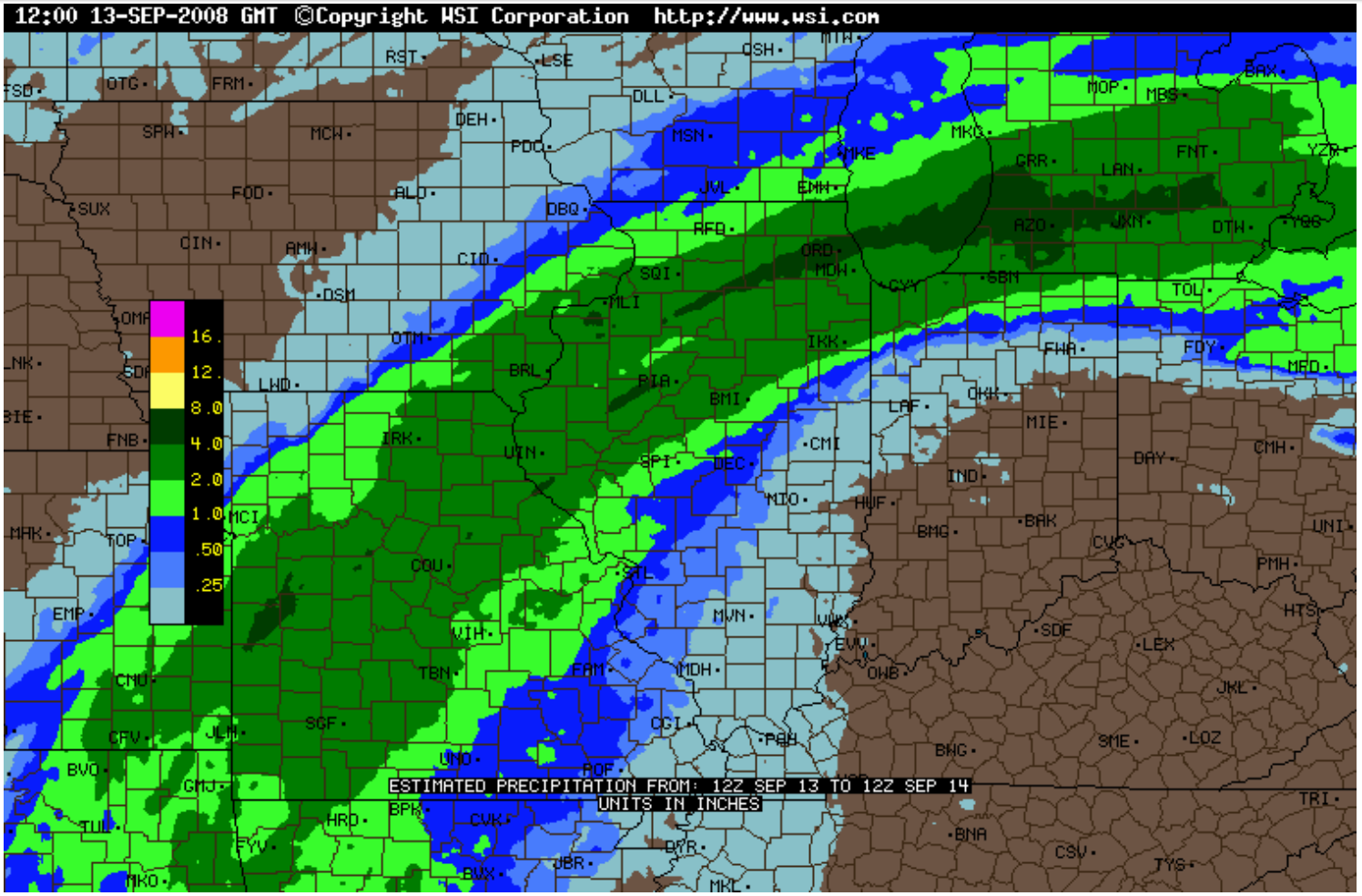
Storm code	Zone code	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
1	1	2.14	2.60	2.97	3.50	4.02	4.37	5.23	6.30	7.14	8.39	9.64	11.09
1	2	2.02	2.48	2.80	3.30	3.79	4.12	4.95	6.04	6.89	8.18	9.38	11.14
1	3	2.27	2.78	3.13	3.68	4.23	4.60	5.60	6.91	7.89	9.24	10.36	11.90
1	4	2.10	2.58	2.92	3.43	3.93	4.29	5.12	6.27	7.10	8.19	9.10	10.18
1	5	2.13	2.62	2.96	3.48	4.00	4.35	5.15	6.21	6.97	8.04	8.90	9.92
1	6	2.16	2.65	2.99	3.52	4.05	4.40	5.35	6.62	7.45	8.66	9.79	11.26
1	7	2.30	2.80	3.16	3.70	4.27	4.64	5.58	6.80	7.61	8.66	9.70	10.87
1	8	2.22	2.74	3.09	3.63	4.18	4.54	5.54	6.80	7.80	9.20	10.44	11.81
1	9	2.30	2.88	3.23	3.80	4.33	4.75	5.74	7.09	8.07	9.54	10.68	11.79
1	10	2.55	3.15	3.58	4.21	4.84	5.26	6.36	7.81	8.90	10.34	11.36	12.50
2	1	1.76	2.12	2.38	2.76	3.17	3.45	4.13	5.10	5.91	7.21	8.36	9.97
2	2	1.66	1.98	2.24	2.60	2.99	3.25	3.93	4.91	5.70	6.93	8.04	9.96
2	3	1.92	2.30	2.56	2.97	3.41	3.71	4.57	5.80	6.65	7.90	8.95	10.50
2	4	1.77	2.12	2.37	2.78	3.20	3.48	4.17	5.11	5.84	6.96	7.98	9.21
2	5	1.75	2.10	2.37	2.75	3.15	3.42	4.12	4.96	5.67	6.76	7.65	8.78
2	6	1.77	2.13	2.39	2.78	3.19	3.47	4.19	5.32	6.20	7.44	8.53	9.93
2	7	1.85	2.22	2.50	2.90	3.31	3.63	4.34	5.33	6.11	7.28	8.37	9.65
2	8	1.85	2.21	2.49	2.90	3.31	3.62	4.40	5.46	6.34	7.68	8.88	10.68
2	9	1.90	2.29	2.59	3.00	3.45	3.75	4.48	5.57	6.50	7.91	9.16	10.57
2	10	2.09	2.52	2.83	3.29	3.77	4.10	4.99	6.20	7.21	8.45	9.45	10.82
3	1	1.58	1.90	2.11	2.45	2.82	3.06	3.73	4.67	5.42	6.59	7.64	8.87
3	2	1.53	1.83	2.02	2.34	2.70	2.93	3.55	4.44	5.18	6.32	7.41	8.78
3	3	1.72	2.05	2.28	2.64	3.02	3.30	4.08	5.11	5.87	6.97	7.95	9.48
3	4	1.59	1.91	2.12	2.44	2.80	3.05	3.70	4.55	5.26	6.15	7.25	8.16
