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David R. Miller
University of Connecticut

Glenn S. Warner
University of Connecticut

Fred L. Ogden
University of Connecticut

Arthur T. DeGaetano

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Introduction

This bulletin presents descriptions of the occurrence and distribution of precipitation in Connecticut determined from analyses of long-term records at weather stations. Although the length of records vary, a number of stations now have over 100 years of data. Authors of previous publications regarding precipitation in Connecticut typically used a 30 year period (or so called "normal" period) for their analyses. These publications include: Kirk (1939) who used data prior to 1939, Brumbach (1965) who relied on measurements from the 1932-1961 period, and Hunter and Mead (1983) who used the 1951-1980 period. The annual average in each of these publications varied due to the variation in precipitation from one 30 year period to another. This variation can be seen in Figure 1 of this publication, which shows annual precipitation amounts from 1885-1989.

Data Sets Used.

The precipitation amount, time and space distributions presented are from daily data records of 73 stations and hourly data records of 71 separate stations across Connecticut and adjacent portions of New York, Rhode Island and Massachusetts. Tables 1 and 2 list the stations and their periods of record.

Daily climatological data were included in the analysis if they contained at least 30 years of record, regardless of the starting or ending date. Therefore, record length varied by station, with the most recent data ending in August 1996. All available hourly data were used regardless of period of record, which in most cases was less than 30 years. The quality of the daily precipitation data was evaluated based on a spatial comparison with neighboring stations. To be considered valid, precipitation amounts of 10 inches (245 mm) or more had to be corroborated by the occurrence of at least 5 inches (127 mm) of precipitation at two or more stations within 200 miles (322 km) on the same day, the previous day, or the following day. Precipitation amounts between 5 and 10 inches (127 and 245 mm) were validated in a similar manner, using 3-inch (76-mm) amounts at neighboring stations. Excessive hourly precipitation was validated by comparing daily and hourly observations at adjacent stations.

The data used in the 15-minute frequency analysis were from 12 stations listed in Table 3. The data were obtained from Hydrosphere, Inc. of Boulder, Colorado on a CD-ROM entitled "CLIMATE-DATA, Volume 5.0, NCDC 15 Minute Precipitation Values". This CD-ROM record contains all 15-minute temporal resolution precipitation data archived at the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, in Asheville, North Carolina, through August, 1996.

Annual Precipitation

The spatially averaged annual total precipitation in Connecticut over the last 100 years is plotted in Figure 1. Apparent from the graph is a generally increasing trend in precipitation over the century with high year to year variability. A linear regression fit to the data in Figure 1 is significantly different from a zero trend line with 95% confidence. Thus the increasing trend can be considered statistically significant. The trend of increasing precipitation is consistent across the state, although the rate

of increase varies from about 7.5 to 10.7 inches (190 to 272 mm) over the one-hundred-year period depending on which long-term record is used. The differences may be the result of natural random variation among stations rather than actual differences in the rate of increases. Extrapolation of these historic increases to the future is risky.

No similar trend in year to year variance could be found, and therefore the variability is apparently not changing. Periods, from one to three decades long, of lower than average precipitation, alternate with periods of higher than average precipitation throughout the record.

Table 4 presents the summary statistics for the annual precipitation for each month of the year. The long term mean annual precipitation is 44.84 inches (114 mm) per year. The maximum annual precipitation during the century was 64.06 inches (1627 mm) and the minimum was 30.98 inches (786.9 mm) with a standard deviation of 7.29 inches (185 mm). In short, about 2/3 of the time the total annual precipitation is within 16% of the 100-year average.

Seasonal Precipitation

When averaged over the period of record the total precipitation is distributed rather evenly throughout the year with slightly higher amounts in the summer than in the winter months as shown in Figure 2. Precipitation averages from 3 to 4 inches (76 to 102 mm) a month with occasional large storm amounts in almost any month. The size of the outliers shown in Figure 2 peak in the summer and fall months indicates that the extreme values are not evenly distributed throughout the year. The effect of this uneven distribution is discussed later in the section on precipitation extremes.

Snowfall

Snowfall is a minor component of the total precipitation budget in Connecticut. The proximity of the ocean moderates the snowfall in Connecticut, especially along the coast. The average snowfall in Connecticut is about 30 inches (762 mm) along the coast, 40 inches (1016 mm) inland and 60 inches (1524 mm) in the northwest corner of the state. Eighty inches (2032 mm) is exceeded once in 20 years, on average. The average maximum snow depth on the ground is about 8 inches (203 mm) along the coast and 12 inches (305 mm) in the northern portion of the state.

Storms

Major storms, which generate large amounts of precipitation in Connecticut during the summer and fall seasons, are generally tropical in origin. The tropical storms are classified as *hurricanes* if the wind speeds are sufficient, or as *tropical low pressure storms* otherwise. In terms of precipitation, both can deliver extreme amounts in the short period of time (about a half day) that it takes for them to traverse the Connecticut region. Although infrequent, these storm systems tend to provide the majority of our high intensity rains over periods greater than one hour.

Discussions of how these storms affect different parts of the state have been heard in the past. But their infrequent occurrence and rather random paths make any real analysis of variability across the

state intractable. Six hurricanes and 18 tropical lows have crossed Connecticut and Long Island in the 100 years before 1994. The paths and detailed data of each storm are available on U.S. Department of Commerce, National Oceanic and Atmospheric Administration, web site (<http://www.noaa.gov>).

Large extra-tropical storms are possible at any time of year but prevail in the winter and spring season. The most notable of these are the periodic *Nor'easters*, which move slowly in the ocean southeast of New England and produce one to several days of blizzards or rain driven by the cyclonic winds around the low.

Short-term intensive precipitation is generally greatest in localized thunderstorms, which are the most prevalent rainstorms in the warm season. They generally move from southwest to northeast across the state and most often are associated with a frontal system. They seldom last longer than about an hour at any individual location and often are accompanied by small hail, severe lightening, high winds and rarely, a tornado.

Precipitation Extremes

Extreme Precipitation Regions in Connecticut

Four precipitation subregions were identified by statistically comparing the extreme precipitation records of the stations and grouping those with the least statistical differences and minimizing the geographical distance between the sites following the methods of Wilks (1995) and DeGaetano (1996). The region boundaries were adjusted to fit town political boundaries and follow the major drainage basin divides. Figure 3 shows the four regions superimposed on a town boundary map and drainage basin map.

Computation of Return Periods

The probability (p) of a given size and duration precipitation event happening can be expressed as a decimal fraction or percent. For example, a given annual storm has $p = 0.1$ or a 10 percent chance of occurring this year. For precipitation these odds are most often expressed as a *return period*, and the 0.1 chance annual storm is called a 1-in-10 year occurrence or a “10 year” storm. That is, the average occurrence of storms of this magnitude or greater is 10 years. The return period (T) is calculated by $T = 1/p$. It is important to understand that the actual time between storms will not be 10 years, it will only average out to be 10 years over a very long period. Thus a location may receive a number of these storms in several years, or not receive one for decades. The occurrence of a 10-year storm does not change the probability of getting a 10-year storm the following year. There will still be a 10 percent chance in obtaining a 10-year storm each year.

Return periods were computed by DeGaetano (1997) using partial-duration precipitation data (i.e. the n largest daily precipitation values in n years of record) for each station in the state. Smoothing and extrapolation of the observed extreme precipitation values was done following the technique of Wilks (1995) by fitting the Beta-P distribution (Mielke and Johnson, 1974) for each station.

Due to the lack of long-term hourly precipitation observations, a set of empirically derived equations was used to adjust the daily precipitation extremes to values representative of shorter duration.

The adjustment factors used here have been derived specifically for use in the northeastern United States (McKay and Wilks, 1995). Constant adjustment factors of 1.13, 1.07, 0.97 and 0.79 were used to estimate extreme precipitation amounts for accumulation periods of 24, 18, 12, and 6 hours, respectively from the daily values. An adjustment for the 24-hour accumulation period was necessary to account for precipitation events occurring within a 24-hour period, but spanning two fixed observation time intervals. Multiple regression equations based on latitude, longitude, elevation, and daily extreme precipitation amounts were used to estimate extreme precipitation amounts for 1, 2 and 3-hour accumulation periods.

Spatial Distribution of Extreme Precipitation Events

Isohyets are contours of equal precipitation on a map. Figures 4a through 4x are isohyetal maps of Connecticut showing the spatial distribution of 24, 12, 6, and 1-hour precipitation accumulations corresponding to average return periods of 2, 5, 10, 25, 50, and 100 years. The isohyets shown are spatial averages of the station values drawn after using the interpolation algorithm of Wilks and Cember (1993). Example 1 below demonstrates how these curves might be used.

Example 1. Using the Statewide Isohyet Maps.

A hydrologic consultant needs the 100 year 1-hour storm in SW Connecticut to design a detention basin that will store increased runoff due to increased impervious areas in a development.

Solution:

SW Connecticut is in Region 4. The consultant decides to use Figure 4f showing the statewide distribution of total amounts for the 100 yr - 1 hr storm. The site falls between the 2.4 and 2.5 inch (60 and 64 mm) isohyets, and by interpolation, the amount for the design is 2.45 inches (62 mm).

Intensity-Duration-Frequency Curves

Within each region, the station with the highest 24-hour extreme precipitation accumulation was selected. Based on this representative station, precipitation intensity for various storm duration periods are plotted as a function of return period in Figures 5a, 5b, 5c and 5d. Given that all stations within a region can be described by the same empirical extreme precipitation distribution, this single intensity-duration curve is assumed representative of all sites in a region. The following examples show how these intensity-duration curves might be used.

Example 2. Reading the Intensity-Duration-Frequency (IDF) curves.

An engineer is designing a road culvert near Storrs, CT. The structure will be built to handle the flow from a 25-year recurrence interval rainfall, i.e. a discharge whose probability of occurring any year is 4 %. The engineer also needs to know the 100-year peak discharge for flood management purposes. It has been determined that the time of concentration (t_c) of the small watershed above the culvert is 1.5 hours. Therefore the intensities for a rainfall equal to this t_c are needed.

Solution:

Storrs, CT is located in Region 2, and the precipitation intensity-duration-frequency curves for Region 2 are shown in Figure 5b.

The 25 yr, 1.5 hr precipitation event = 1.75 in/hr (44 mm/hr), and

The 100 yr, 1.5 hr precipitation event= 2.0 in/hr (51 mm/hr)

Note: Examples 1 and 2 show two approaches to calculate either total storm precipitation or average intensity. Example 2 uses the Intensity-Duration-Frequency (IDF) curves (Figures 5a - 5d) which are based on the highest precipitation amounts within each region. Example 1 uses the averages across the state which are based on all rain gages. Average intensities calculated from the statewide isohyetal maps (Figures 4a – 4x) may therefore be somewhat lower than from the IDF curves in Figure 5.

Area Reduction Curves

For applications involving drainage basins larger than a few square miles, it is necessary to consider the extreme precipitation depth averaged over the entire basin, which will be smaller than the extreme precipitation at a single point because no storm covers a large area evenly. The area reduction curves for 1, 3, 6 and 24 hour duration storms (shown in Figures 6a, 6b, 6c, and 6d) for each region are intended as an aid for extrapolating single point precipitation amounts to drainage basins of various areas. The example below shows how these curves might be used.

Example 3. Use of Area Reduction Curves.

A consultant is designing a spillway for a large reservoir having a drainage area (DA) of 125 mi² (324 km²) located in Region 2. Since the DA is relatively large, the point precipitation statistics will be greater than an average precipitation over the entire watershed.

Solution:

The consultant uses the Area Reduction Curves along with the point precipitation IDF curves to determine the best estimate for the watershed-wide storm. The critical precipitation duration for peak flow is 6 hours. The 100 yr - 6 hr precipitation intensity (Figure 5 b) is 1.15 in/hr (29 mm/hr) which gives a total amount for 6 hours of 6.9 inches (175.3 mm). The “percent of point precipitation” from Figure 6b for 125 mi² (324 km²) is estimated as 89 %. Therefore 0.89 x 6.90 in (175 mm) = 6.14 in (156 mm).

Note: There is a greater area reduction for shorter duration storms (e.g. 1 hr) than longer duration storms (e.g. 24 hr) because intense summer thunderstorms typically cover relatively small areas.

Seasonal Distribution of Extreme Precipitation Events

Although the mean annual precipitation is fairly evenly distributed throughout the year, the occurrence of extreme precipitation is not. Probabilities calculated from the long-term records for receiving a particular size storm during any week are shown in Figures 7a - 7l by week of the year for 24, 6, and

1 hour durations for each of the four regions. They demonstrate that the highest intensity storms occur more often in the summer and fall seasons for both short duration (thunderstorms) and long duration (tropical/hurricane) storms.

Intensity-Frequency of 15 Minute Precipitation

Hydrologic engineering designs of catchments with fast response time, such as rooftops and impervious areas, are often controlled by short-duration, high-intensity precipitation. Therefore an analysis of 12 stations with over 10 years of record of 15-minute interval precipitation data was conducted. The data selection and quality control procedures are described in Ogden (1998). The limited number of 15-minute recording gages in Connecticut prevented analysis based on the precipitation regions. Therefore, the values developed are applicable statewide, with the possible exception of the mountainous region in extreme northwestern Connecticut, where orographic effects are more significant.

The 229 annual maximum 15-minute precipitation accumulations were fitted with a 3-parameter gamma distribution. This distribution is also known as the Pearson type 3 distribution. The gamma distribution is one of the most widely used distributions in hydrology because most hydrologic variables are skewed, and the gamma distribution considers the skewness. The 15-minute precipitation accumulations for 2, 5, 10, 25, 50, and 100-year average recurrence intervals, were calculated from the CDF by fitting with a 10th order polynomial. A Newton-Raphson iterative technique was used to determine the corresponding 15-minute precipitation accumulations. The results are shown in Table 5.

Of the 229 gage-years of annual maximum values, three of the approximately 6,000,000 15-minute precipitation periods considered had precipitation accumulations of 1.3 inches (33 mm) each. These recordings correspond to average precipitation rates of 5.2 inches (132 mm) per hour over the 15-minute period, which has an average recurrence interval of 194 years according to this analysis. This value represents the maximum 15-minute precipitation accumulations observed in Connecticut since 15-minute temporal resolution gages were installed beginning in 1971.

Droughts and Dry Days

Drought is generally defined as a period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause problems. In Connecticut two distinct types of drought are recognized, hydrological droughts which result in low water supplies in surface and ground water reservoirs, and agricultural droughts where there is insufficient moisture in the soil to supply the needs of plants. Hydrological droughts don't occur in Connecticut without prolonged dry spells of three to six months or more. An agricultural drought only occurs during the growing season and can take place with dry conditions as short as two weeks on some sandy soils.

Figure 1 indicates long term hydrological droughts occurred during the periods 1904 - 1920, 1928-1931 and 1963-1966. Each of these periods had a number of individual years well below the average precipitation.

The probability of a number of consecutive days with no precipitation is of concern to industries such as recreation, sports and green industries when planning outdoor activities. Engineers use these probabilities for planning storm water treatment and the calculation of antecedent moisture in the ground among other things.

Tables 6, 7, 8 and 9 (regions 1 through 4, respectively) provide the probability, in percent, of a given number of consecutive dry days occurring following any day within a specific week. Dry days are defined as either zero or a trace of precipitation. Values are averages for the seven days ending on the date shown. Average probabilities for the year are given in the bottom row. Lines indicating the 50, 10 and 1 percent probabilities are shown on the table.

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Tables

[Table 1. List of Daily Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.](#)

Table 2. List of Hourly Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.

Table 3. List of 15-minute Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.

Table 4. Averages, Extremes and Variability of Monthly and Annual Precipitation 1895 - 1994.

Table 5. Intensities and Return Periods of 15-minute Precipitation Accumulations (in) 1971-1994.

Table 6. Probabilities (percent) of Number of Consecutive Dry Days Following Any Day in a Given Week. Region 1.

Table 7. Probabilities (percent) of Number of Consecutive Dry Days Following Any Day in a Given Week. Region 2.

Table 8. Probabilities (percent) of Number of Consecutive Dry Days Following Any Day in a Given Week. Region 3.

Table 9. Probabilities (percent) of Number of Consecutive Dry Days Following Any Day in a Given Week. Region 4.

Figures

Figure 1. Connecticut Total Annual Precipitation, 1895 - 1994.

Figure 2. Monthly Precipitation in the Central Region of Connecticut, 1895 - 1989. The box and whisker plots show the non-outlier ranges, inter-quartile ranges, and means. The filled segments show the standard deviations, and the circles and stars are outliers and extremes, respectively.

Figure 3. Four Precipitation Regions in Connecticut.

Figure 4a – 4x. Contour maps of precipitation amounts for 2, 5, 10, 25, 50 and 100 year return periods for rainfalls of 1, 6, 12 and 24-hour duration.

Figure 5a – 5d. Intensity-Duration-Frequency (IDF) Curves. Regions 1 - 4 respectively.

Figure 6a – 6d. Area Reduction Curves. Regions 1 - 4, respectively.

Figure 7a – 7l. Weekly Distribution of 24, 6 and 1hr Extreme Precipitation. Regions 1 - 4, respectively.

Table 1. List of Daily Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.

Station Number	Station Name	Lat. (deg)	Long. (deg)	Elev. (feet)	Start Year	End Year
Connecticut						
060299	BARKHAMSTED	41.92	72.95	660	1948	1996
060806	BRIDGEPORT WSO ARPT	41.17	73.13	10	1948	1996
060918	BROOKLYN	41.78	71.95	240	1950	1983
060961	BULLS BRIDGE DAM	41.65	73.48	260	1948	1996
060973	BURLINGTON	41.80	72.93	510	1937	1996
061488	COCKAPONSET RANGER ST	41.47	72.52	160	1948	1996
061689	COVENTRY	41.80	72.35	480	1957	1993
061715	CREAM HILL	41.90	73.32	1300	1926	1972
061762	DANBURY	41.40	73.42	400	1948	1996
062658	FALLS VILLAGE	41.95	73.37	550	1948	1996
063207	GROTON	41.35	72.05	40	1948	1996
063451	HARTFORD BRAINARD FIELD	41.73	72.65	20	1920	1996
063456	HARTFORD WSO ARPT	41.93	72.68	160	1954	1996
064488	MANSFIELD HOLLOW LAKE	41.75	72.18	250	1952	1996
064767	MIDDLETOWN 4 W	41.55	72.72	370	1948	1996
065077	MOUNT CARMEL	41.40	72.90	180	1936	1996
065445	NORFOLK 2 SW	41.97	73.22	1340	1942	1996
065893	NORWALK GAS PLANT	41.12	73.42	40	1956	1989
065910	NORWICH PUB UTIL PLANT	41.53	72.07	20	1956	1996
066655	PUTNAM LAKE	41.08	73.63	300	1948	1996
066966	ROCKY RIVER DAM	41.58	73.43	220	1948	1996
067002	ROUND POND	41.30	73.53	800	1948	1996
067157	SAUGATUCK RESERVOIR	41.25	73.35	300	1948	1996
067373	SHEPAUG DAM	41.72	73.30	840	1948	1996
067432	SHUTTLE MEADOW RESVR	41.65	72.82	410	1948	1996
067970	STAMFORD 5 N	41.13	73.55	190	1955	1996
068065	STEVENSON DAM	41.38	73.17	60	1948	1996
068138	STORRS	41.80	72.25	650	1888	1996
068436	TORRINGTON	41.80	73.12	580	1948	1996
068911	WATERBURY CITY HALL	41.57	73.03	340	1926	1958
069067	WEST BROOK	41.30	72.43	40	1940	1978
069162	WEST HARTFORD	41.75	72.78	270	1948	1996
069568	WIGWAM RESERVOIR	41.68	73.15	570	1948	1996
Rhode Island						
370896	BLOCK ISLAND STATE AP	41.17	71.58	110	1948	1996
374266	KINGSTON	41.48	71.53	100	1926	1996
375215	NEWPORT WATER WORK	41.52	71.32	20	1957	1996
376698	PROVIDENCE WSO AIRPORT	41.73	71.43	50	1948	1996
379423	WOONSOCKET	41.98	71.50	110	1948	1996
Massachusetts						
190562	BELCHERTOWN	42.28	72.35	560	1948	1996
190998	BUFFUMVILLE LAKE	42.12	71.90	500	1959	1996
192107	EAST BRIMFIELD LAKE	42.12	72.13	680	1962	1996
192997	FRANKLIN	42.08	71.42	240	1948	1996
193702	HOLYOKE	42.20	72.60	100	1948	1996
193985	KNIGHTVILLE DAM	42.28	72.87	630	1948	1996
194760	MILFORD	42.17	71.52	280	1948	1996
197627	SOUTHBRIDGE 3 SW	42.05	72.08	720	1948	1996
198046	SPRINGFIELD	42.10	72.58	190	1926	1984
198793	WARE	42.27	72.25	410	1948	1996
199191	WESTFIELD	42.12	72.70	220	1948	1995
199316	WEST MEDWAY	42.13	71.43	210	1957	1996
199371	WEST OTIS	42.17	73.15	1360	1948	1995
199923	WORCESTER WSO AP	42.27	71.87	990	1948	1996
199928	WORCESTER	42.30	71.82	620	1926	1962
New York						
300889	BRIDGEHAMPTON	40.95	72.30	60	1930	1996
301207	CARMEL 1 SW	41.42	73.70	490	1926	1996
302129	DOBBS FERRY	41.02	73.87	240	1948	1996
303259	GLENHAM	41.52	73.93	270	1948	1996
303464	GREENPORT POWER HOUSE	41.10	72.37	20	1958	1996
305334	MILLBROOK	41.85	73.62	820	1948	1996
305377	MINEOLA	40.73	73.62	100	1948	1996
305796	NEW YORK BENSONHURST	40.60	73.98	20	1948	1996
305801	NEW YORK CENTRAL PARK WSFO	40.78	73.97	130	1876	1996
305804	LAUREL HILL	40.73	73.93	10	1922	1983
305811	NEW YORK LAGUARDIA WSO	40.77	73.90	10	1948	1996
305821	NY WESTERLEIGH STAT IS	40.60	74.17	80	1948	1992
306441	PATCHOGUE 2 N	40.80	73.02	60	1948	1996
306674	PLEASANTVILLE	41.13	73.77	320	1948	1996
306817	POUGHKEEPSIE	41.68	73.93	100	1928	1971
306820	POUGHKEEPSIE FAA ARPT	41.63	73.88	150	1948	1996
307134	RIVERHEAD RESEARCH FARM	40.97	72.72	100	1948	1996
307497	SCARSDALE	40.98	73.80	200	1948	1991

Table 2 List of Hourly Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.

