

## **An Analysis of Extreme Rainfall Differences: Old TP-40 Versus the New Cornell Atlas of Precipitation**

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### **INTRODUCTION**

From a chance discussion that I had in September, 1997, with Barry Keim, the New Hampshire State Climatologist, I learned that the venerable Technical Paper 40 was updated several years ago by the [Northeast Regional Climate Center \(NRCC\)](#) at Cornell University. The implications of this change are enormous. In many cases, use of TP 40 is mandated in Massachusetts by legislation, local regulation or bylaw. Although the NRCC revisions are substantial, to my knowledge, no official, systematic method of distributing this information exists.

Mr. Keim noted that rainfall quantities for extreme events had increased, and that continuing use of the old TP-40 could no longer be justified. He referred me to a hydrologist at Cornell, and urged me to request a copy of the updated Atlas.

From the follow up calls that I made with Cornell, I confirmed Mr. Keim's comments. I have since conducted a brief analysis, which compares rainfall quantities in TP-40 to the new Cornell Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada.

### **FINDINGS & BACKGROUND**

Depending on location within Massachusetts, extreme precipitation quantities increase using the new Cornell Atlas by as much as 29%, a dramatic difference when designing hydrologic structures such as detention basins or determining floodplain boundaries. My analyses are included with this paper as Tables, and compare events on the North Shore, South Shore and in Western Massachusetts.

As brief background, the formal name of TP-40 is Rainfall Frequency Atlas of the United States. Developed by the Weather Bureau of the Commerce Department, it was published in May of 1961. The document is composed of rainfall charts for storm events from a 1-year 30-minute rainfall to a 100-year 24-hour event.

TP-40 has long been considered the sole source for rainfall quantity in Massachusetts. Its charts are relied upon by numerous municipalities and local, state and federal agencies, as well as engineers and hydrologists. The rainfall quantities are used for designing retention and detention basins, infiltration devices, culverts and other hydrologic structures.

Of further note, SCSs TR-55, or Urban Hydrology for Small Watersheds, is the basic template used by almost all designers for medium-size watershed storm

water analysis. Its use is mandated by many Planning Boards, Conservation Commissions, [DEP](#) and other groups statewide. Unfortunately, TR-55, issued in June of 1986, publishes the charts from the old TP-40 for its own rainfall charts, thus unintentionally perpetuating the cycle of out-dated information.

Another regulatory caution for designers and scientists seeking to determine the boundary of Bordering Land Subject to Flooding (see 310 CMR 10.57(2)(a)3.a) is that the [Wetlands Protection Act \(WPA\)](#) mandates use of a design storm of seven inches of precipitation which will theoretically result from the statistical 100-year frequency storm. Based on the new Cornell Atlas, this specific mandate underestimates a 100-year storm on the South Shore by 22% (the seven inch requirement is actually less than a 50-year storm), and on the North Shore by 18%. The same section of the WPA requires use of a Type II rainfall, which is incorrect; based on charts in TR-55, the entirety of Massachusetts uses a Type III rainfall.

In sum, although TP-40 is no longer accurate, its use as a reference is ubiquitous. Yet its data is 37 years old, and its continued application is inappropriate. Similarly, the rainfall charts found in TR-55 are in error, and hydrologists and engineers should use the Cornell Atlas of Precipitation Extremes if they are going to mirror real events. Use of the old TP-40 charts may result in undersized structures or faulty drainage analyses, obviously does not serve the public and, in my opinion, substantially increases a designers liability.

## **ANALYTICAL DATA**

I developed the following Tables using arbitrary points in the State which approximate the location of Andover, Plymouth and Northampton, for the North Shore, South Shore and Western Massachusetts, respectively. Data is taken from charts in the Cornell Atlas and TP-40. The charts in any atlas are subject to minor interpretation, so designers should verify my interpretations before use. The Tables below are intended for comparative use only.

The smaller 2-year events change the least, with no change in the western part of the state, to about a 06% increase in rainfall in the South Shore. Similarly, Table 3 indicates that the 10-year event in the west actually declines by 04%, while increasing 09% on the South Shore (see Table 2). The 100-year event, typically the maximum storm for which hydrologic structures are designed, showed the most significant changes. Increases for the 100-year event vary between 12% in the west, to 25% on the North Shore, to a striking 29% on the South Shore.

**TABLE 1.****North Shore Analysis (Mass.)**

	<b>TP-40 (1961)</b>	<b>Cornell (1993)</b>	
<b>Event in YRS</b>	<b>Inches per 24 HRS</b>	<b>Inches per 24 HRS</b>	<b>% of Change</b>
<b>2</b>	<b>3.1</b>	<b>3.2</b>	<b>1.03</b>
<b>10</b>	<b>4.5</b>	<b>4.8</b>	<b>1.07</b>
<b>25</b>	<b>5.5</b>	<b>6.0</b>	<b>1.09</b>
<b>50</b>	<b>6.0</b>	<b>7.0</b>	<b>1.17</b>
<b>100</b>	<b>6.8</b>	<b>8.5</b>	<b>1.25</b>

**TABLE 2.****South Shore Analysis (Mass.)**

	<b>TP-40 (1961)</b>	<b>Cornell (1993)</b>	
<b>Event in YRS</b>	<b>Inches per 24 HRS</b>	<b>Inches per 24 HRS</b>	<b>% of Change</b>
<b>2</b>	<b>3.2</b>	<b>3.4</b>	<b>1.06</b>
<b>10</b>	<b>4.7</b>	<b>5.1</b>	<b>1.09</b>
<b>25</b>	<b>5.6</b>	<b>6.2</b>	<b>1.11</b>
<b>50</b>	<b>6.2</b>	<b>7.3</b>	<b>1.18</b>
<b>100</b>	<b>7.0</b>	<b>9.0</b>	<b>1.29</b>

**TABLE 3.**  
**Western Mass. Analysis**

	TP-40 (1961)	Cornell (1993)	
Event in YRS	Inches per 24 HRS	Inches per 24 HRS	% of Change
2	3.0	3.0	1.00
10	4.5	4.3	0.96
25	5.5	5.5	1.00
50	6.0	6.2	1.03
100	6.5	7.3	1.12

### References

Cornell University, Northeast Regional Climate Center. September, 1993. Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada.

Garner, Patrick. October, 1997. AMWS Newsletter.

Kiem, Barry. September, 1997. Personal remarks.

Mass. DEP. June 30, 1995. Wetlands Protection Act Regulations (310 CMR 10.00).

Sanford, Gary. March, 1998. Personal remarks.

USDA. Urban Hydrology for Small Watersheds. June, 1986. TR-55.

USDC, Weather Bureau. May, 1961. Rainfall Frequency Atlas of the United States.

### CONTACTS

To obtain copies of the new Cornell Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada, contact NRCC at 607.255.1751. Ask for publication RR 93-5.

[NOTE: An edited version of this article also ran in a late 1998 edition of the MACC Newsletter.]