3	5	1.61	1.93	2.16	2.48	2.85	3.10	3.71	4.57	5.20	6.17	6.97	7.83
3	6	1.63	1.95	2.16	2.50	2.88	3.13	3.81	4.85	5.68	6.84	7.76	8.92
3	7	1.62	1.90	2.15	2.50	2.87	3.12	3.73	4.64	5.32	6.30	7.35	8.54
3	8	1.67	1.97	2.20	2.54	2.93	3.22	3.94	4.92	5.74	6.97	8.12	9.55
3	9	1.73	2.02	2.25	2.62	3.00	3.27	3.92	4.92	5.75	7.05	8.23	9.40
3	10	1.88	2.25	2.49	2.87	3.30	3.59	4.36	5.48	6.34	7.53	8.54	9.52
4	1	1.47	1.74	1.93	2.24	2.58	2.80	3.42	4.28	4.96	6.07	7.02	8.07
4	2	1.44	1.70	1.90	2.18	2.49	2.70	3.30	4.09	4.81	5.88	6.84	8.16
4	3	1.61	1.88	2.09	2.42	2.76	3.01	3.68	4.56	5.50	6.45	7.56	8.80
4	4	1.48	1.76	1.95	2.25	2.58	2.81	3.38	4.19	4.86	5.78	6.62	7.51
4	5	1.51	1.77	1.95	2.26	2.57	2.82	3.40	4.16	4.77	5.66	6.40	7.16
4	6	1.52	1.81	2.00	2.30	2.64	2.87	3.49	4.45	5.21	6.28	7.12	8.19
4	7	1.52	1.78	1.98	2.30	2.64	2.87	3.42	4.26	4.88	5.84	6.75	8.00
4	8	1.57	1.85	2.06	2.38	2.75	2.97	3.59	4.52	5.26	6.43	7.36	8.81
4	9	1.59	1.87	2.07	2.40	2.76	3.00	3.60	4.52	5.28	6.48	7.58	8.62
4	10	1.75	2.08	2.31	2.65	3.02	3.30	4.00	5.03	5.80	6.93	7.86	8.79
5	1	1.40	1.64	1.80	2.08	2.36	2.57	3.11	3.95	4.63	5.60	6.53	7.36
5	2	1.38	1.61	1.76	2.03	2.31	2.51	3.04	3.80	4.47	5.51	6.46	7.58
5	3	1.53	1.77	1.95	2.24	2.56	2.79	3.45	4.29	4.93	6.07	7.04	8.20
5	4	1.39	1.63	1.80	2.04	2.32	2.52	3.02	3.76	4.45	5.32	6.08	6.92
5	5	1.36	1.58	1.75	2.00	2.27	2.47	3.01	3.71	4.26	5.04	5.82	6.61
5	6	1.42	1.66	1.84	2.10	2.38	2.59	3.11	3.93	4.65	5.57	6.46	7.45
5	7	1.40	1.63	1.78	2.07	2.35	2.55	3.03	3.80	4.44	5.37	6.23	7.41
5	8	1.49	1.73	1.90	2.20	2.48	2.71	3.28	4.13	4.76	6.02	7.07	8.21
5	9	1.44	1.68	1.85	2.12	2.41	2.62	3.16	4.00	4.62	5.79	6.71	7.73
5	10	1.63	1.91	2.10	2.41	2.74	2.97	3.62	4.51	5.21	6.23	7.11	8.27