Station Number	Station Name	Lat. (deg)	Long. (deg)	Elevation (feet)	Star Year	End Year
Connecticut						
060634	BLOOMFIELD	41.83	72.73	170	1948	1951
060806	BRIDGEPORT WSO ARPT	41.17	73.13	10	1948	1994
061093	CANDLEWOOD LAKE	41.48	73.47	500	1948	1951
061488	COCKAPONSET RANGER ST	41.47	72.52	160	1948	1994
062169	EAST HAVEN	41.28	72.87	30	1948	1994
063447	HARTFORD CITY YARD	41.80	72.65	20	1974	1975
063449	HARTFORD RESERVOIR 6	41.80	72.73	370	1973	1986
063451	HARTFORD BRAINARD FIELD	41.73	72.65	20	1948	1994
063456	HARTFORD WSO AIRPORT	41.93	42.68	160	1954	1994
063857	JEWETT CITY	41.63	71.90	400	1948	1994
064488	MANSFIELD HOLLOW LAKE	41.75	72.18	250	1952	1994
064757	MIDDLETOWN WB	41.55	72.55	130	1956	1958
065018	MOODUS RESERVOIR	41.50	72.43	460	1948	1951
065273	NEW HAVEN WB AIRPORT	41.27	72.88	20	1948	1977
065285	NEWINGTON	41.70	72.73	150	1948	1951
065445	NORFOLK 2 SW	41.97	73.22	1340	1942	1994
066645	PUTNAM	41.92	71.92	300	1948	1994
066650	PUTNAM HEIGHTS	41.90	71.87	560	1948	1951
066660	PUTNAM WATER WORKS	41.93	71.93	280	1962	1965
066942	ROCKVILLE	41.87	72.43	510	1948	1951
067373	SHEPAUG DAM	41.72	73.30	840	1948	1994
067959	STAFFORD SPRINGS 2	41.95	72.30	460	1966	1994
067970	STAMFORD 5 N	41.13	73.55	190	1955	1994
068138	STORRS	41.80	72.25	650	1948	1994
068330	THOMASTON DAM	41.70	73.05	540	1994	1994
068911	WATERBURY CITY HALL	41.57	73.03	340	1948	1958
069388	WEST THOMPSON LAKE	41.95	71.90	360	1965	1994
069568	WIGWAM RESERVOIR	41.68	73.15	570	1948	1994
069704	HARTFORD WSO AIRPORT	41.93	72.68	210	1949	1954
Rhode Island						
370896	BLOCK ISLAND STATE AP	41.17	71.58	110	1948	1994
375215	NEWPORT WATER WORKS	41.52	71.32	20	1957	1994
375225	NEWPORT	41.50	71.30	10	1950	1951
376698	PROVIDENCE WSO AIRPORT	41.73	71.43	50	1948	1994
376703	PROVIDENCE WB CITY	41.83	71.42	70	1948	1953
379423	WOONSOCKET	41.98	71.50	110	1948	1994
Massachusetts						
190998	BUFFUMVILLE LAKE	42.12	71.90	500	1959	1994
192107	EAST BRIMFIELD LAKE	42.12	72.13	680	1962	1994
194667	MENDON AIRPORT	42.10	71.57	450	1948	1950
199093	WEST BRIMFIELD	42.17	72.27	380	1948	1951
099196	WESTFIELD 2 NE AIRPORT	42.17	72.72	260	1948	1952
199382	CHICOPEE FALLS WESTO	42.20				
New York						
300862	BRENTWOOD	40.78	73.25	100	1948	1951
301207	CARMEL 1 SW	41.42	73.70	490	1926	1994
301559	CLINTON CORNERS	41.82	73.77	280	1991	1994
301761	COPAKE	42.10	73.53	550	1988	1994
304024	HUDSON	42.25	73.78	320	1948	1957
304025	HUDSON CORRECTION FAC	42.25	73.80	60	1957	1994
304424	KINGSTON	41.93	74.00	280	1948	1951
304426	KINGSTON CITY HALL	41.92	73.98	50	1973	1984
304613	LARCHMONT	40.93	73.75	40	1948	1994
305346	MILLERTON	41.95	73.52	730	1948	1953
305796	NEW YORK BENSONHURST	40.60	73.98	20	1948	1994
305799	NEW YORK BOTANICAL GARD	40.87	73.88	90	1973	1976
305801	NEW YORK CNTRL PRK WSFO	40.78	73.97	130	1948	1994
305803	NEW YORK WSO KENNEDY	40.65	73.78	20	1949	1994
305806	NEW YORK UNIVERSITY ST	40.85	73.92	180	1948	1951
305811	NEW YORK LAGUARDIA WSO	40.77	73.90	10	1948	1994
305816	NEW YORK WB CITY	40.70	74.02	10	1948	1960
305821	NY WESTERLEIGH STAT IS	40.60	74.17	80	1948	1992
306768	PORT JEFFERSON	40.95	73.07	10	1953	1976
306817	POUGHKEEPSIE	41.68	73.93	100	1948	1971
306820	POUGHKEEPSIE FAA ARPT	41.63	73.88	150	1948	1994
306825	POUGHKEEPSIE 1 N	41.72	73.93	50	1953	1990
307134	RIVERHEAD RESEARCH FARM	40.97	72.72	100	1948	1994
307497	SCARSDALE	40.98	73.80	200	1948	1991
307498	SCARSDALE 2 ESE	40.98	73.77	220	1971	1986
308406	TANNERSVILLE 2 SW	42.15	74.12	1920	1991	1994
309400	WHITE PLAINS MPL MOOR	41.02	73.73	150	1948	1951
309670	YORKTOWN HEIGHTS 1 W	41.27	73.80	670	1964	1994

Table 3. List of 15-minute Stations Used, Including Coordinates, Elevation and Digitally Available Period of Record.

Station Name	Latitude	Longitude	Elevation (ft)	Coverage %	Start Date	End Date
COCKAPONSET RANGER STN	41:28	72:32	160	66	6/1978	8/1996
EAST HAVEN SALTONSTALL	41:17	72:52	30	67	4/1978	8/1996
HARTFORD BRAINARD FIELD	41:44	72:39	20	80	1/1984	8/1996
HARTFORD RESERVOIR 6	41:48	72:44	370	62	3/1973	5/1986
JEWETT CITY	41:38	71:54	400	76	6/1972	8/1996
MANSFIELD HOLLOW LAKE	41:45	72:11	250	79	8/1972	8/1996
NORFOLK 2 SW	41:58	73:13	1340	94	1/1984	8/1996
ROCKVILLE	41:52	72:26	510	68	5/1971	8/1996
STAFFORD SPRINGS 2	41:57	72:18	460	71	9/1978	7/1996
STORRS	41:48	72:15	650	76	5/1971	8/1996
THOMASTON DAM	41:42	73:03	540	86	5/1971	8/1996
WEST THOMPSON LAKE	41:57	71:54	360	81	5/1971	8/1996

Table 4. Averages, Extremes and Variability of Monthly and Annual Precipitation (in), 1895-1994.

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Ann
Max	12.31	8.01	10.16	11.36	10.39	11.58	12.23	15.15	13.90	12.37	9.06	9.36	64.06
Min	0.53	0.49	0.17	0.89	0.60	0.59	1.09	1.03	0.34	0.36	0.67	0.79	30.98
Med	3.01	2.90	3.52	3.73	3.55	3.26	3.56	3.68	3.22	3.13	4.00	3.36	44.05
Avg	3.40	3.15	3.77	3.84	3.74	3.56	3.94	4.03	3.82	3.80	3.99	3.79	44.84
Stdev	1.78	1.23	1.74	1.73	1.75	1.86	1.73	2.12	2.25	2.19	1.86	1.74	7.29
5th%	1.24	1.44	1.43	1.55	1.35	1.36	1.71	1.51	1.23	1.19	1.24	1.40	34.84
95th%	6.37	5.08	7.23	6.31	6.32	6.56	6.55	7.83	8.39	7.77	6.96	6.99	57.96

Table 5. Intensities and Return Periods of 15-minute Rainfall Accumulations (in) 1971-1994. (Ogden, 1998)

Average Recurrence Interval (years)	15-minute rainfall accumulation (in)	Average rainfall rate over the 15 minute period (in/h)
2	0.55	2.2
5	0.75	3.0
10	0.87	3.48
25	1.02	4.08
50	1.12	4.48
100	1.21	4.84

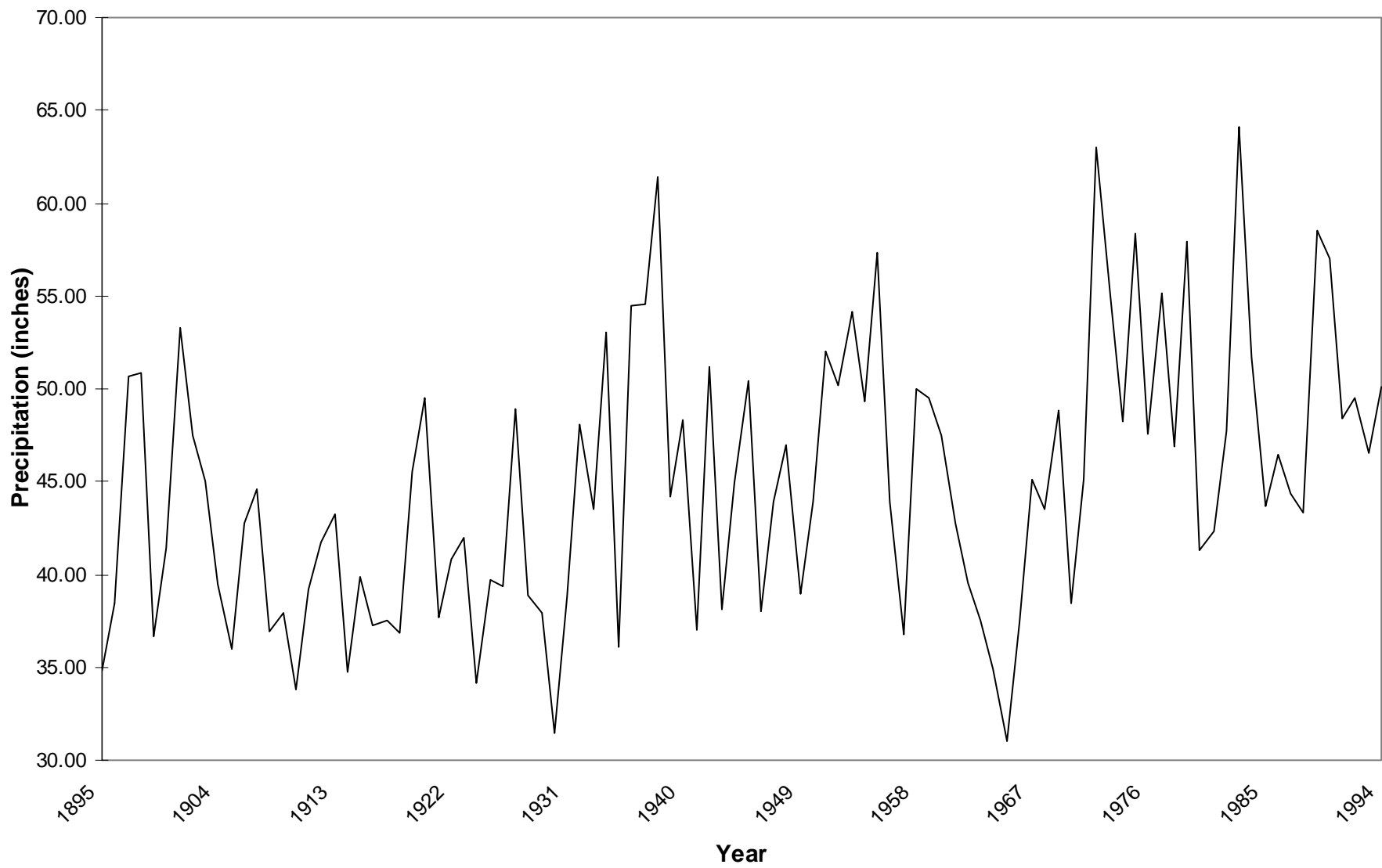


Figure 1. Connecticut Total Annual Precipitation, 1895-1994.

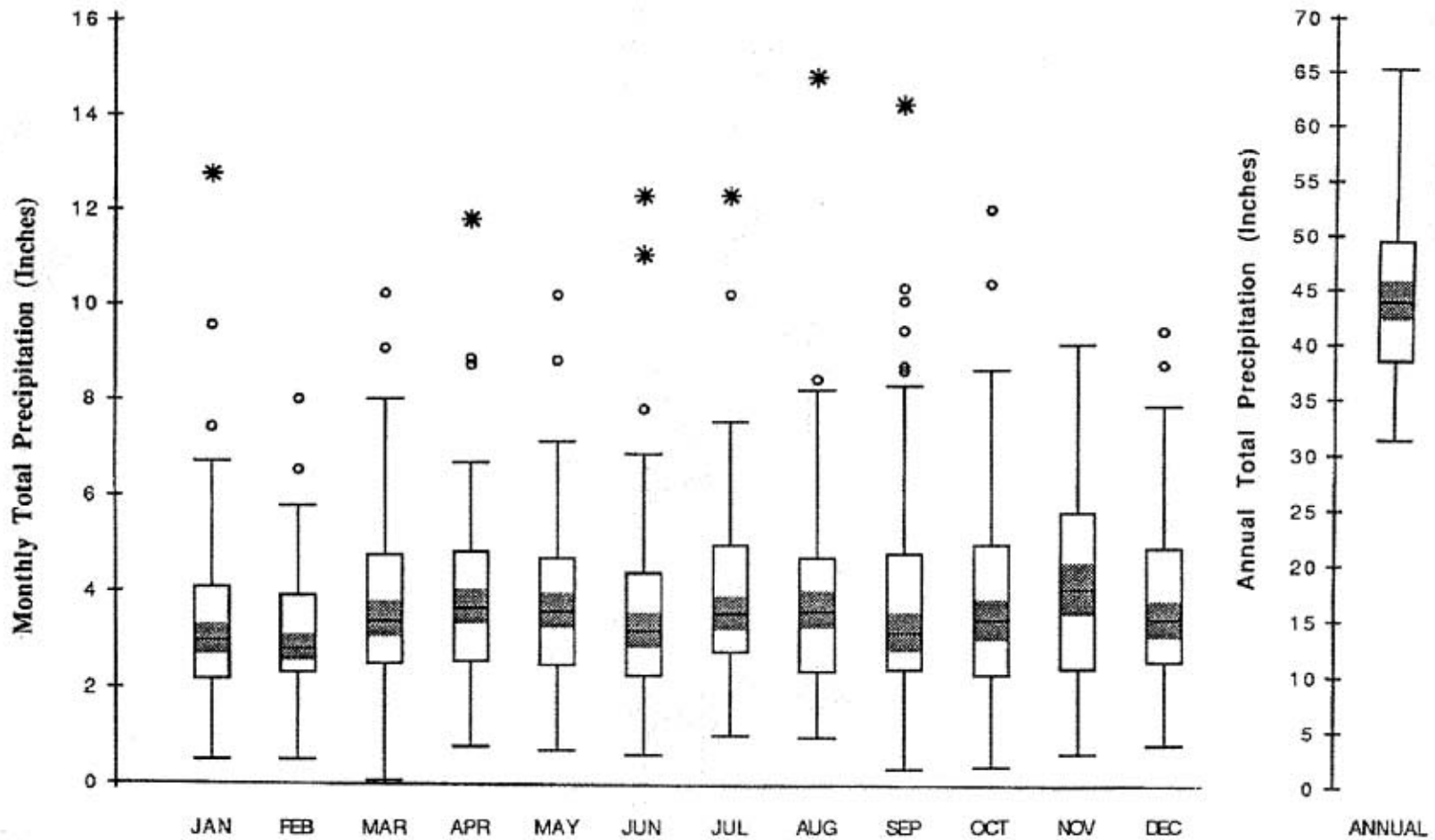


Figure 2. Monthly Precipitation in the Central Region of Connecticut, 1895-1989. The box and whisker plots show the non-outlier ranges, 25% and 75% interquartile ranges and medians. The shaded portions of the boxes show the standard deviations and the circles and stars are outliers and extremes, respectively.

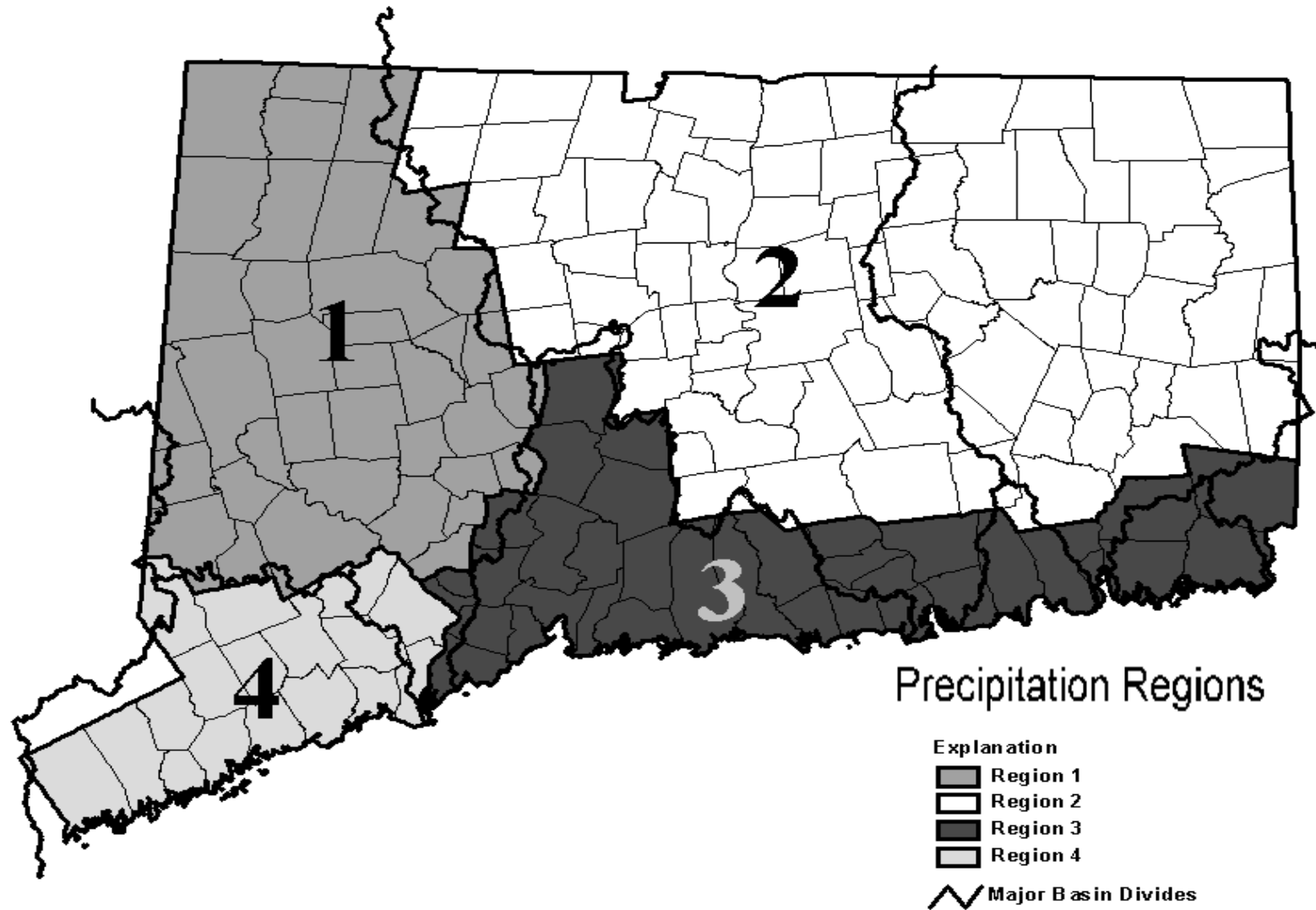


Figure 3. Four Precipitation Regions in Connecticut.