24 Hour Storm

100 Year, NE IL
7.58”

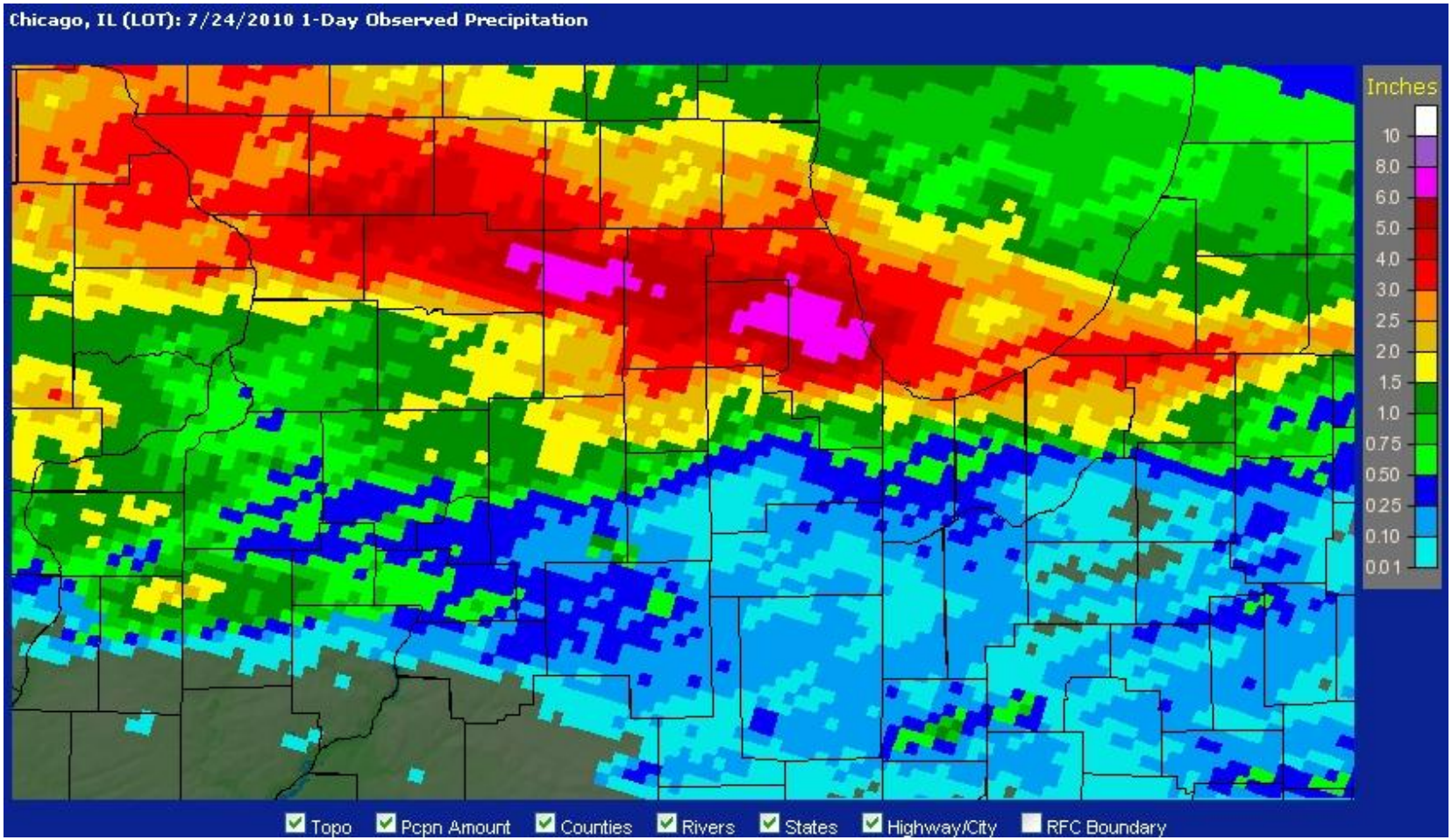
Recent Storm Events

September 2008 Storm Event



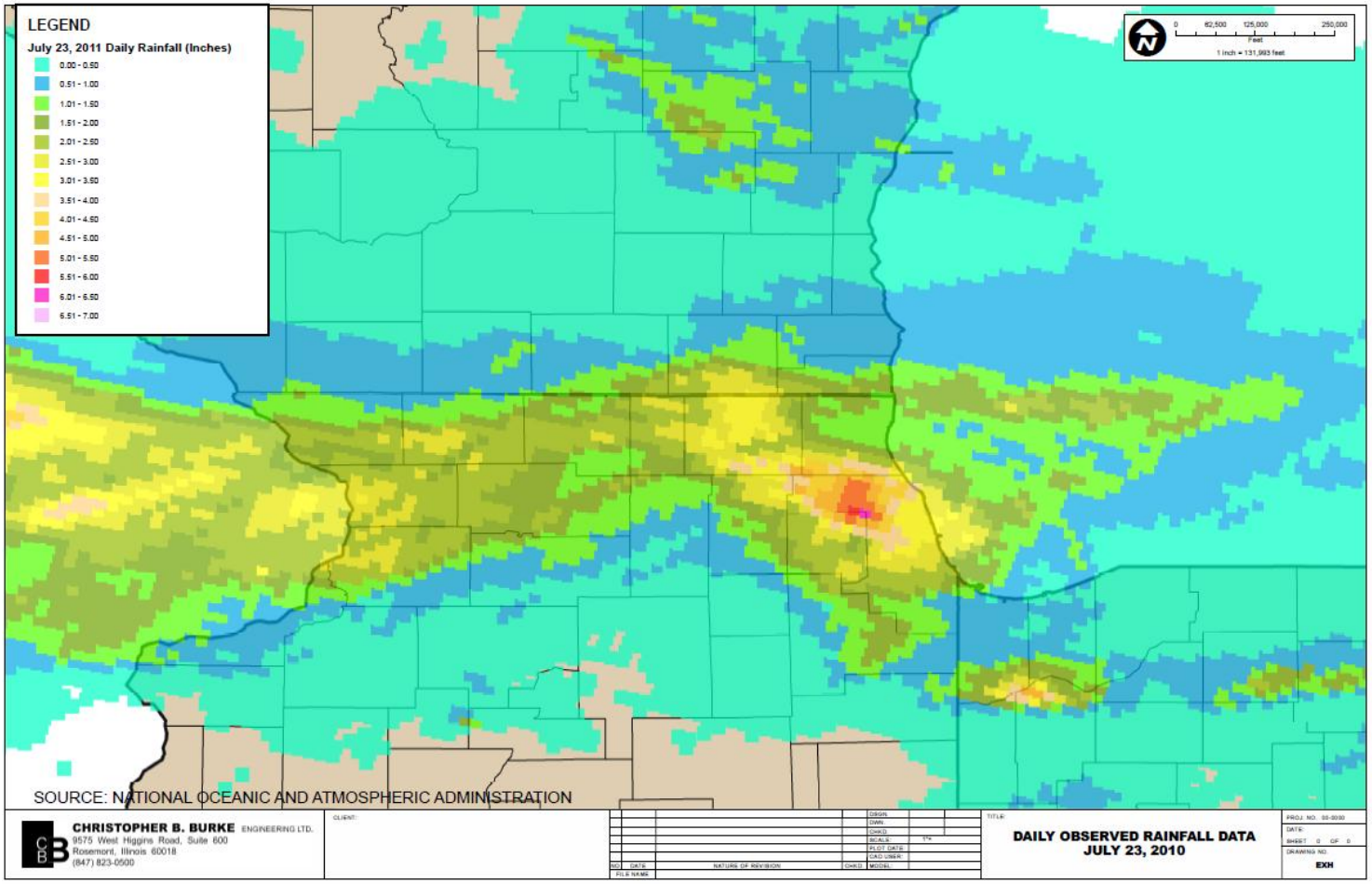
The 24-Hour Rainfall Total at O'Hare was 6.83"