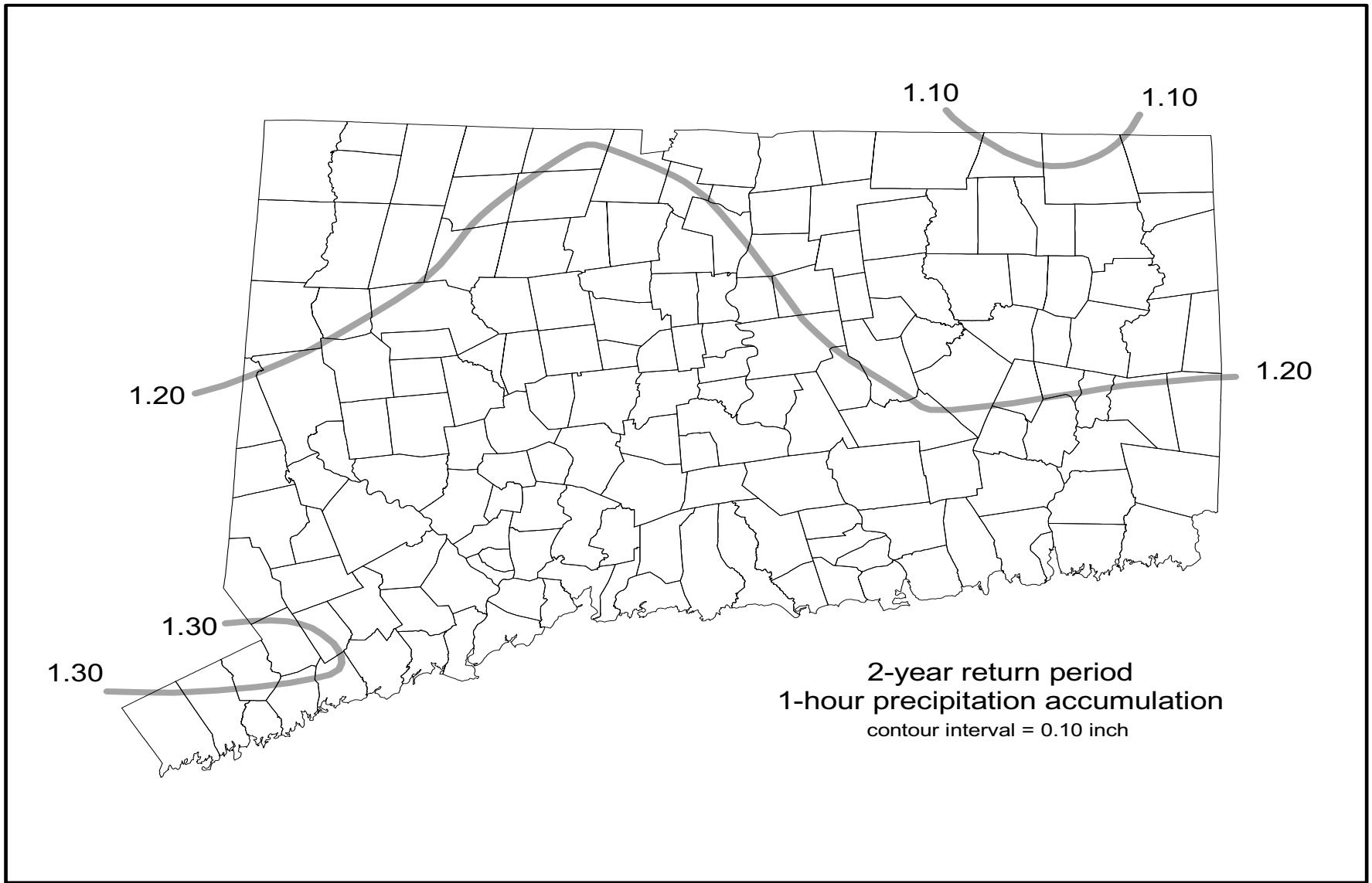


Figure 4a. Contour Map of 2-Year, 1-Hour Precipitation Accumulation in Connecticut.

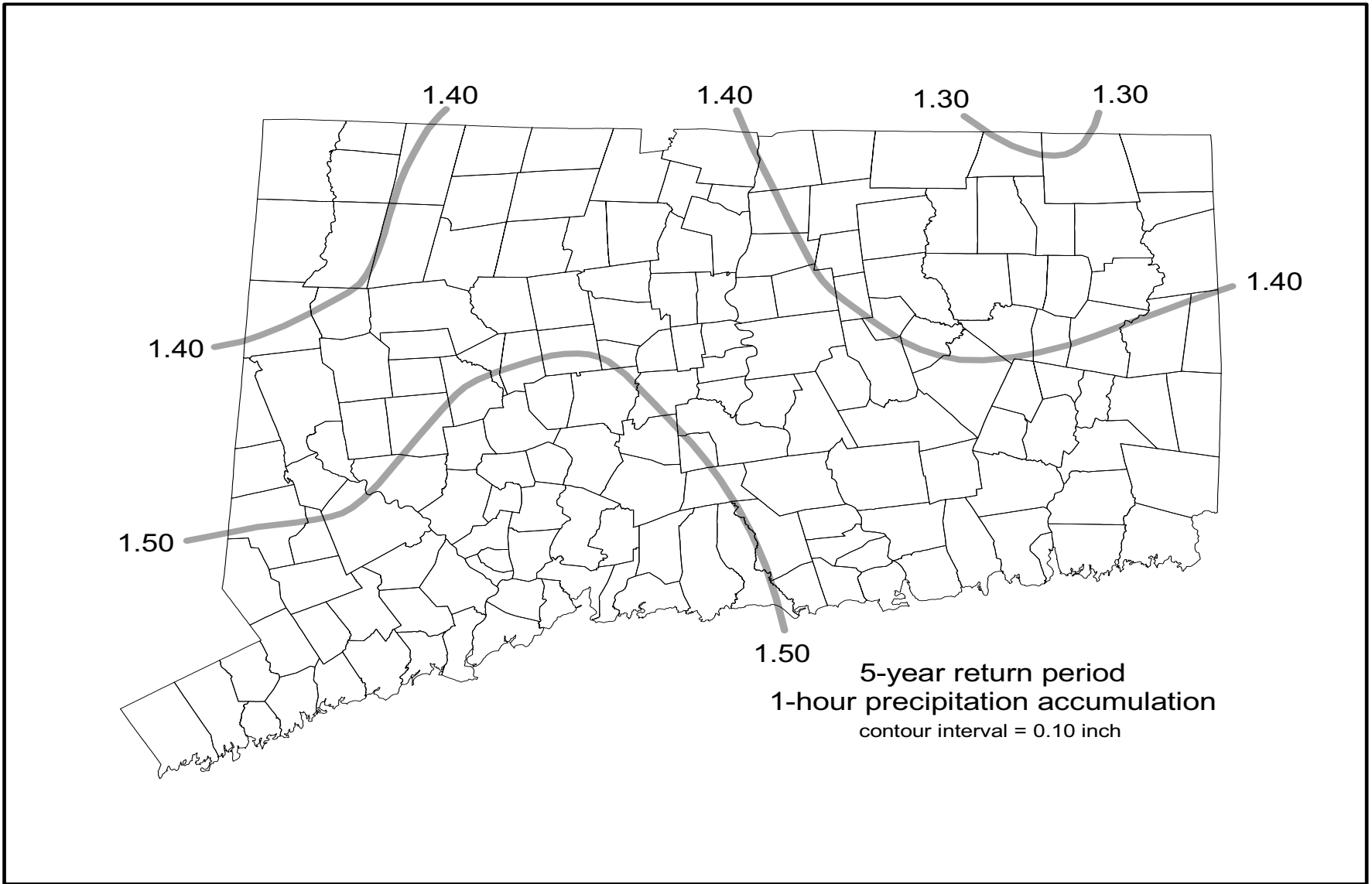


Figure 4b. Contour Map of 5-Year, 1-Hour Precipitation Accumulation in Connecticut.

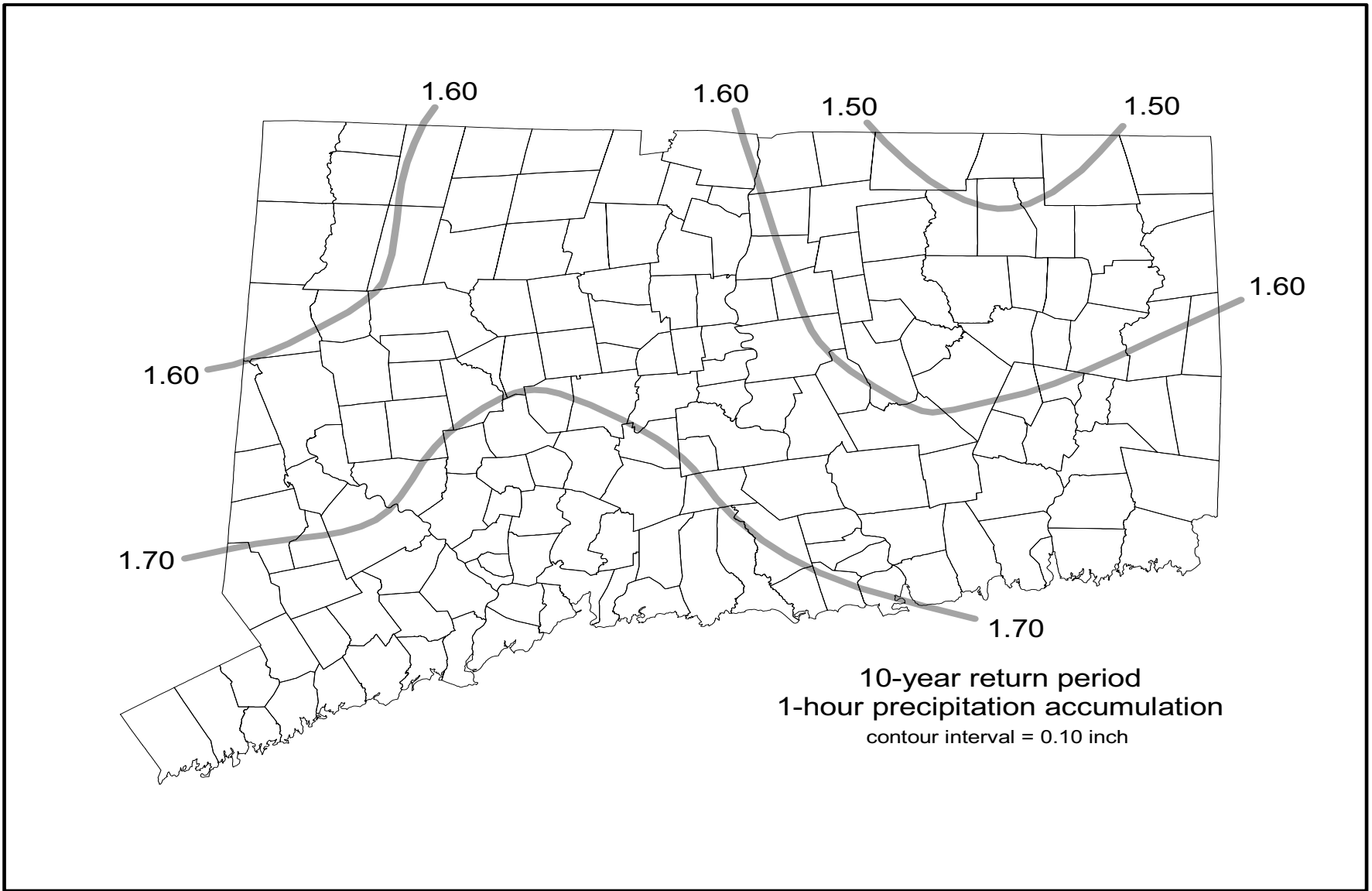


Figure 4c. Contour Map of 10-Year, 1-Hour Precipitation Accumulation in Connecticut.

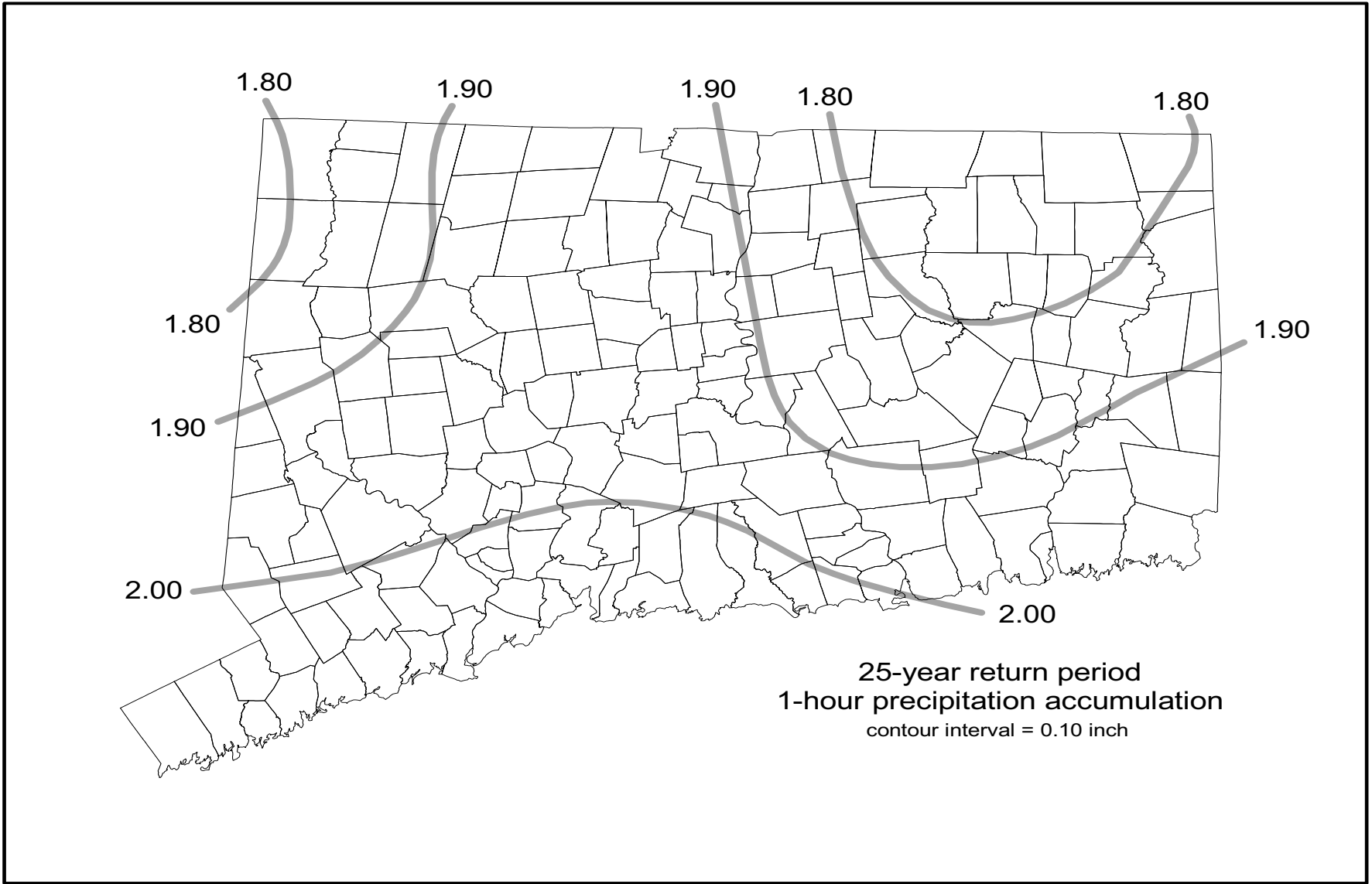


Figure 4d. Contour Map of 25-Year, 1-Hour Precipitation Accumulation in Connecticut.

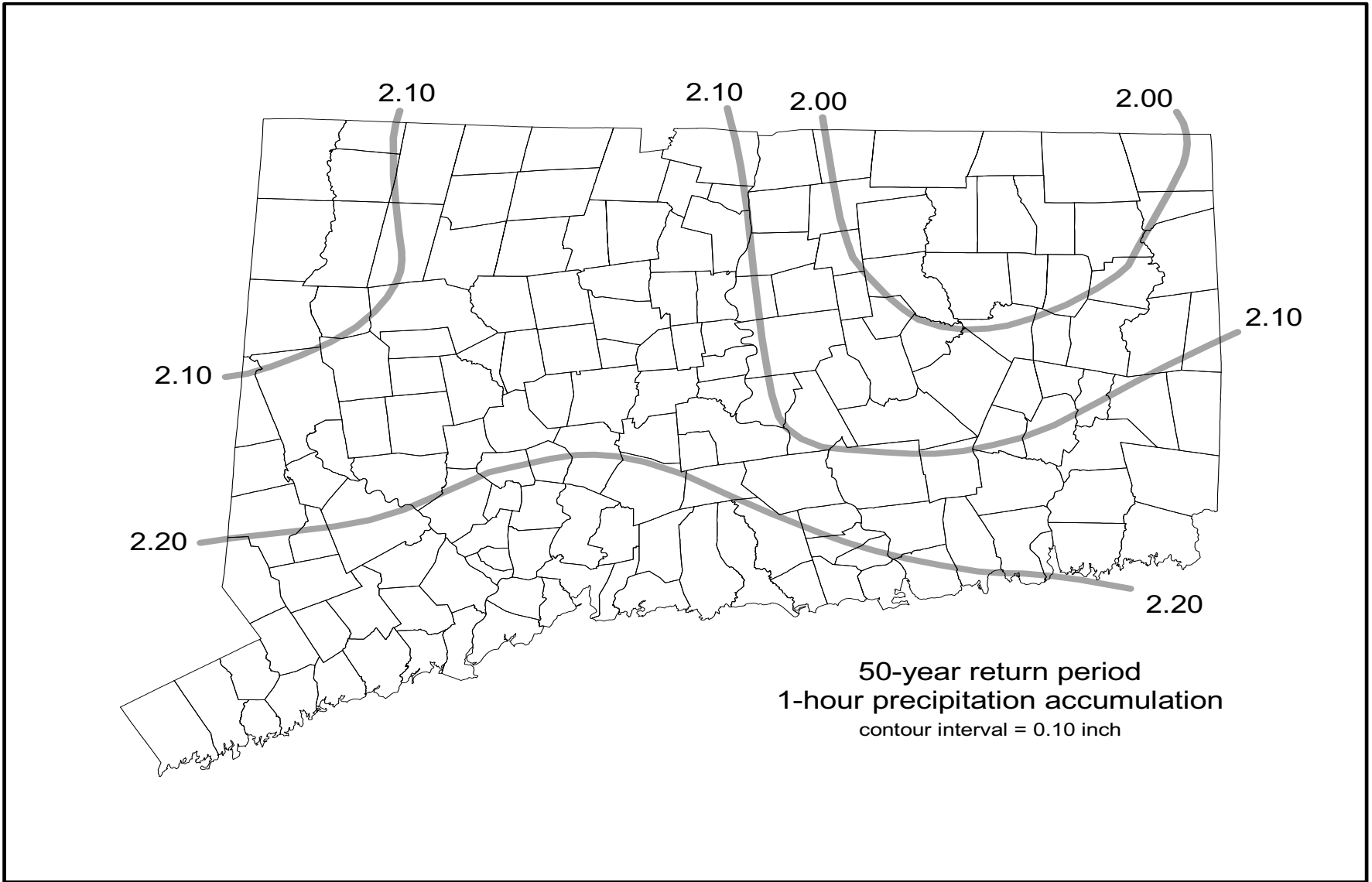


Figure 4e. Contour Map of 50-Year, 1-Hour Precipitation Accumulation in Connecticut.

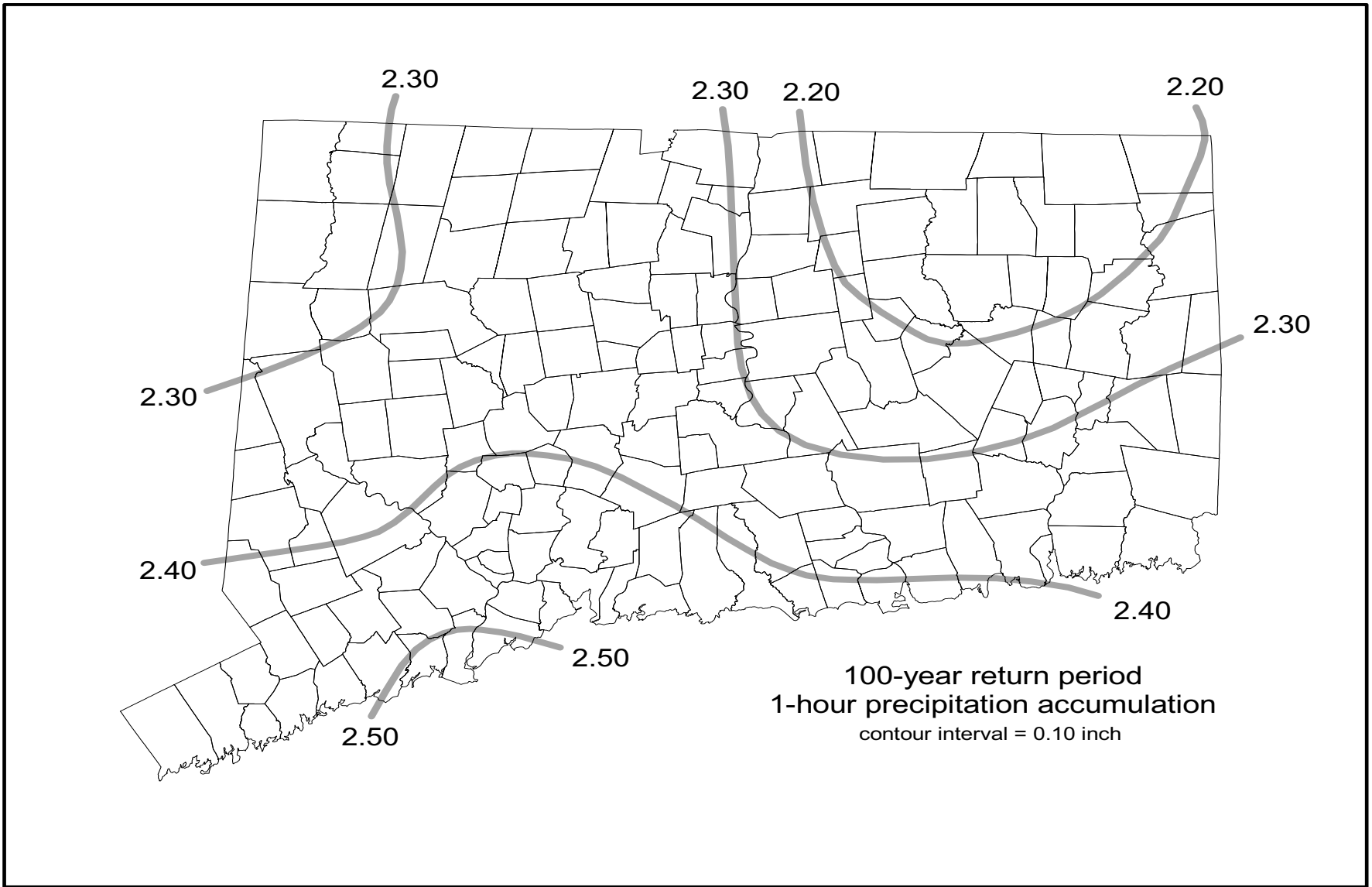


Figure 4f. Contour Map of 100-Year, 1-Hour Precipitation Accumulation in Connecticut.