July 2010 Storm Event



The 24-Hour Rainfall Total at O'Hare was 6.39"

July 2011 Storm Event



The 24-Hour Rainfall Total at O'Hare was 8.21"

Summary of Recent Events

Station	24-Hour Rainfall Depth (inches)				
	August 13-14, 1987	July 17-18, 1996	September 12-13, 2008	July 23-24, 2010	July 22-23, 2011
Argonne	1.07[a]	11.56[a]	4.03[a]		
Aurora	4.25[a]	17.04[a]	5.28[a]	2.76[c]	2.92[b]
Elgin	7.26[a]	3.24[a]	5.68[a]		
Midway	1.80[c]	8.60[c]	6.83[c]	5.70[c]	8.60[c]
O'Hare	9.35[a]	2.63[a]	6.83[a]	6.39[b]	8.21[b]
Wheaton	7.26[a]	9.52[a]	5.27[a]		
Wheeling			4.38[c]	2.99[c]	6.06[c]

Sources:

[a] Data Provided by DuPage County

[b] Data Provided by Illinois State Water Survey

[c] Data Provided by the National Climatic Data Center

[d] Data Provided by United State Geological Survey

Rainfall Analysis Methods

Methods

GUMBEL EXTREME VALUE (TYPE 1) DISTRIBUTION

$$p_t^{Tr} = \overline{p} + K_G s$$

Where

$\overline{\boldsymbol{p}}$ is the arithmetic average of the rainfall data

$\boldsymbol{K_G}$ is the Gumbel Extreme Value frequency factor

$\boldsymbol{s}$ is the standard deviation of the rainfall data

Methods

LOG PEARSON TYPE III DISTRIBUTION

$$\log(p_t^{Tr}) = \overline{y} + K_{LP3} s_y$$

Where

$\overline{y}$ is the arithmetic average of the log transformed rainfall data

K_{LP3} is the Log Pearson Type III frequency factor

s_y is the standard deviation of the log transformed rainfall data

Methods

PLOTTING POSITION FORMULA

$$T_r = \frac{N+1}{i}$$

Where

T_r is the calculated return period

i is the numerical rank of the storm event

N is the total number of storm events in the data set

Data Considerations

CALENDAR DAY

24-Hour Totals for a specific day

PARTIAL DURATION

The Top N Events in the data set

N=the number of years

24-HOUR MAXIMUM

Rolling 24-Hour Totals

Picks up storms that straddle over two calendar days

ANNUAL DURATION

The Largest Event in Each Calendar Year

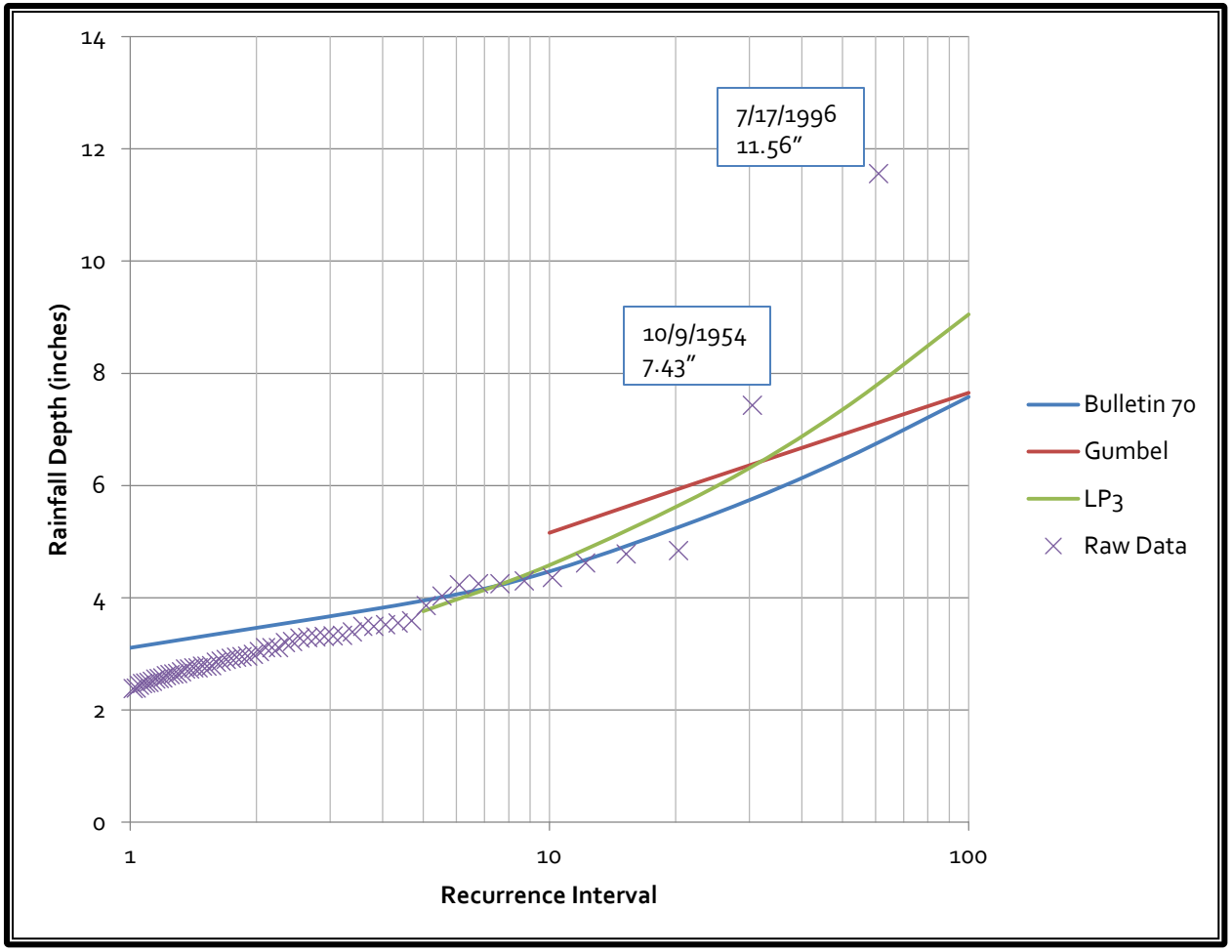
Rainfall Analysis Results

ARGONNE

Period of Record:
1948-2008

Type of Data:
Hourly

Data Provided by:
DuPage County

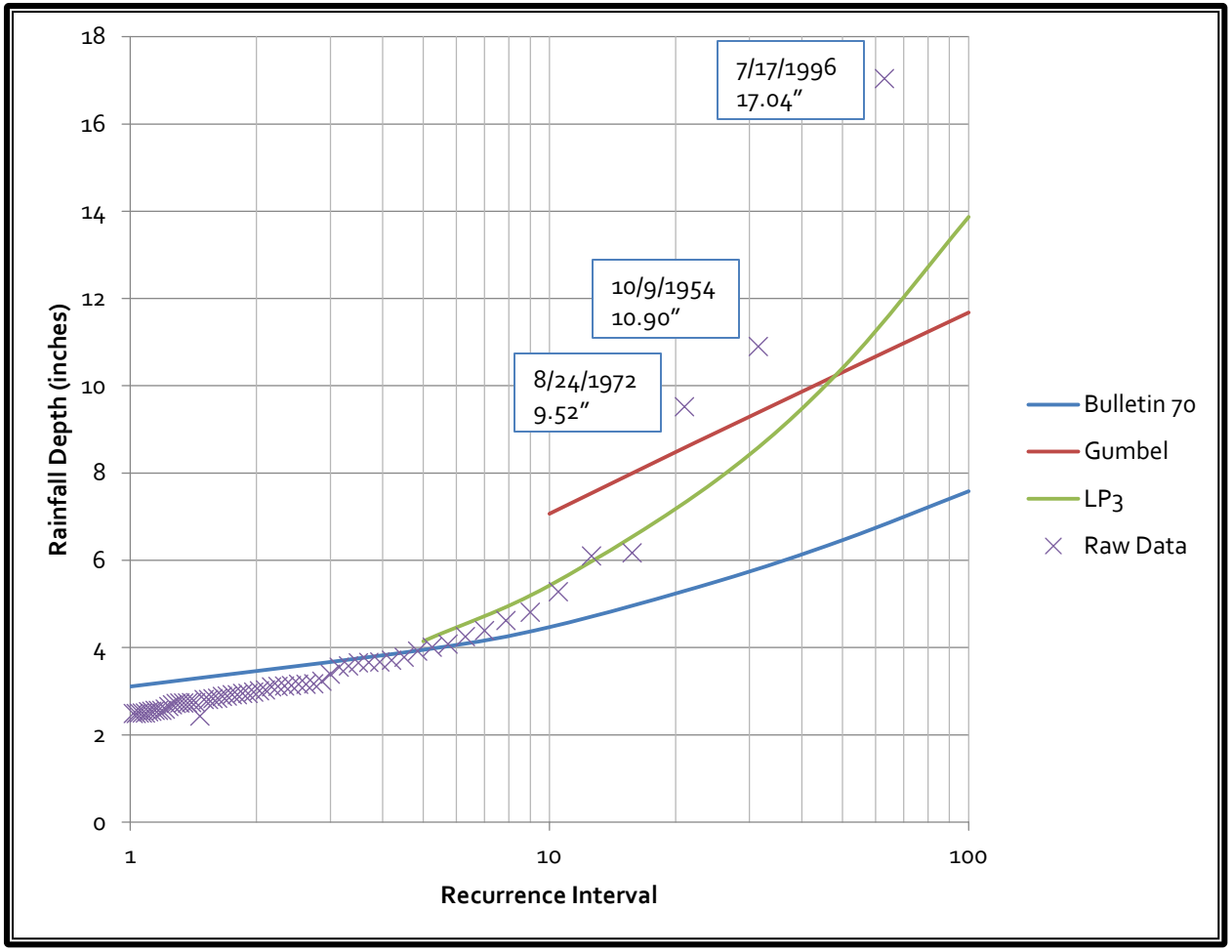


AURORA

Period of Record:
1948-2011

Type of Data:
Hourly

Data Provided by:
DuPage County &
Illinois State Water Survey –Midwest Regional Climate Center