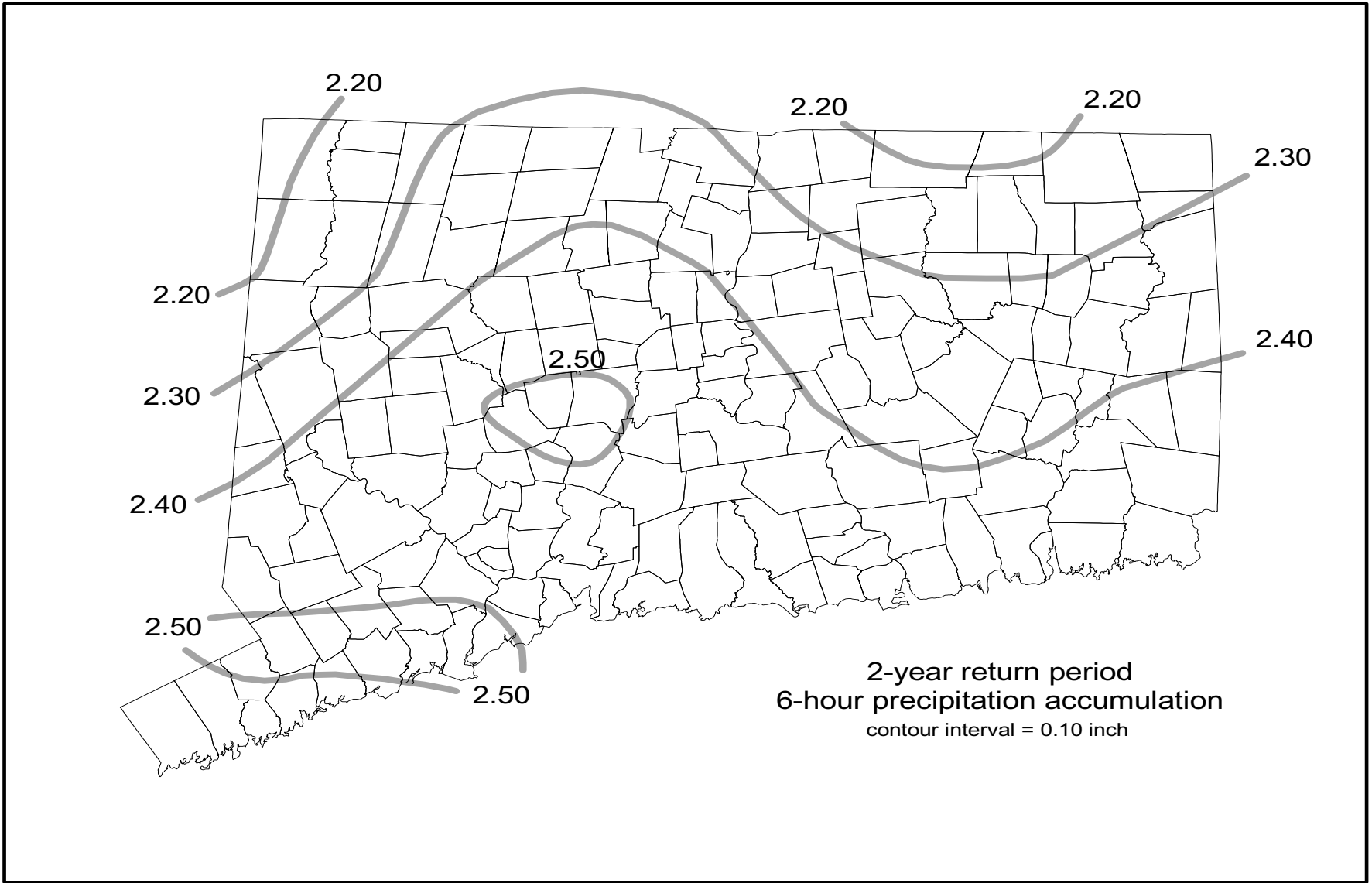


Figure 4g. Contour Map of 2-Year, 6-Hour Precipitation Accumulation in Connecticut.

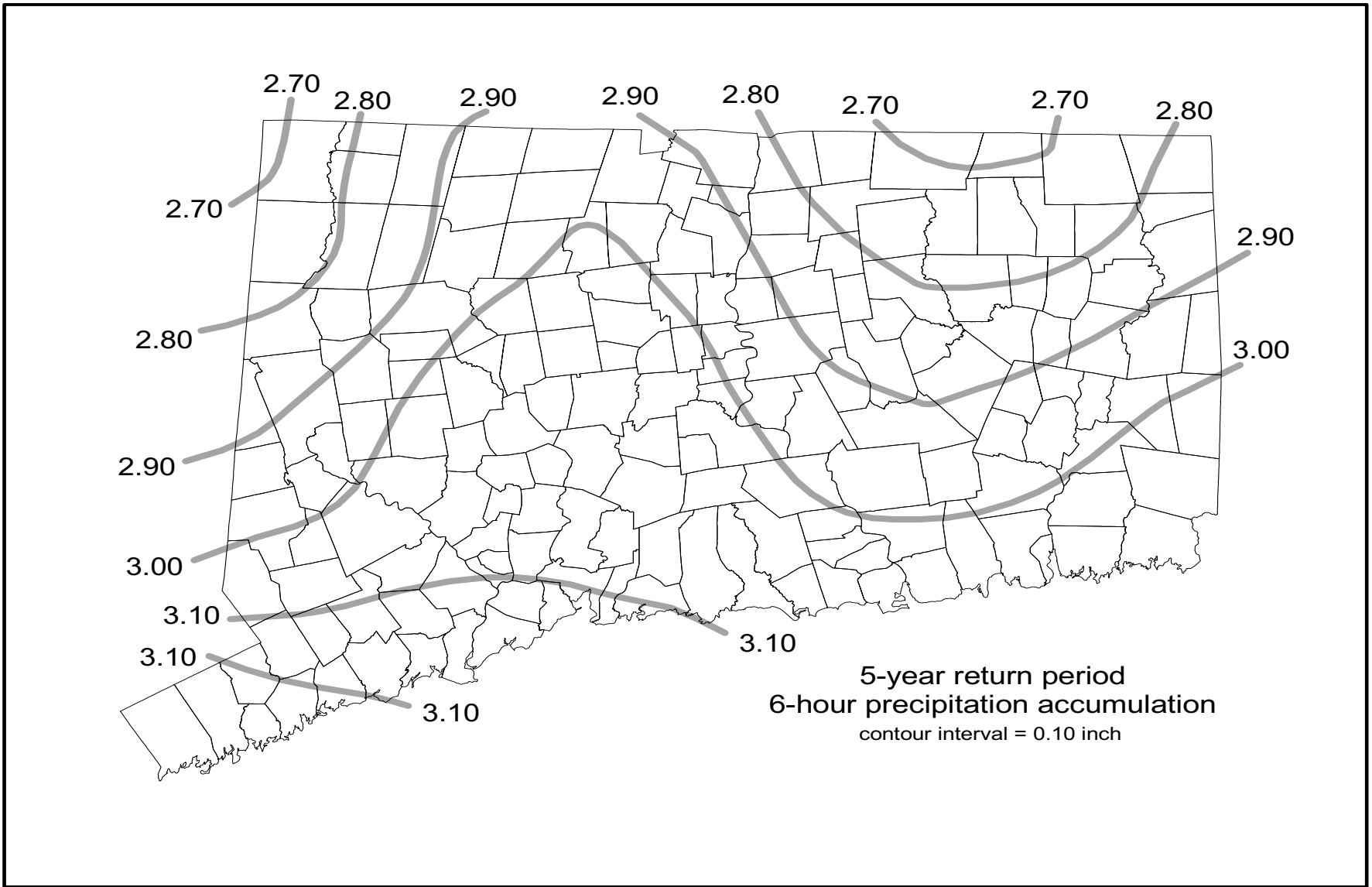


Figure 4h. Contour Map of 5-Year, 6-Hour Precipitation Accumulation in Connecticut.

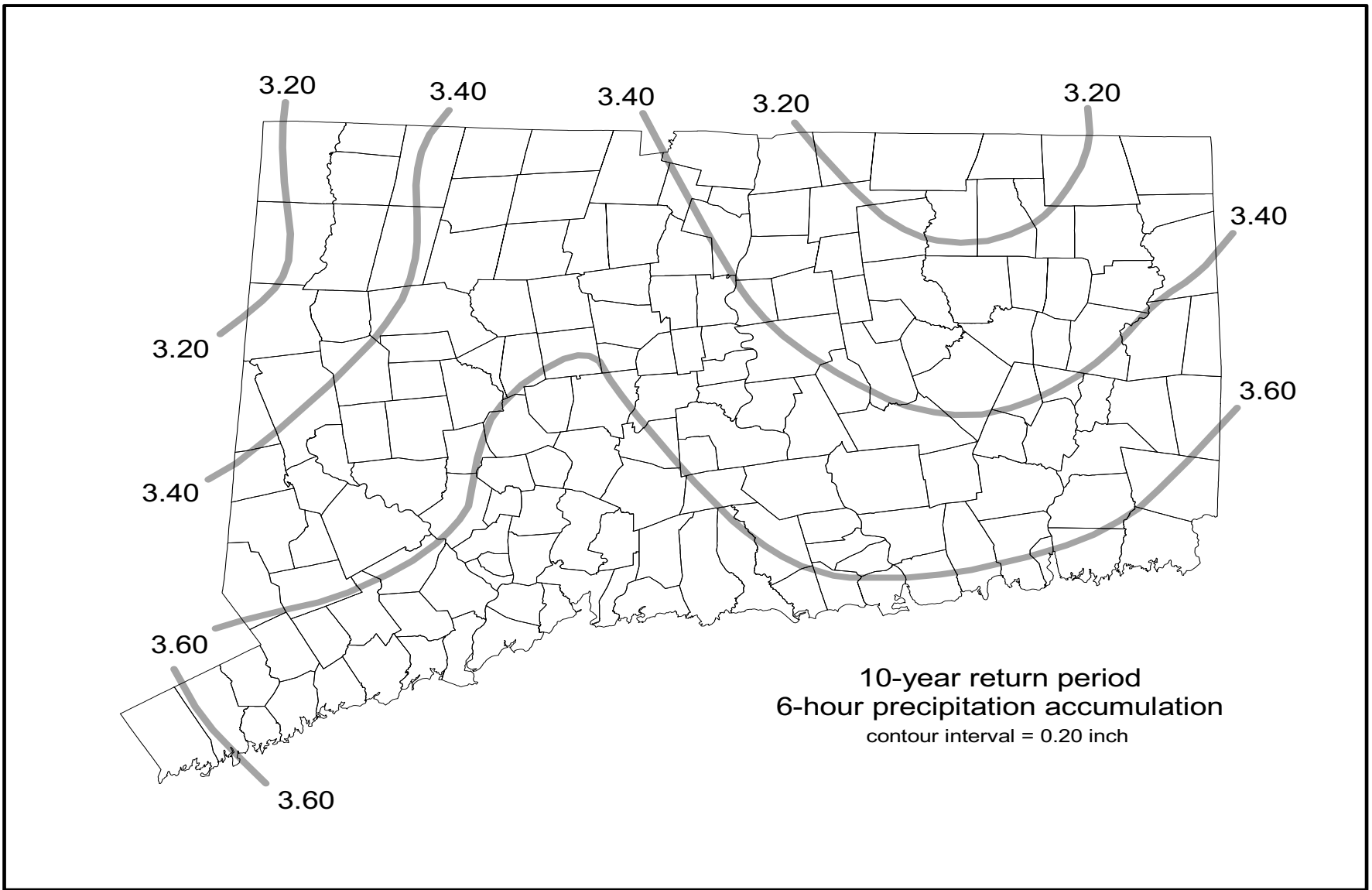


Figure 4i. Contour Map of 10-Year, 6-Hour Precipitation Accumulation in Connecticut.

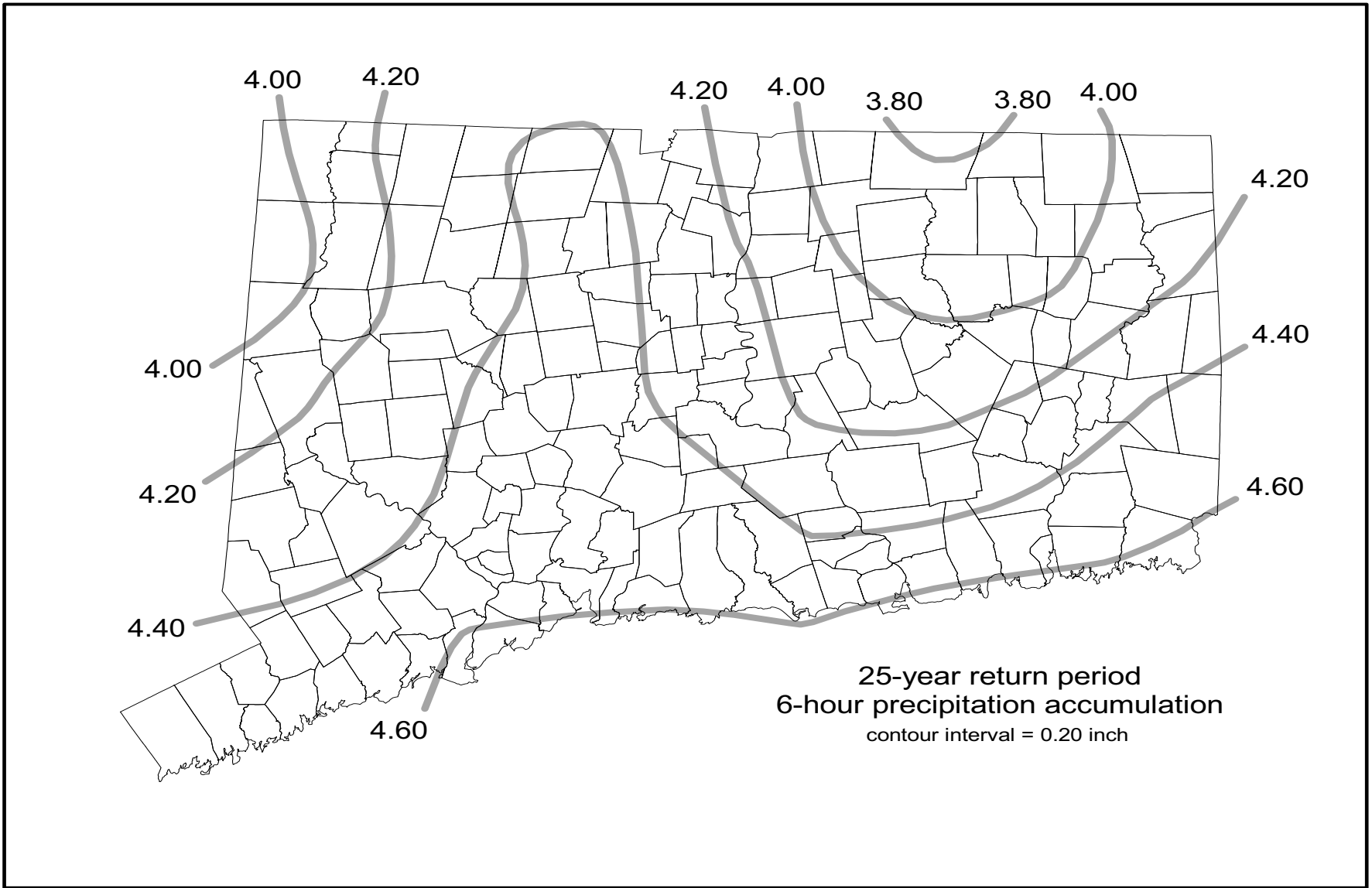


Figure 4j. Contour Map of 25-Year, 6-Hour Precipitation Accumulation in Connecticut.

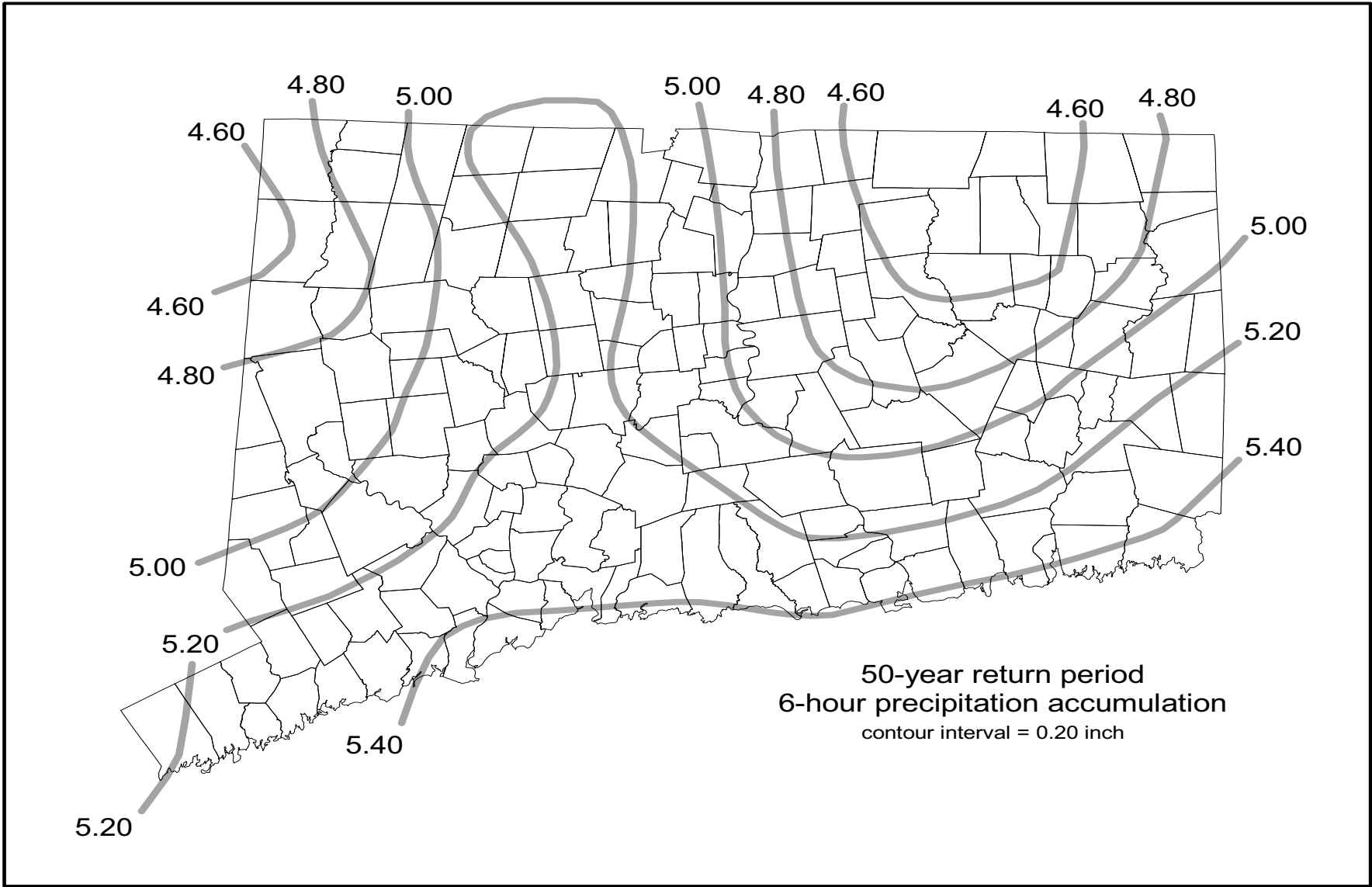


Figure 4k. Contour Map of 50-Year, 6-Hour Precipitation Accumulation in Connecticut.

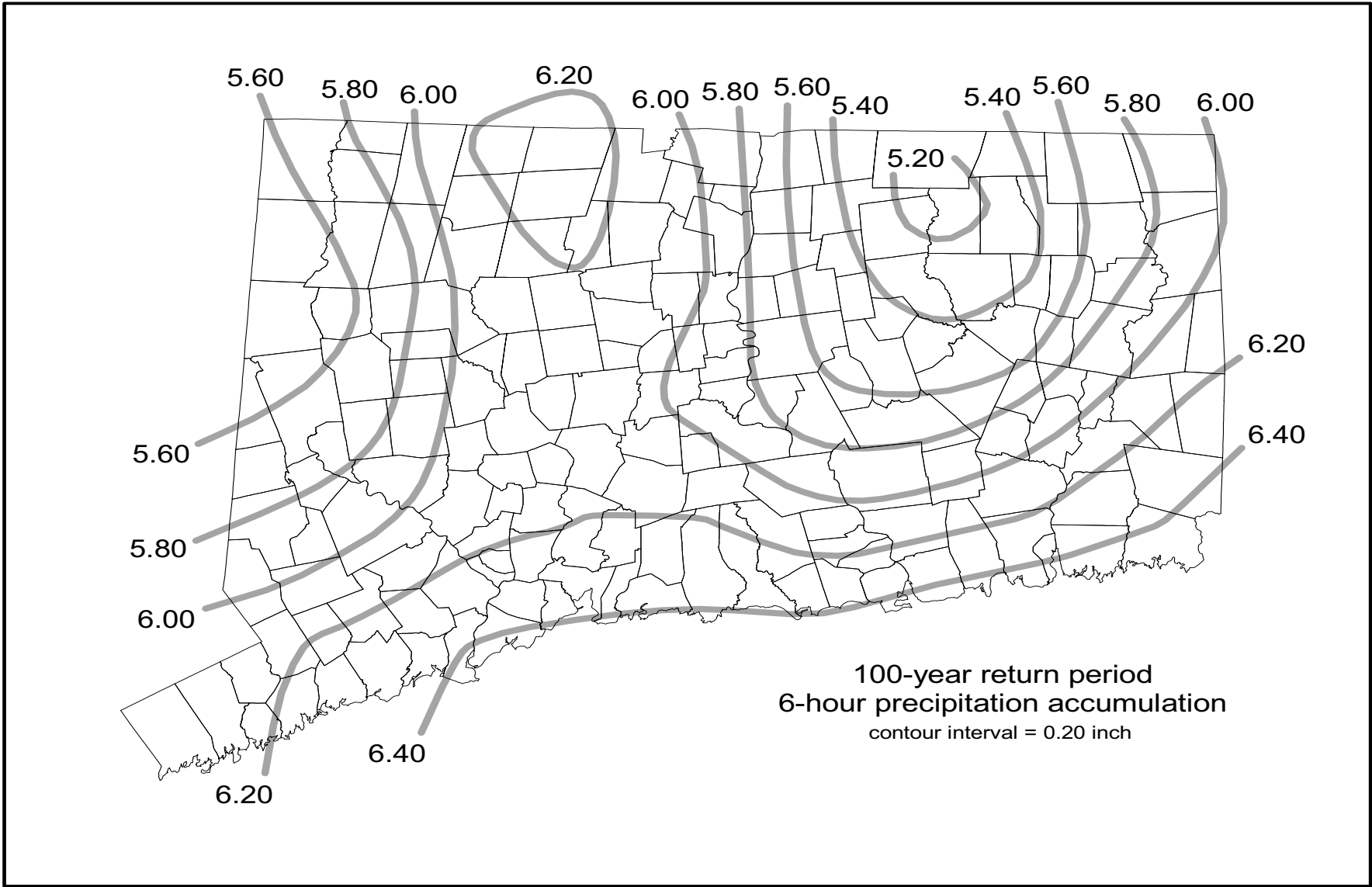


Figure 4I. Contour Map of 100-Year, 6-Hour Precipitation Accumulation in Connecticut.

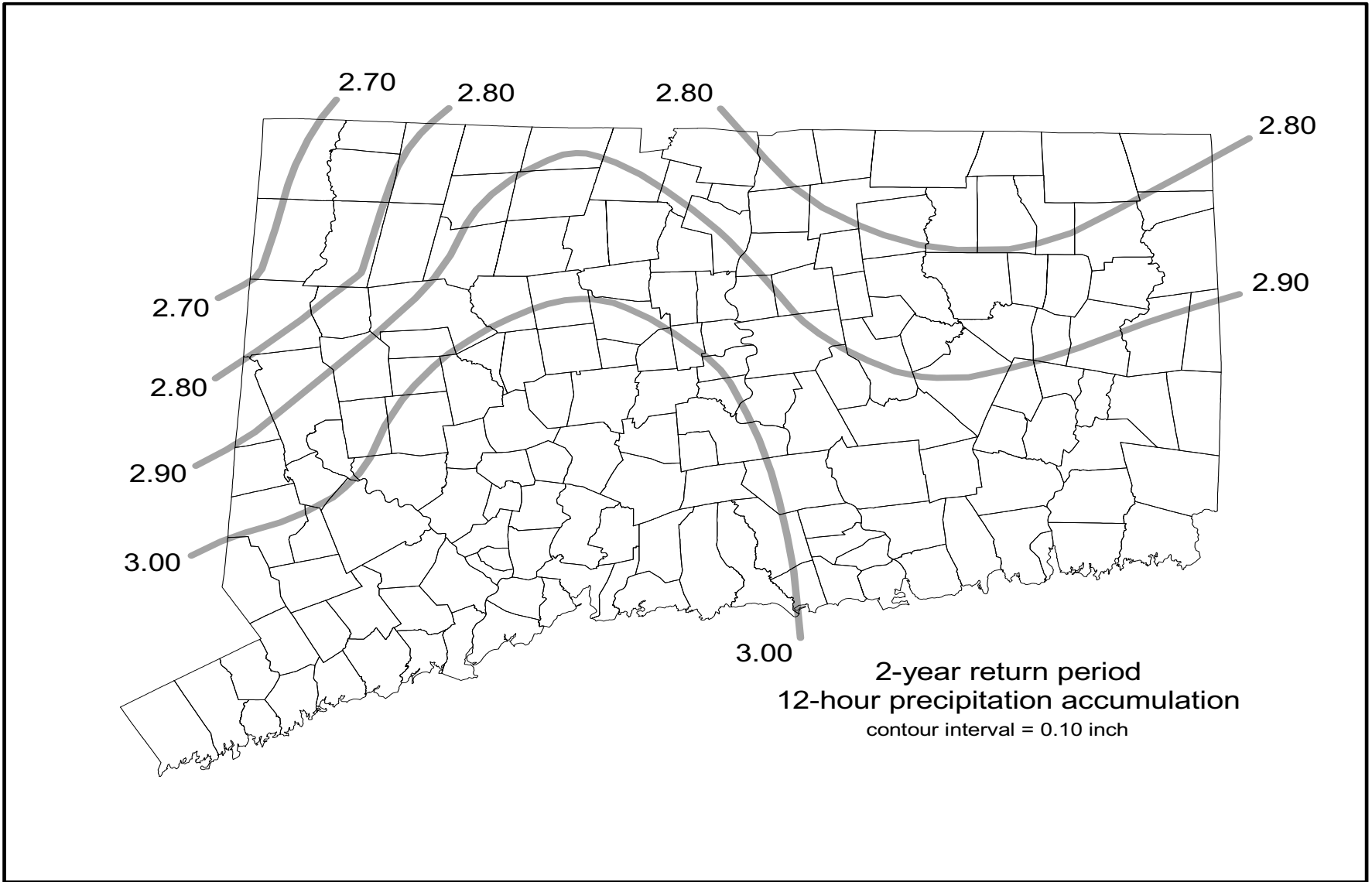


Figure 4m. Contour Map of 2-Year, 12-Hour Precipitation Accumulation in Connecticut.

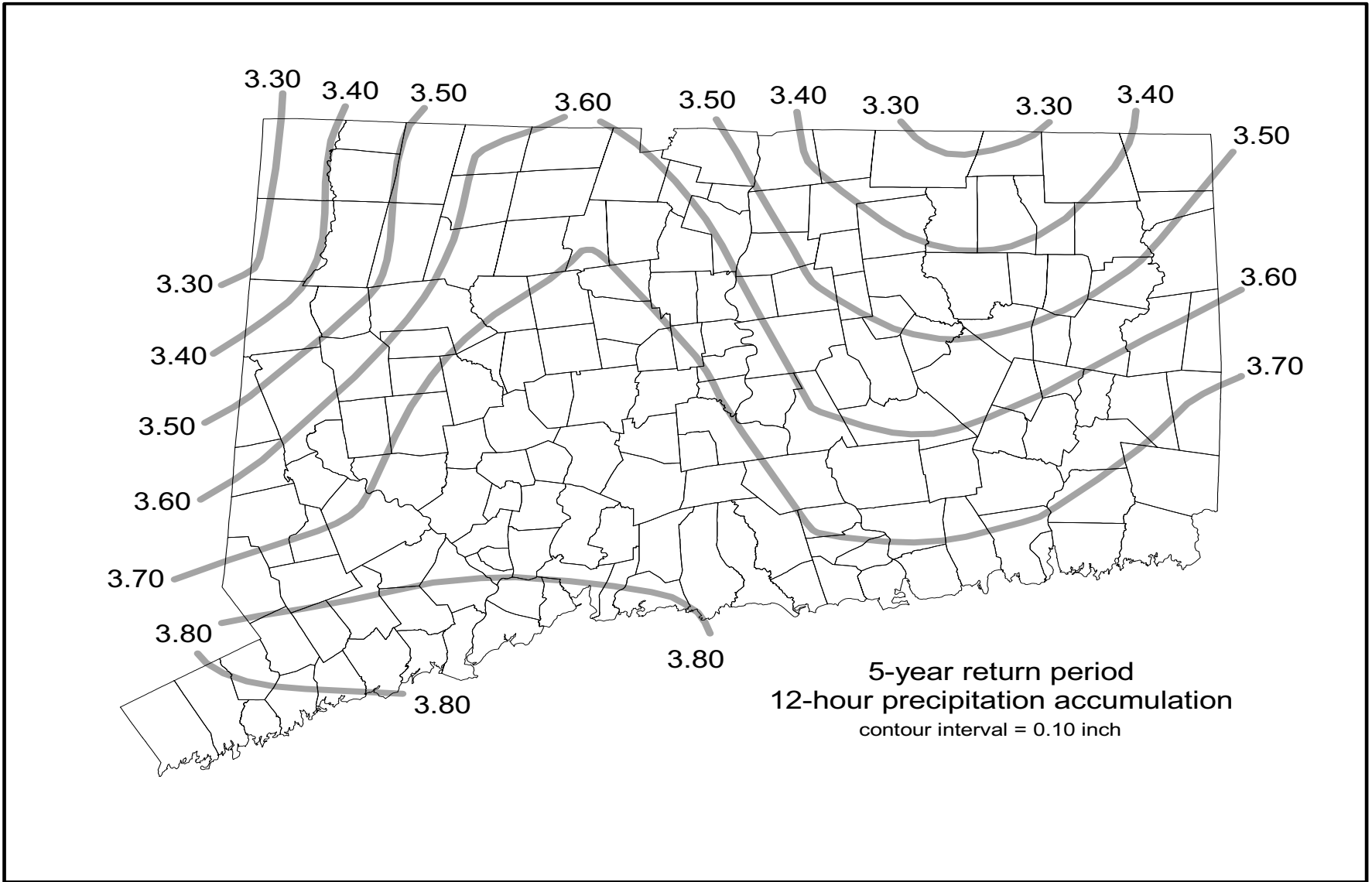


Figure 4n. Contour Map of 5-Year, 12-Hour Precipitation Accumulation in Connecticut.

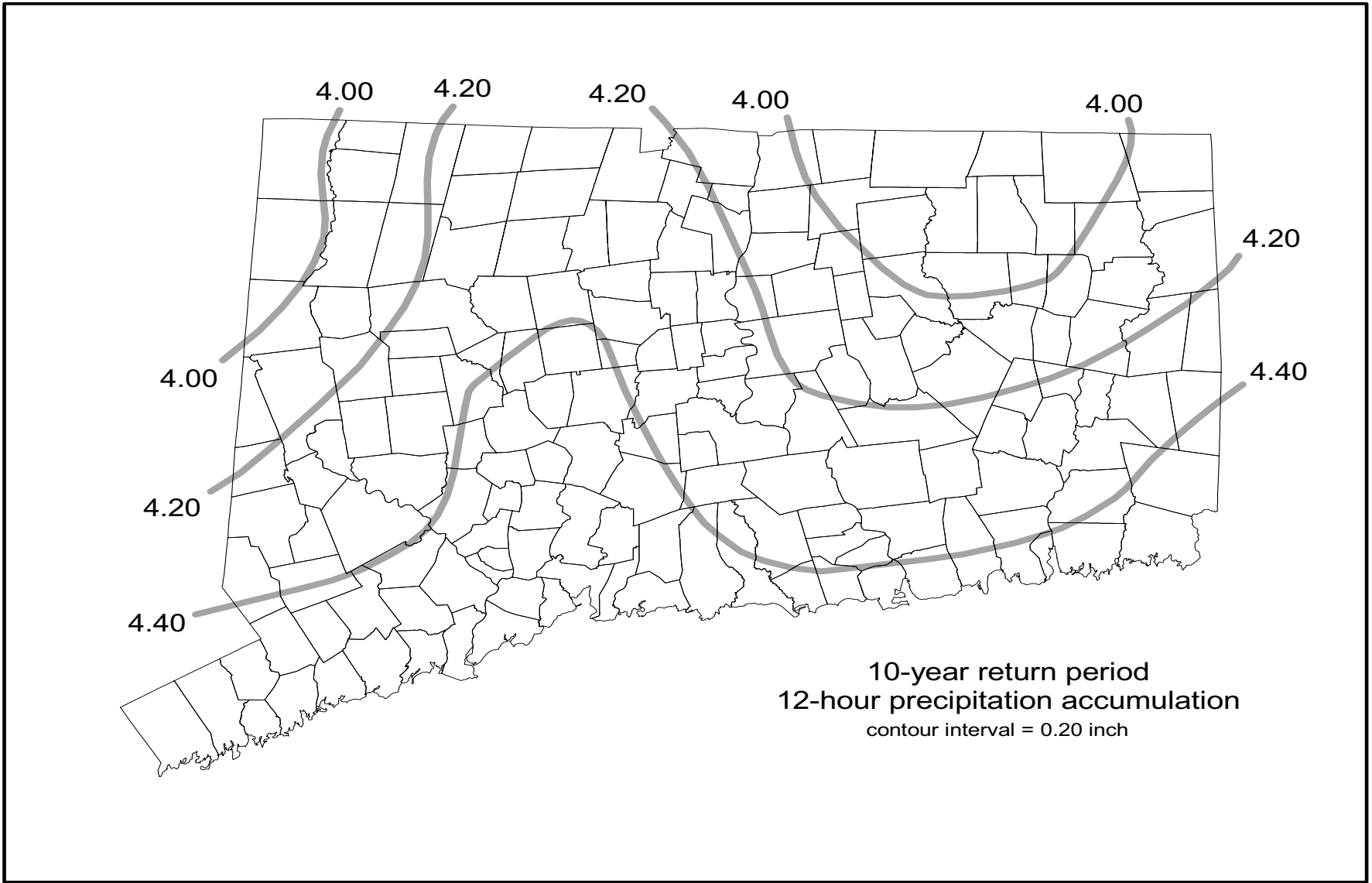


Figure 4b. Contour Map of 10-Year, 12-Hour Precipitation Accumulation in Connecticut.

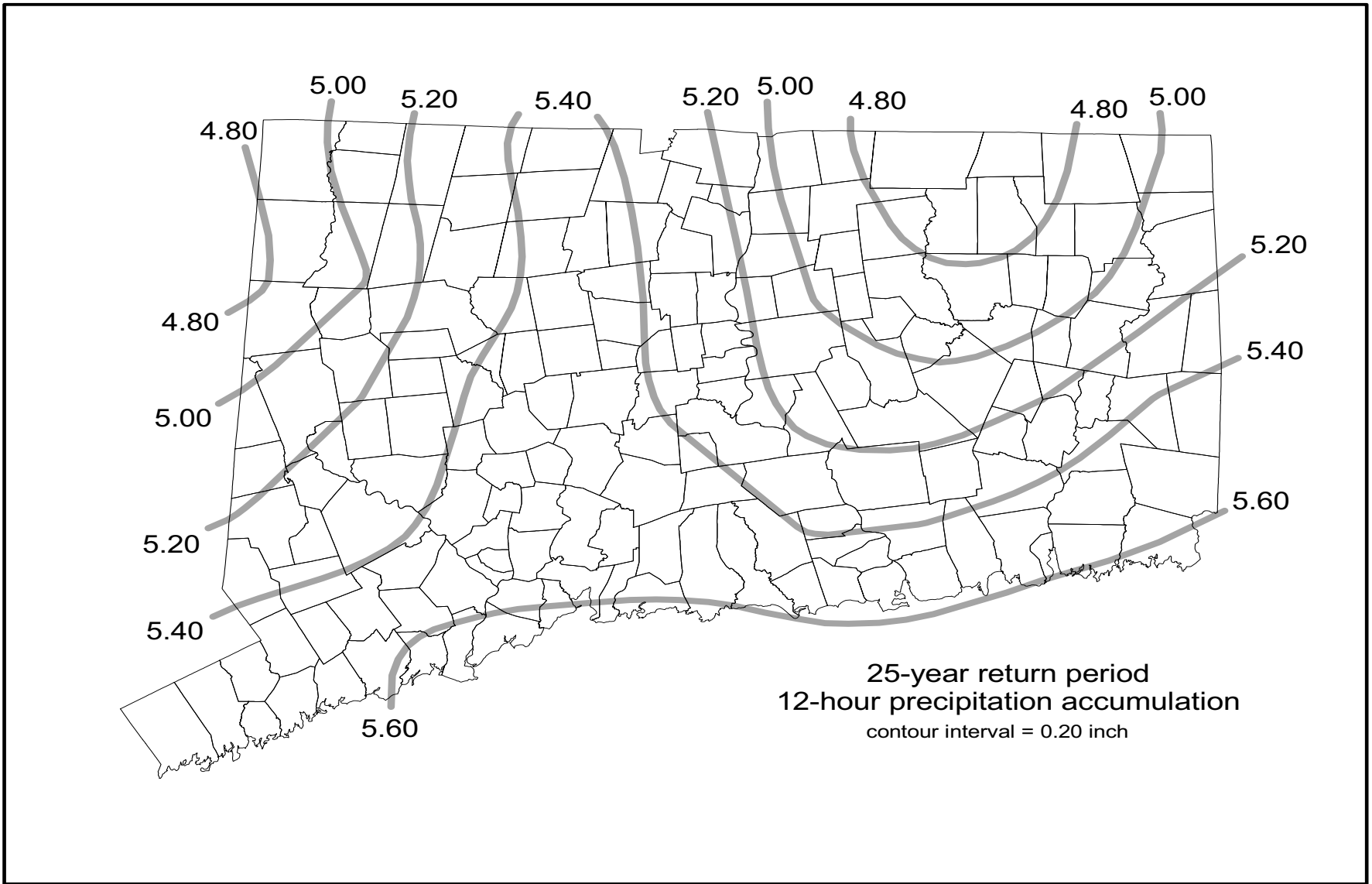


Figure 4p. Contour Map of 25-Year, 12-Hour Precipitation Accumulation in Connecticut.