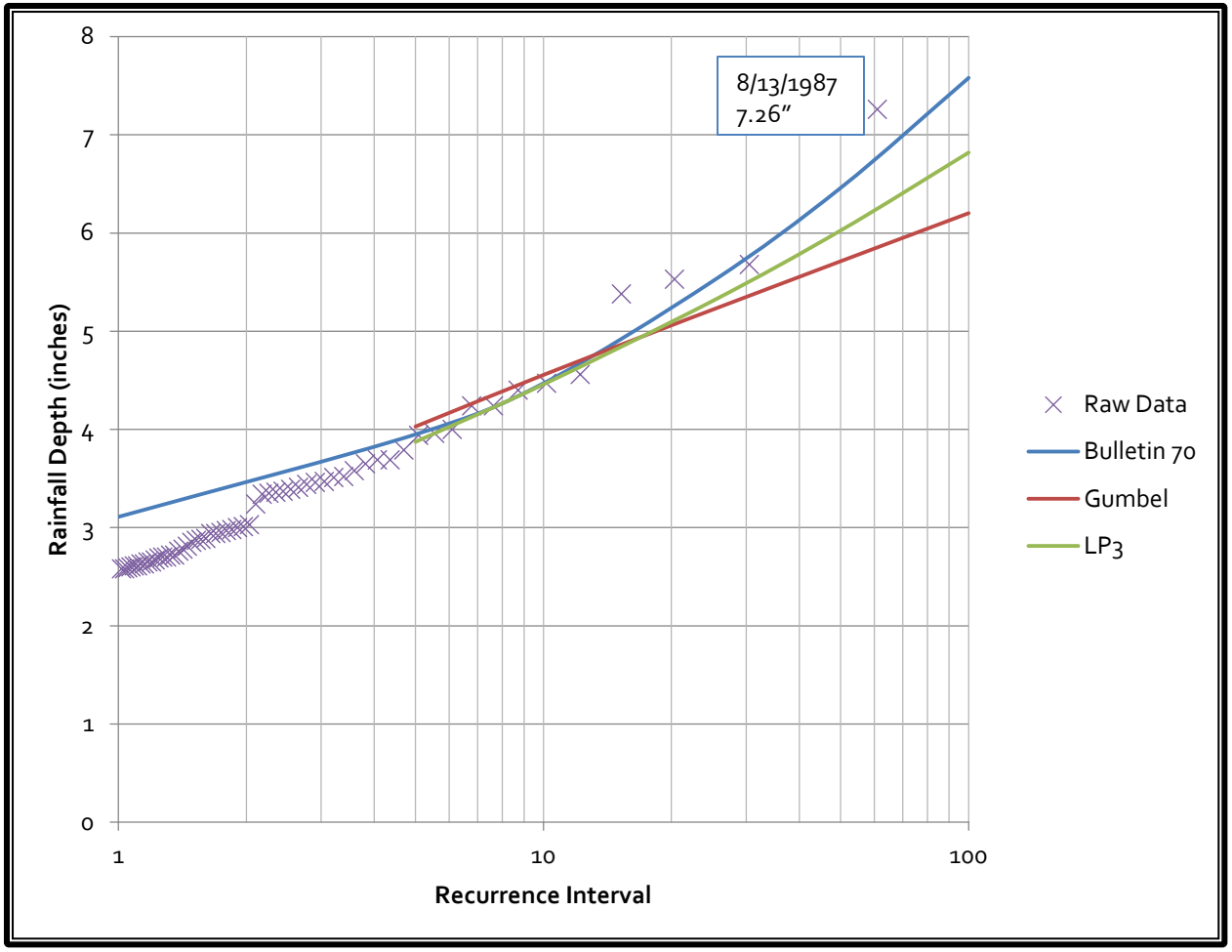


ELGIN

Period of Record:
1948-2008

Type of Data:
Hourly

Data Provided by:
DuPage County



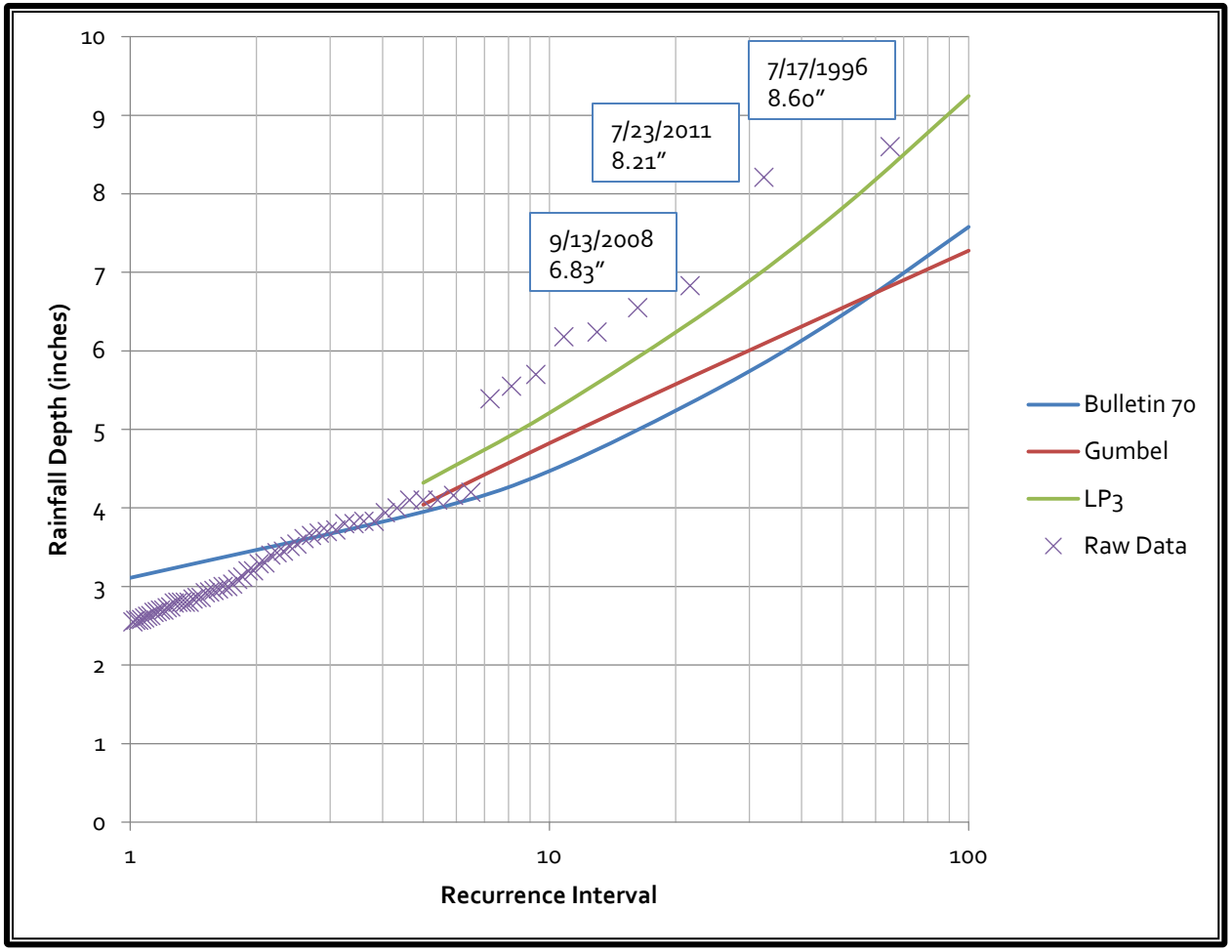
MIDWAY

Period of Record:
1948-2011

Type of Data:
Hourly

Data Provided by:
National Climatic Data Center, National Oceanic and Atmospheric Administration