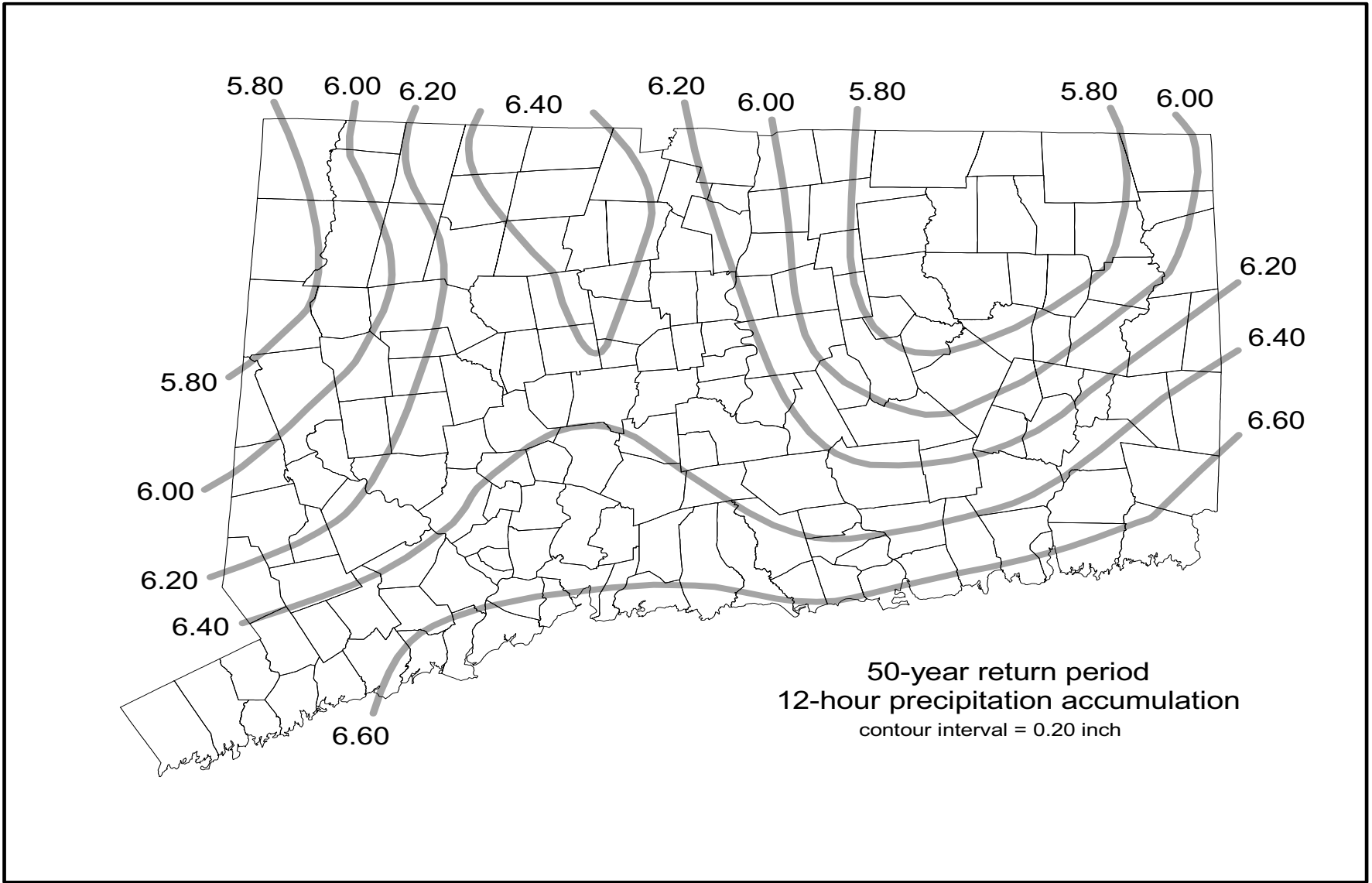


Figure 4q. Contour Map of 50-Year, 12-Hour Precipitation Accumulation in Connecticut.

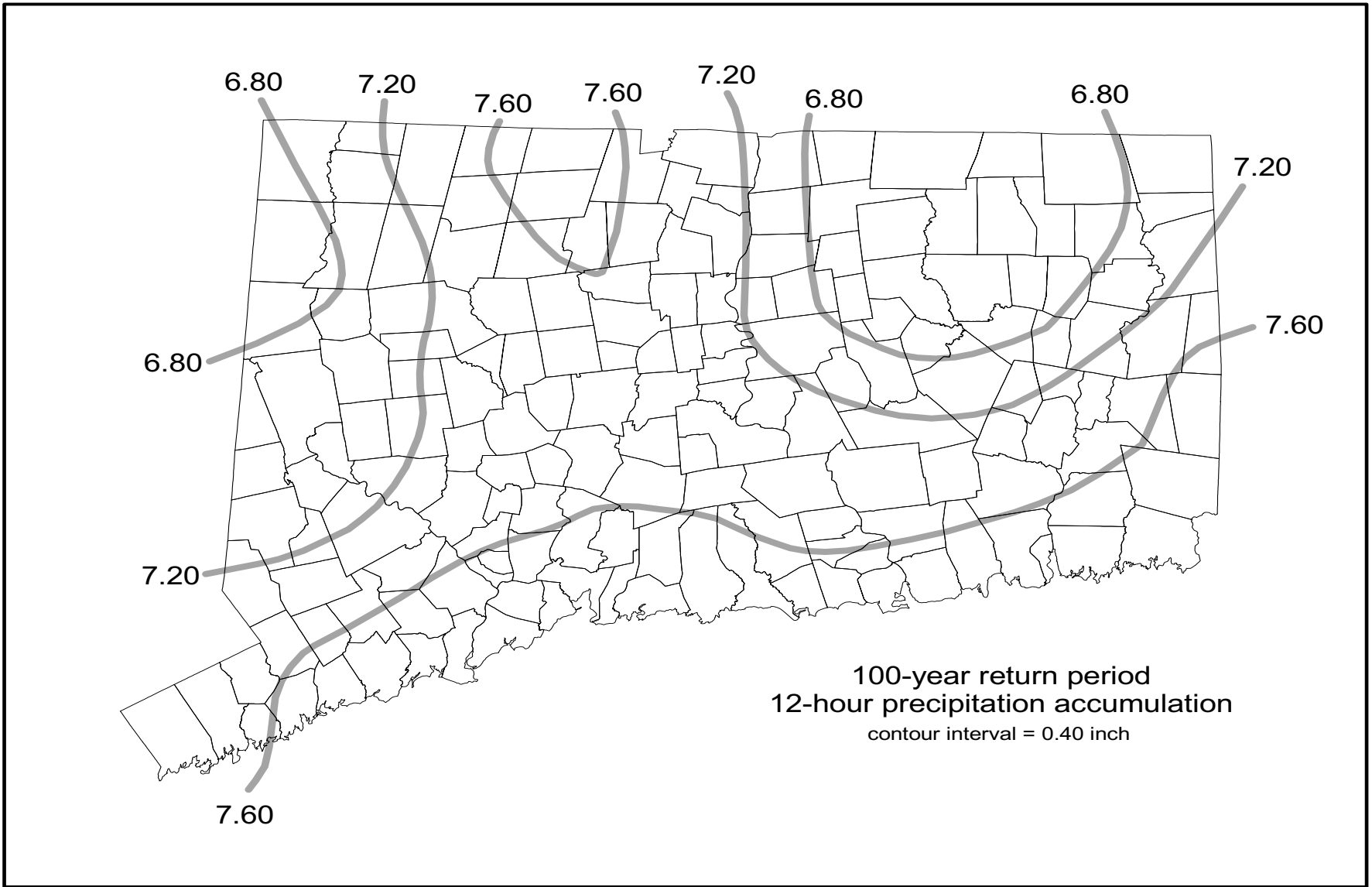


Figure 4r. Contour Map of 100-Year, 12-Hour Precipitation Accumulation in Connecticut.

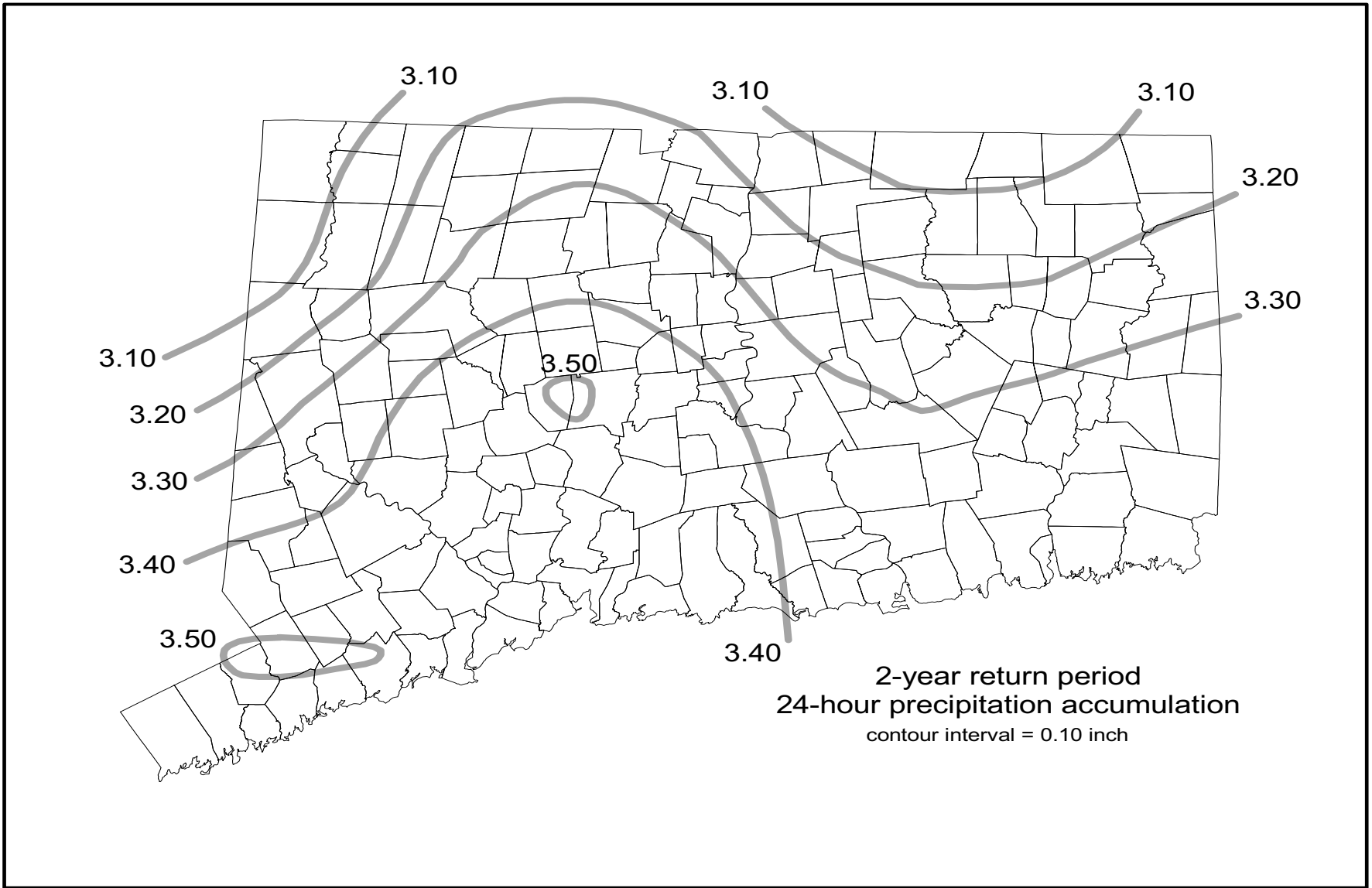


Figure 4s. Contour Map of 2-Year, 24-Hour Precipitation Accumulation in Connecticut.

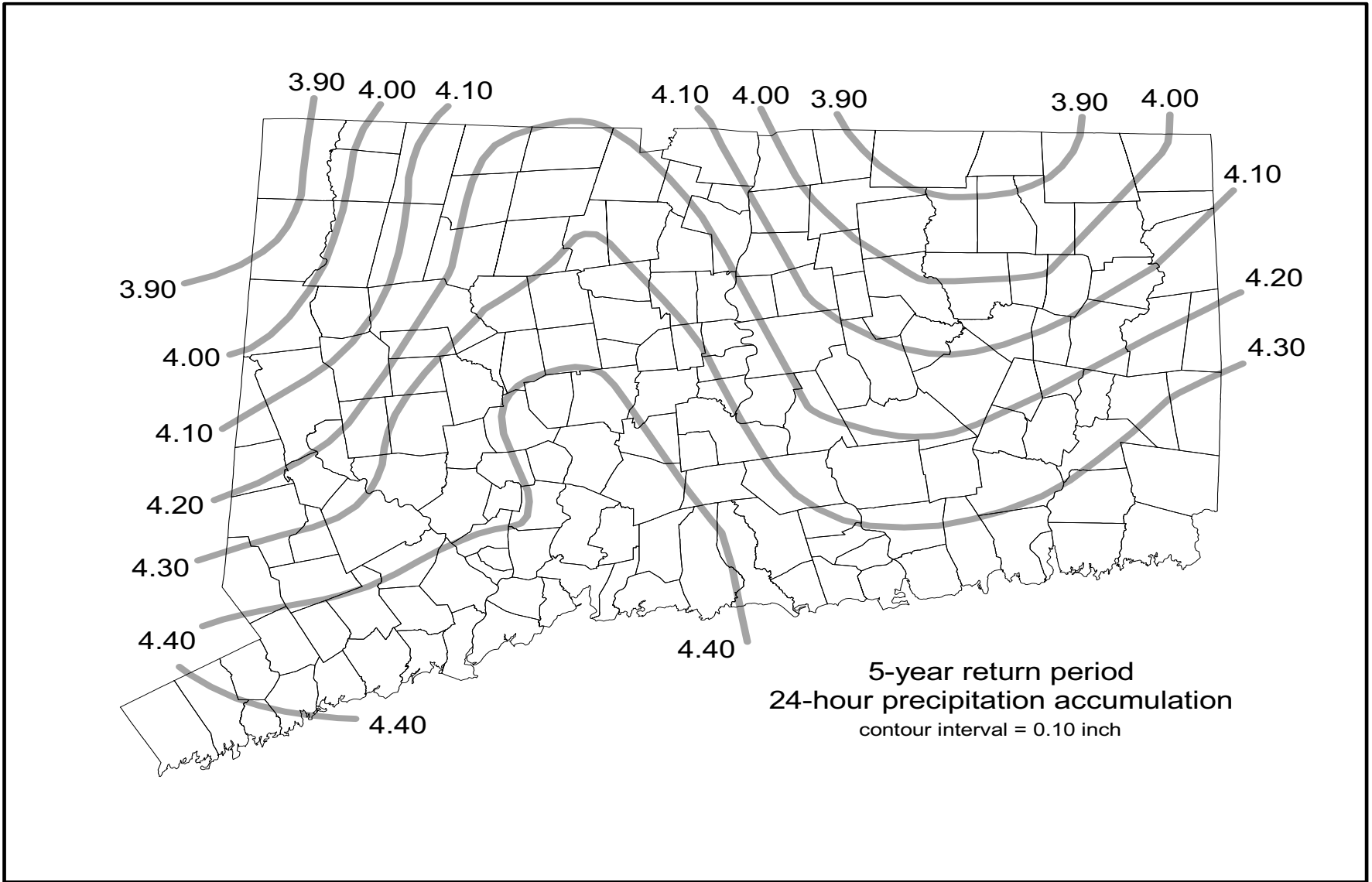


Figure 4t. Contour Map of 5-Year, 24-Hour Precipitation Accumulation in Connecticut.

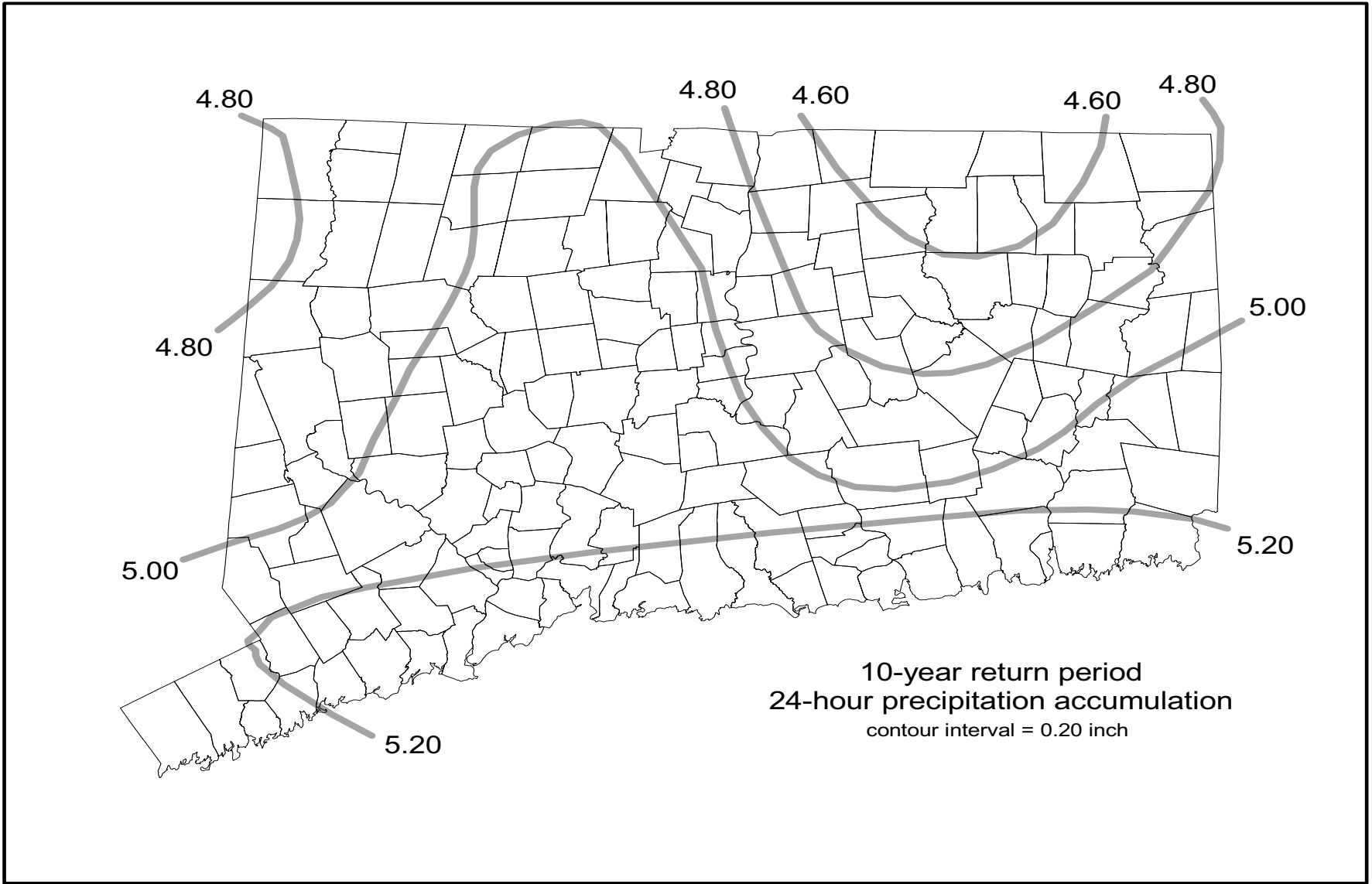


Figure 4u. Contour Map of 10-Year, 24-Hour Precipitation Accumulation in Connecticut.

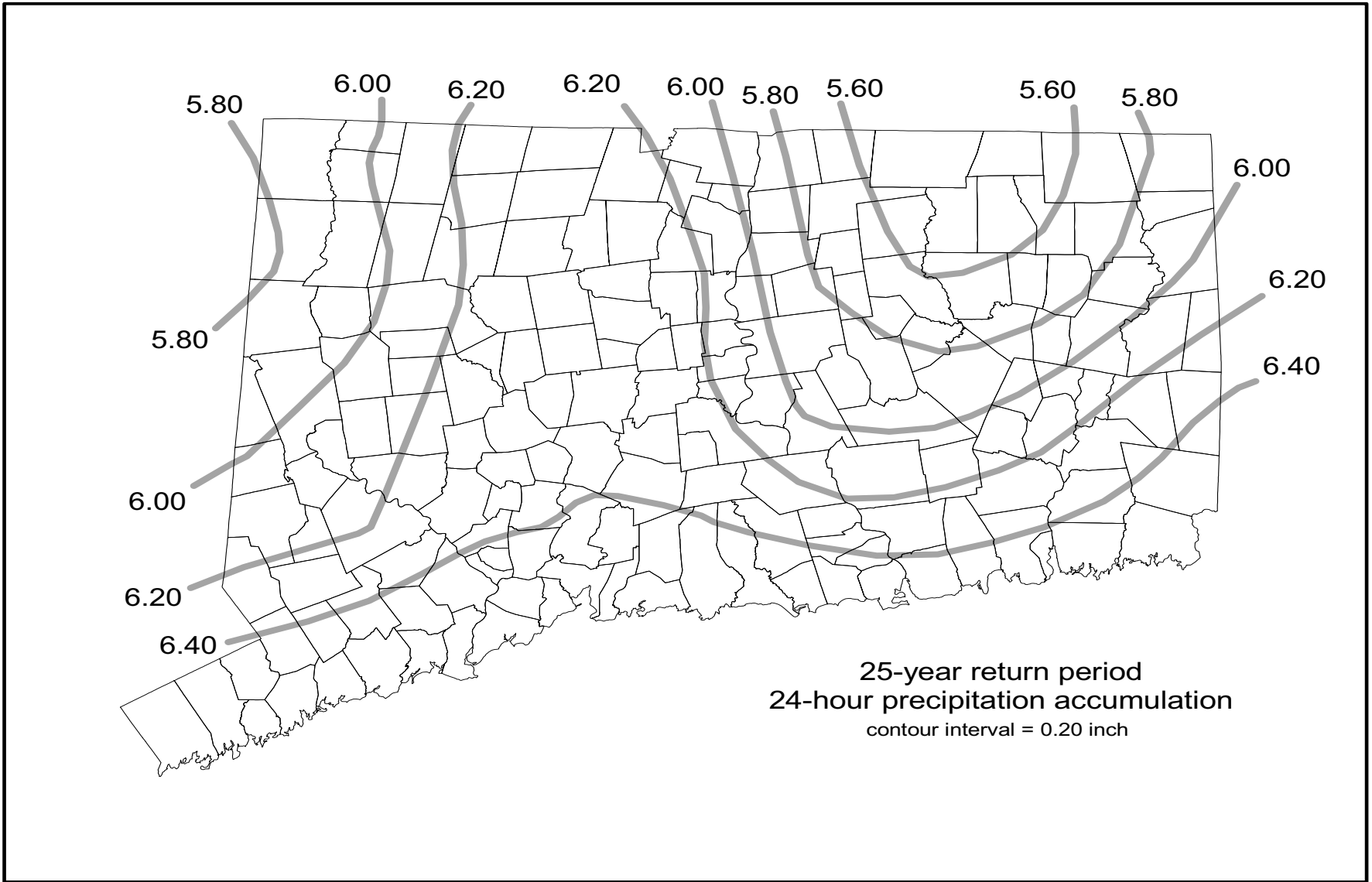


Figure 4v. Contour Map of 25-Year, 24-Hour Precipitation Accumulation in Connecticut.

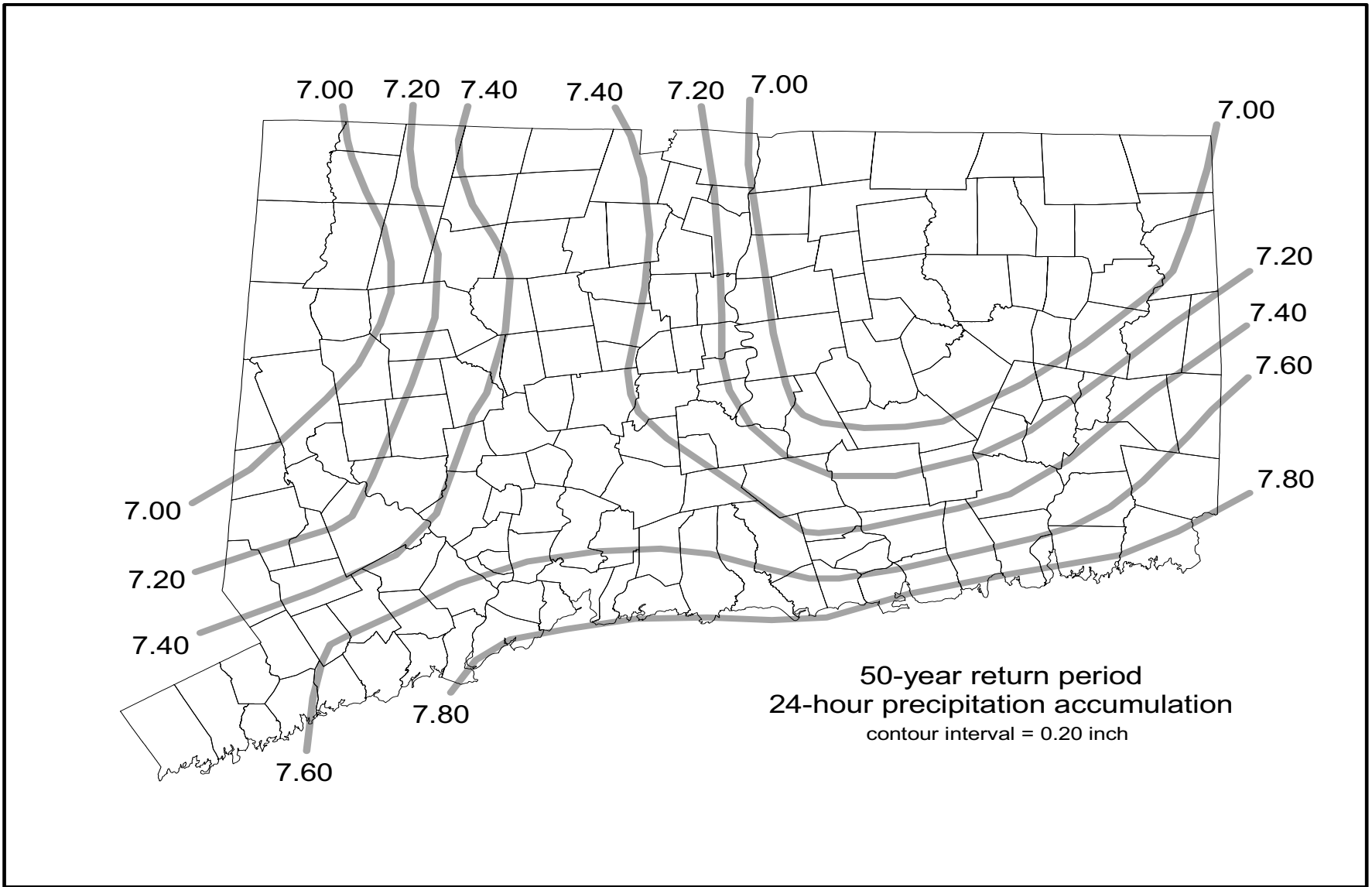


Figure 4w. Contour Map of 50-Year, 24-Hour Precipitation Accumulation in Connecticut.

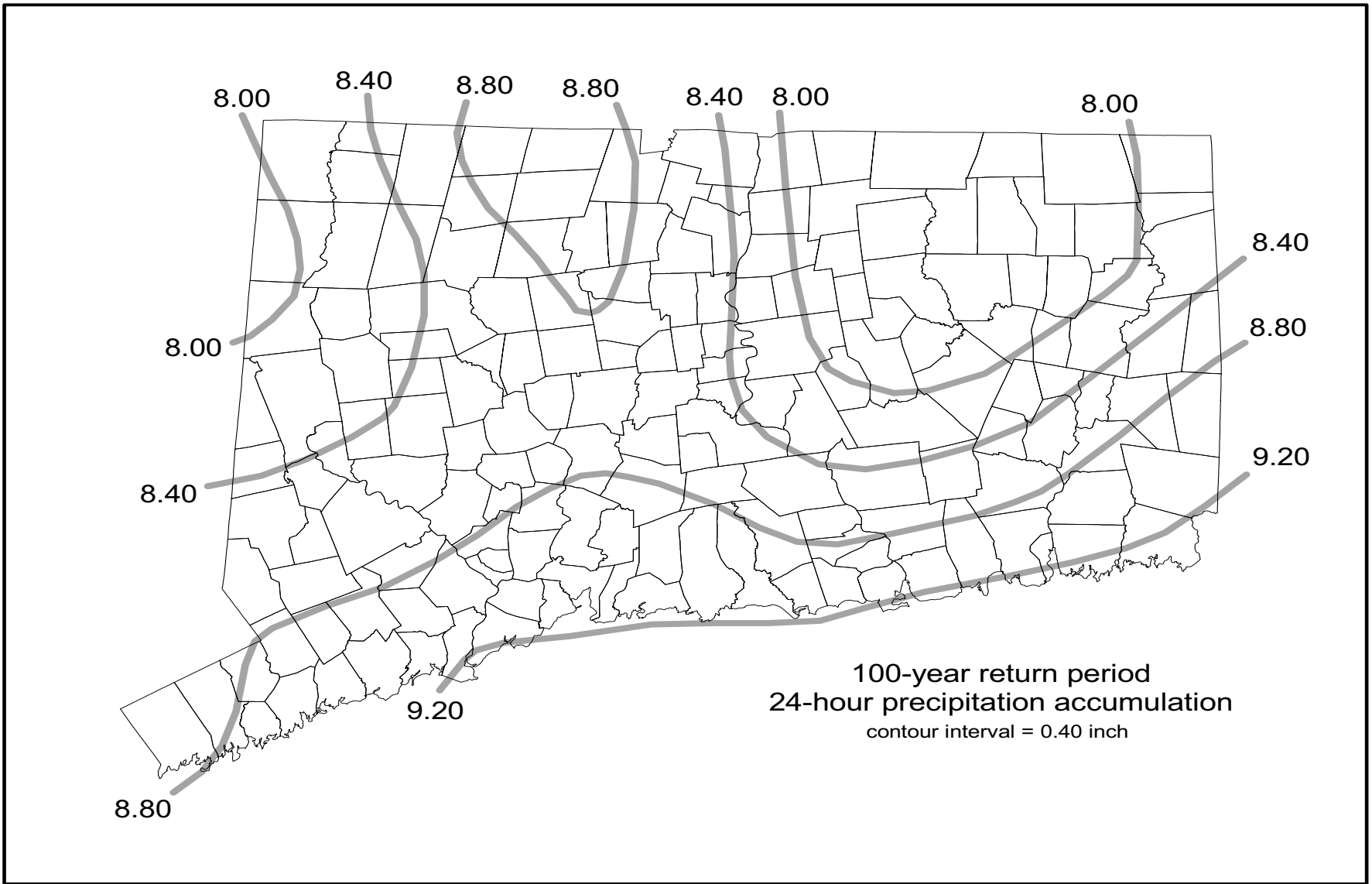


Figure 4x. Contour Map of 100-Year, 24-Hour Precipitation Accumulation in Connecticut.

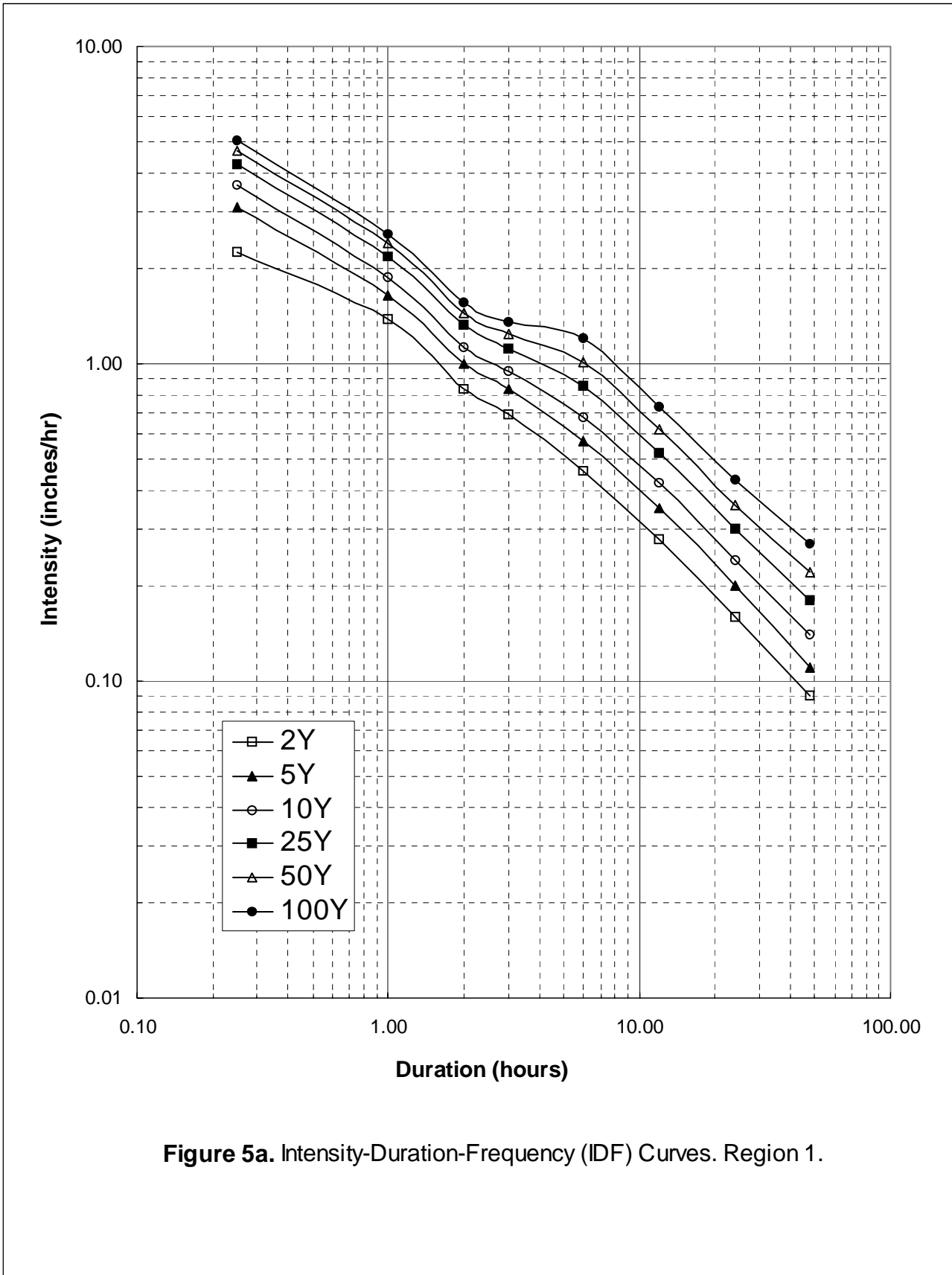


Figure 5a. Intensity-Duration-Frequency (IDF) Curves. Region 1.

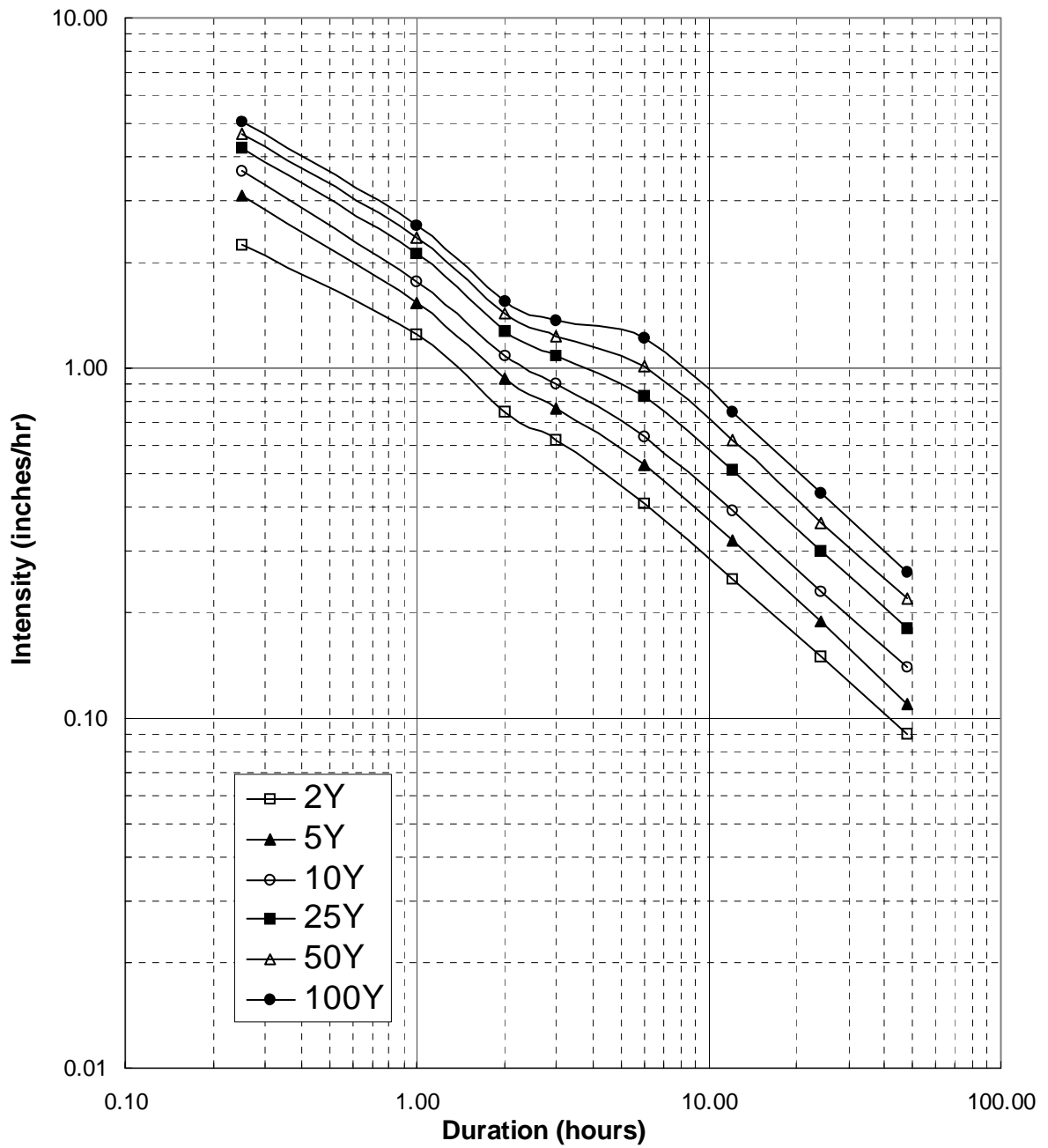
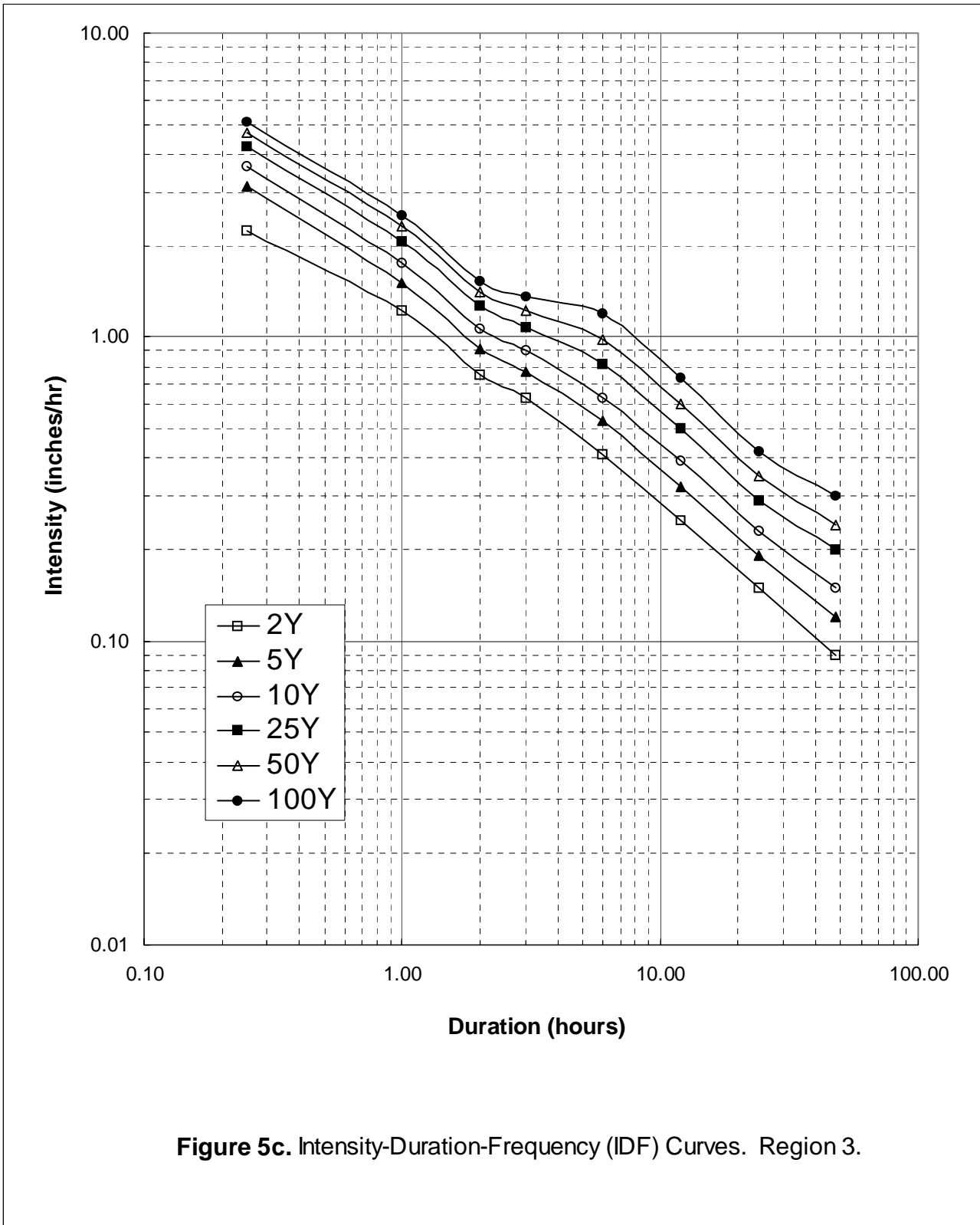


Figure 5b. Intensity-Duration-Frequency (IDF) Curves. Region 2.