Analysis by: Victor Martinez, Graduate Student of Prof. Christopher Burke at University of Illinois at Chicago (2011)

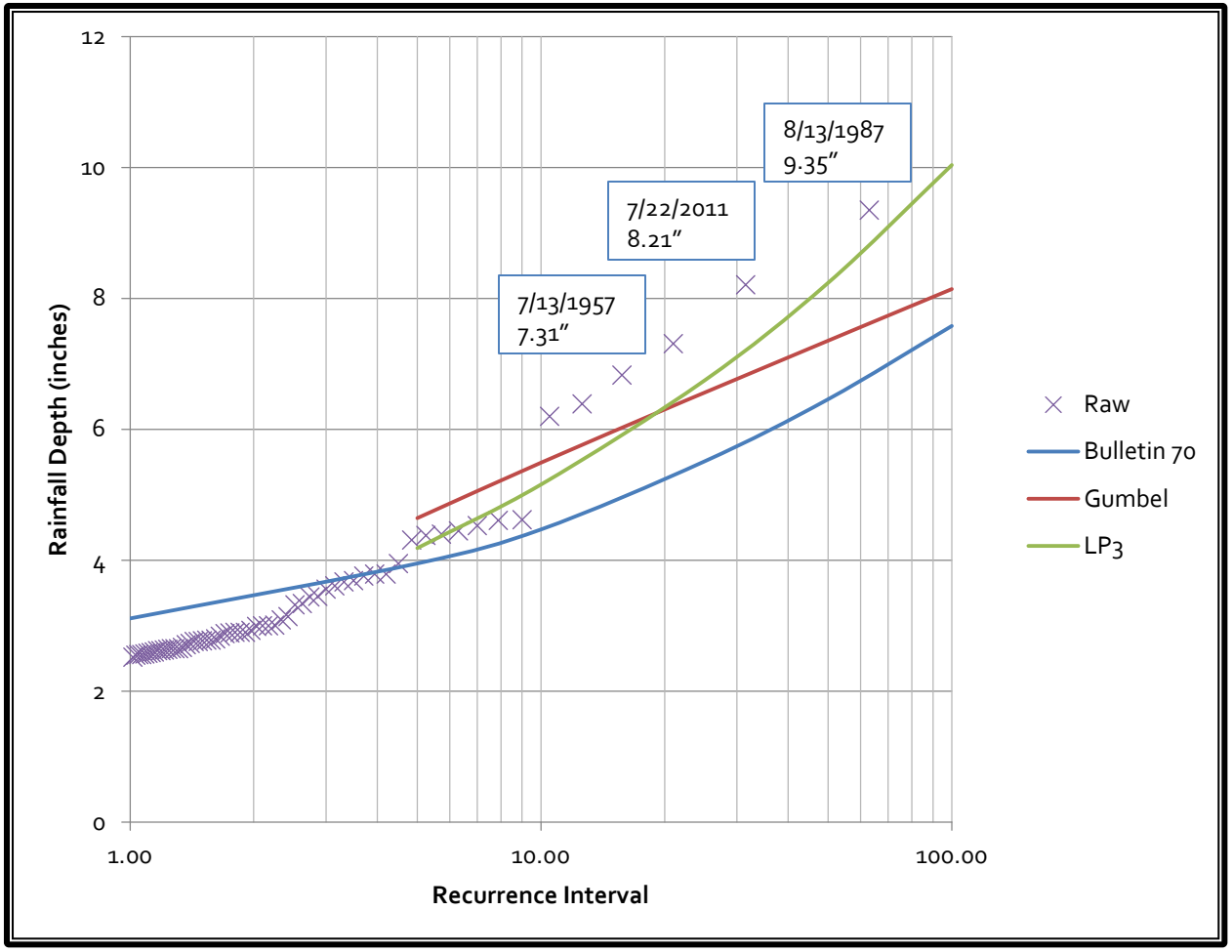


O'HARE

Period of Record:
1948-2011

Type of Data:
Hourly

Data Provided by:
DuPage County &
Illinois State Water Survey –Midwest Regional Climate Center

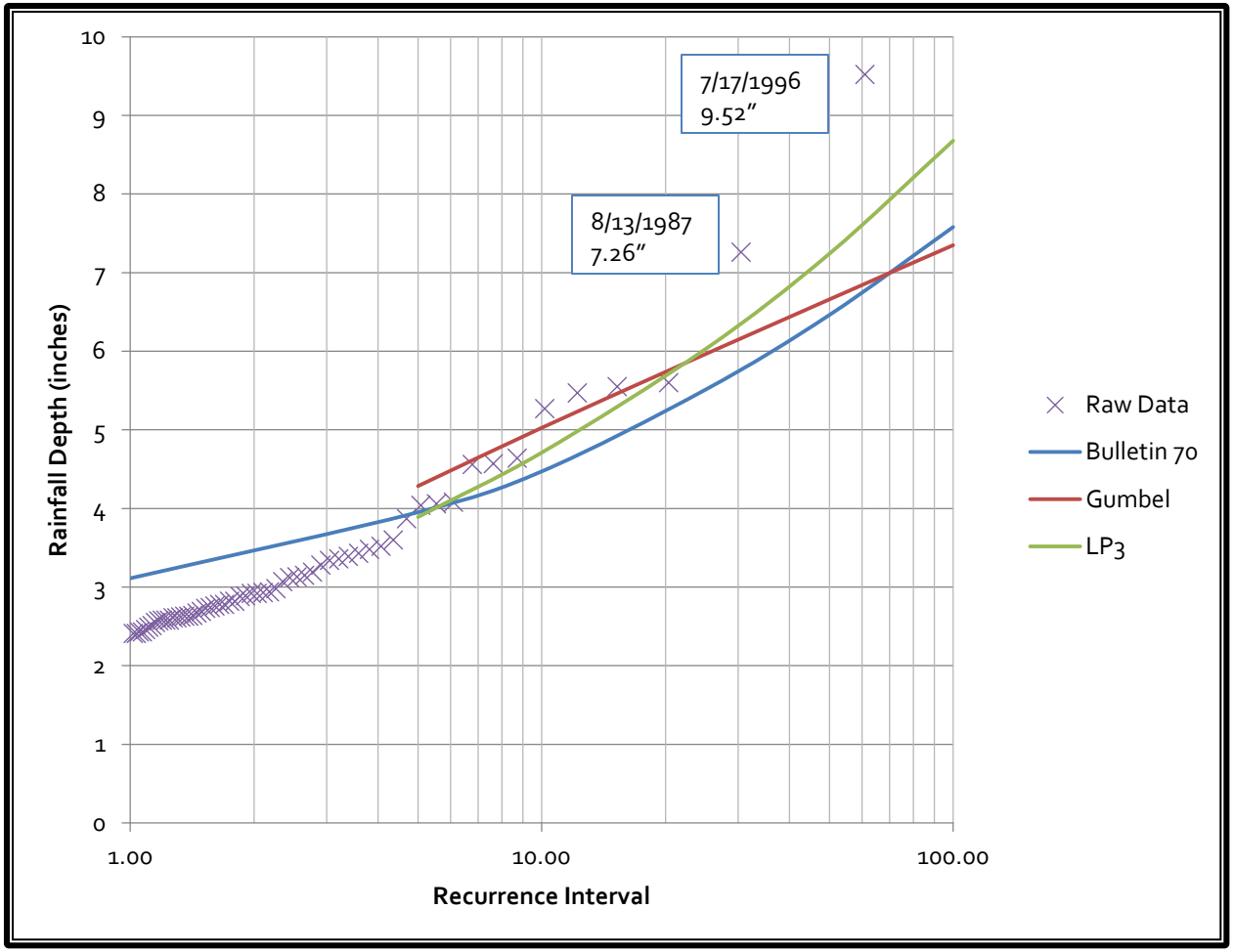


WHEATON

Period of Record:
1948-2008

Type of Data:
Hourly

Data Provided by:
DuPage County



Gumbel Analysis Summary Table

Rainfall Depth (inches)

Station	Frequency				
	5	10	25	50	100
Argonne	4.36	5.16	6.16	6.91	7.65
Aurora	4.99	7.18	9.94	11.99	14.02
Elgin	4.03	4.56	5.22	5.71	6.20
Midway	4.04	4.83	5.81	6.55	7.28
O'Hare	4.64	5.49	6.56	7.35	8.14
Wheaton	4.29	5.03	5.96	6.66	7.35
Bulletin 70	3.80	4.47	5.51	6.46	7.58

Log Pearson Type 3 Analysis Summary Table

Rainfall Depth (inches)

Station	Frequency				
	5	10	25	50	100
Argonne	3.76	4.58	5.99	7.35	9.05
Aurora	4.15	5.43	7.83	10.39	13.83
Elgin	3.87	4.46	5.31	6.03	6.82
Midway	4.32	5.21	6.59	7.82	9.25
O'Hare	4.19	5.16	6.75	8.24	10.04
Wheaton	3.89	4.71	6.03	7.24	8.68
Bulletin 70	3.80	4.47	5.51	6.46	7.58

Comparing 100-Year Events to Bulletin 70

Station	100-Year Gumbel Rainfall Depth	100-Year Log Pearson Type 3 Rainfall Depth
Argonne	0.07" higher than Bulletin 70	1.47" higher than Bulletin 70
Aurora*	6.44" higher than Bulletin 70	6.25" higher than Bulletin 70
Elgin	1.38" lower than Bulletin 70	0.76" lower than Bulletin 70
Midway	0.30" lower than Bulletin 70	1.67" higher than Bulletin 70
O'Hare	0.56 "higher than Bulletin 70	2.46" higher than Bulletin 70
Wheaton	0.23" lower than Bulletin 70	1.10" higher than Bulletin 70

*Data skewed by July 1996 event, this data point may be an outlier, further analysis required

Conclusions

Future Work

- Remove any outliers from completed analysis
- Complete analysis of other hourly rainfall data available
- Complete analysis for other storm durations
- Determine an appropriate distribution for northeastern Illinois
- Create regionally varied rainfall depths and new Intensity-Duration-Frequency Curves for northeastern Illinois

Questions and Comments

Megan Elberts
melberts@cbbel.com