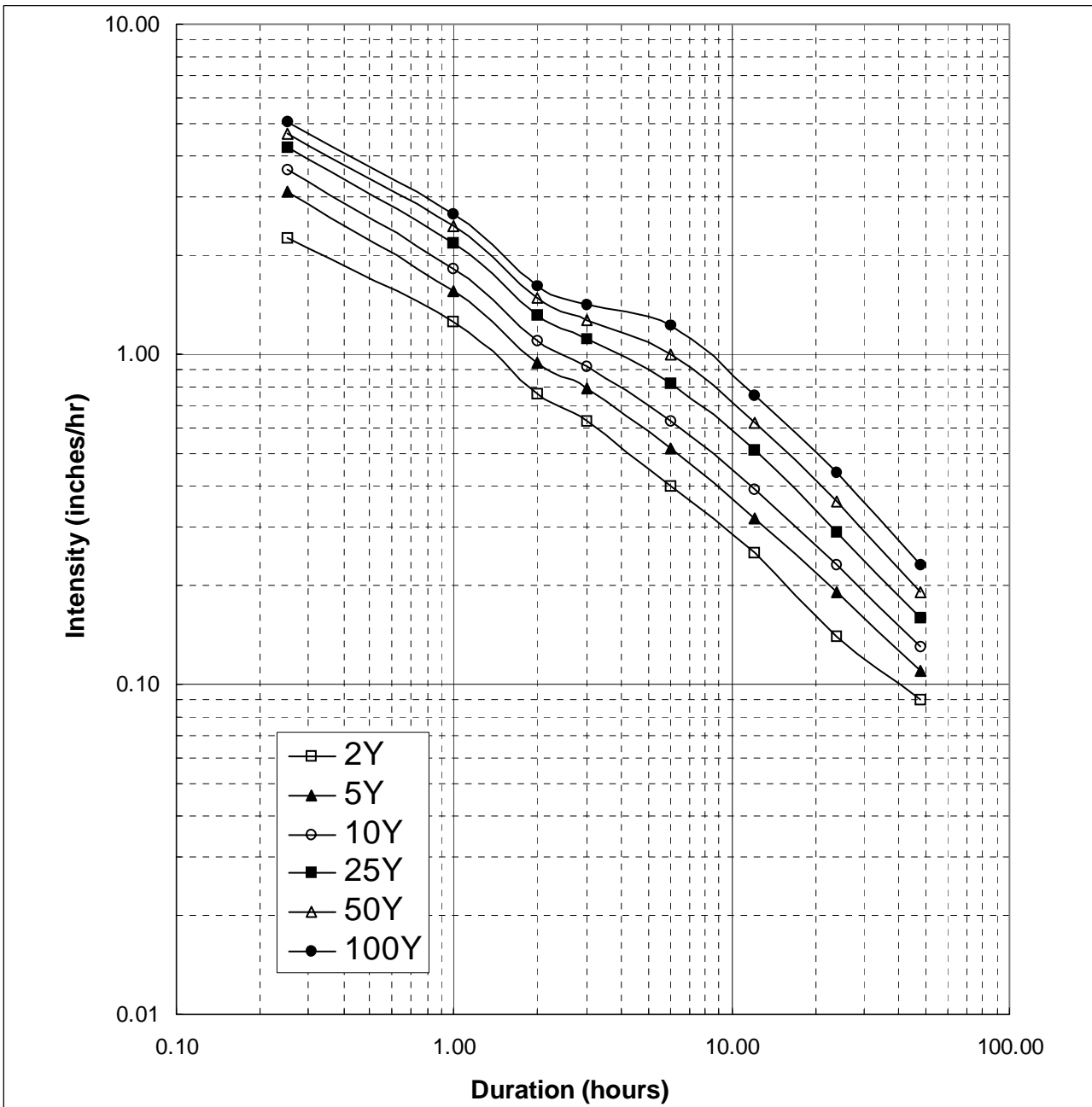


Figure 5d. Intensity-Duration-Frequency (IDF) Curves. Region 4.

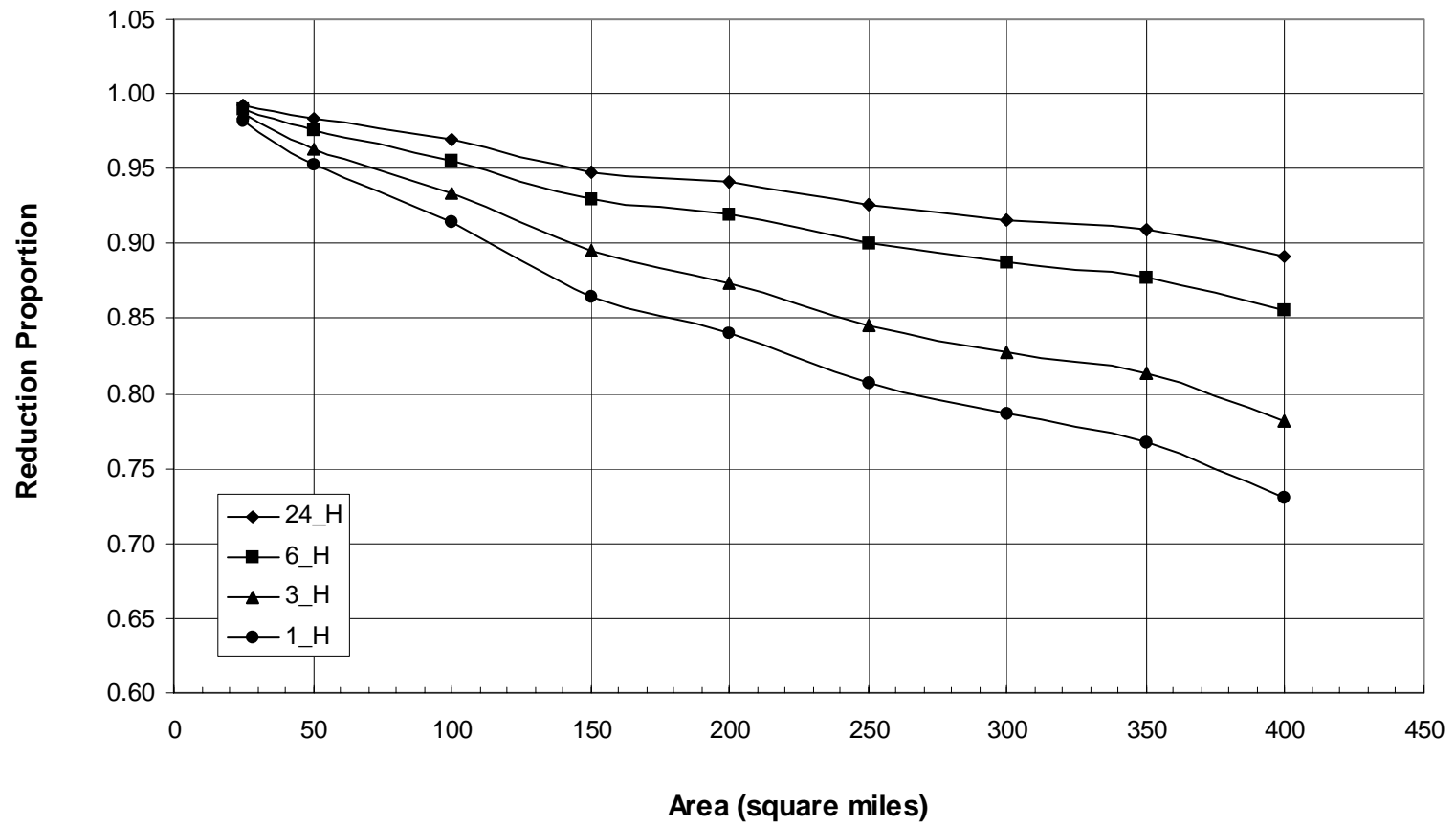


Figure 6a. Area Reduction Curves. Region 1.

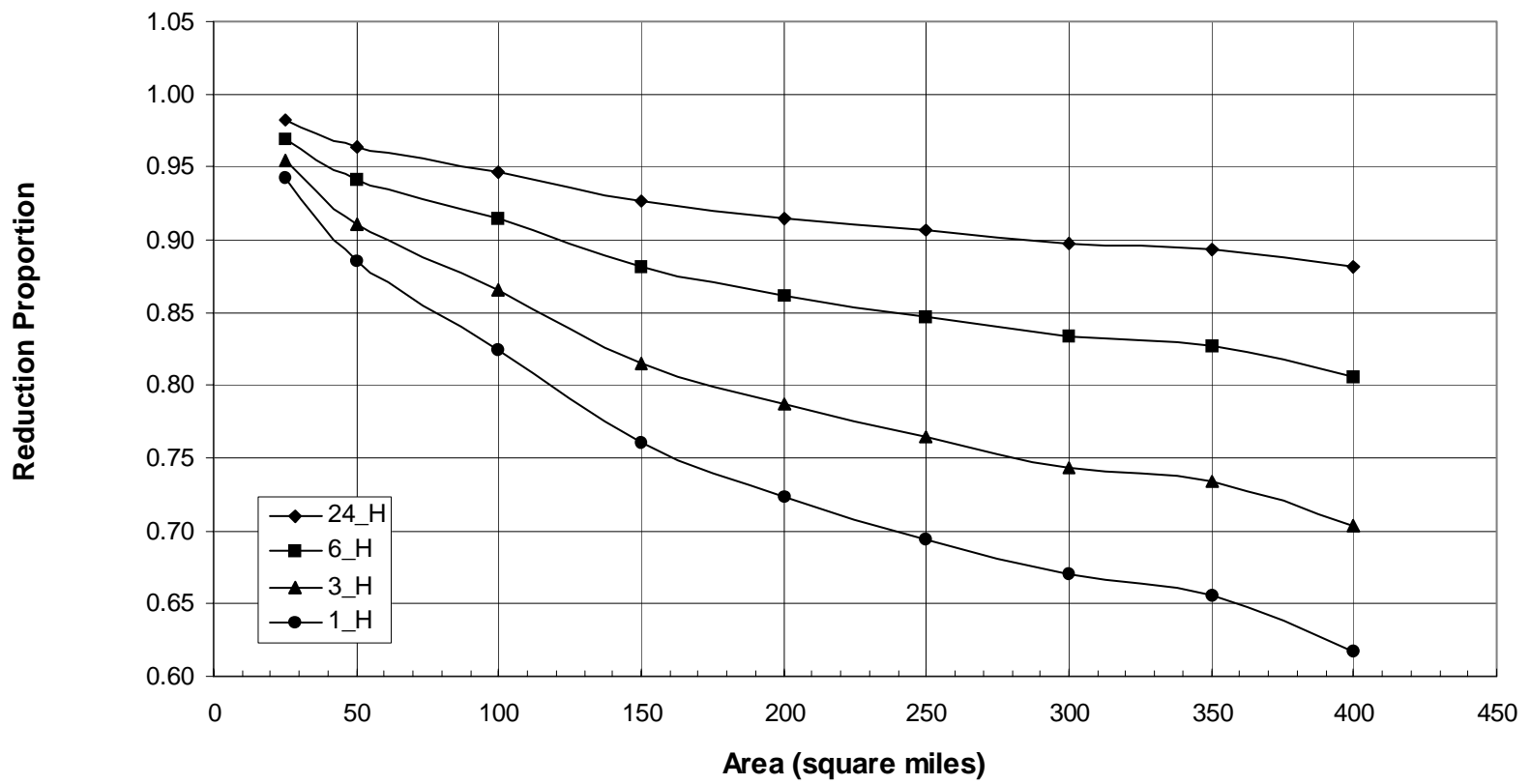


Figure 6b. Area Reduction Curves. Region 2.

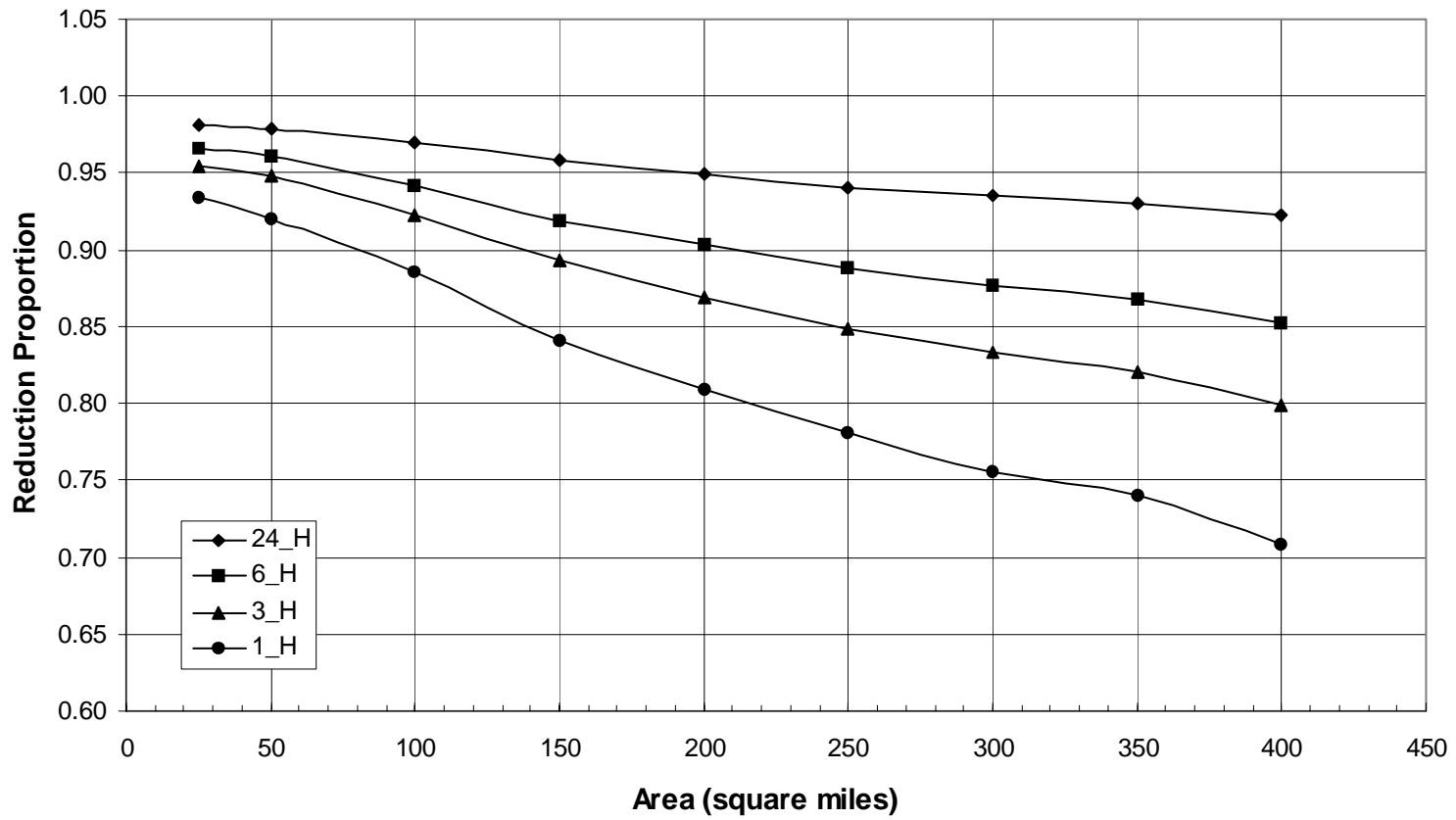


Figure 6c. Area Reduction Curves. Region 3.

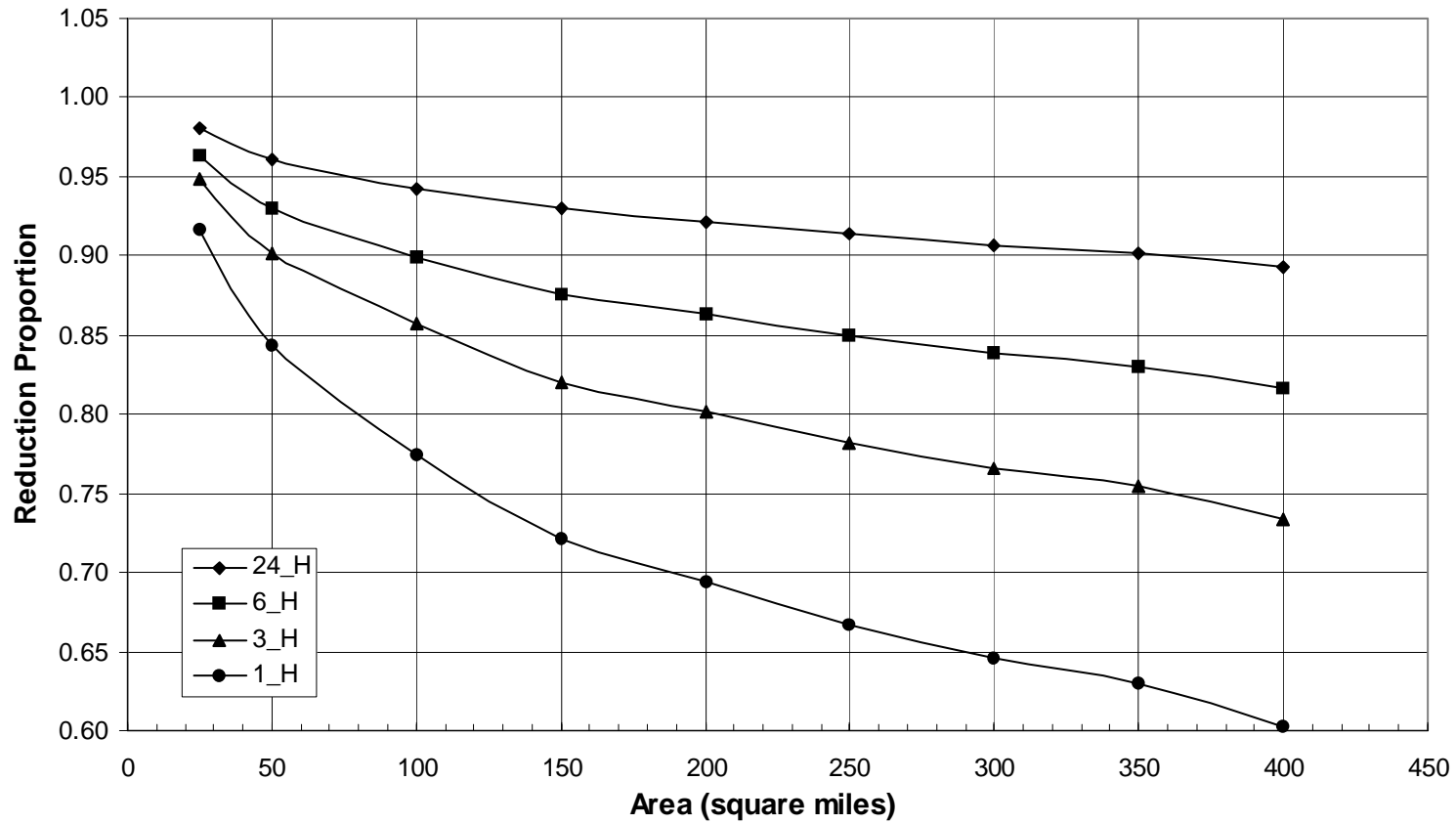


Figure 6d. Area Reduction Curves. Region 4.

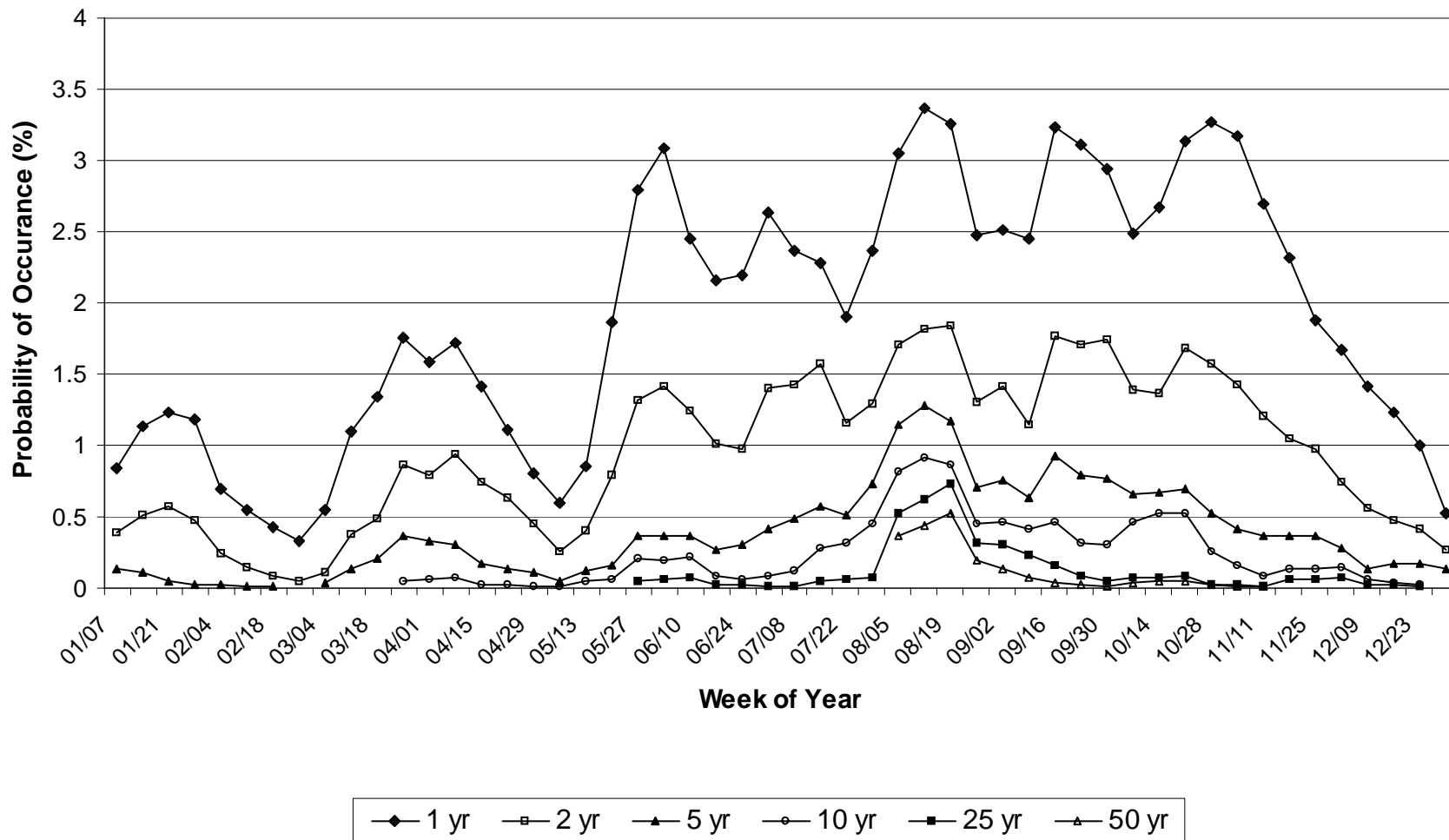


Figure 7a. Weekly Distribution of 24 hr Extreme Precipitation. Region 1.

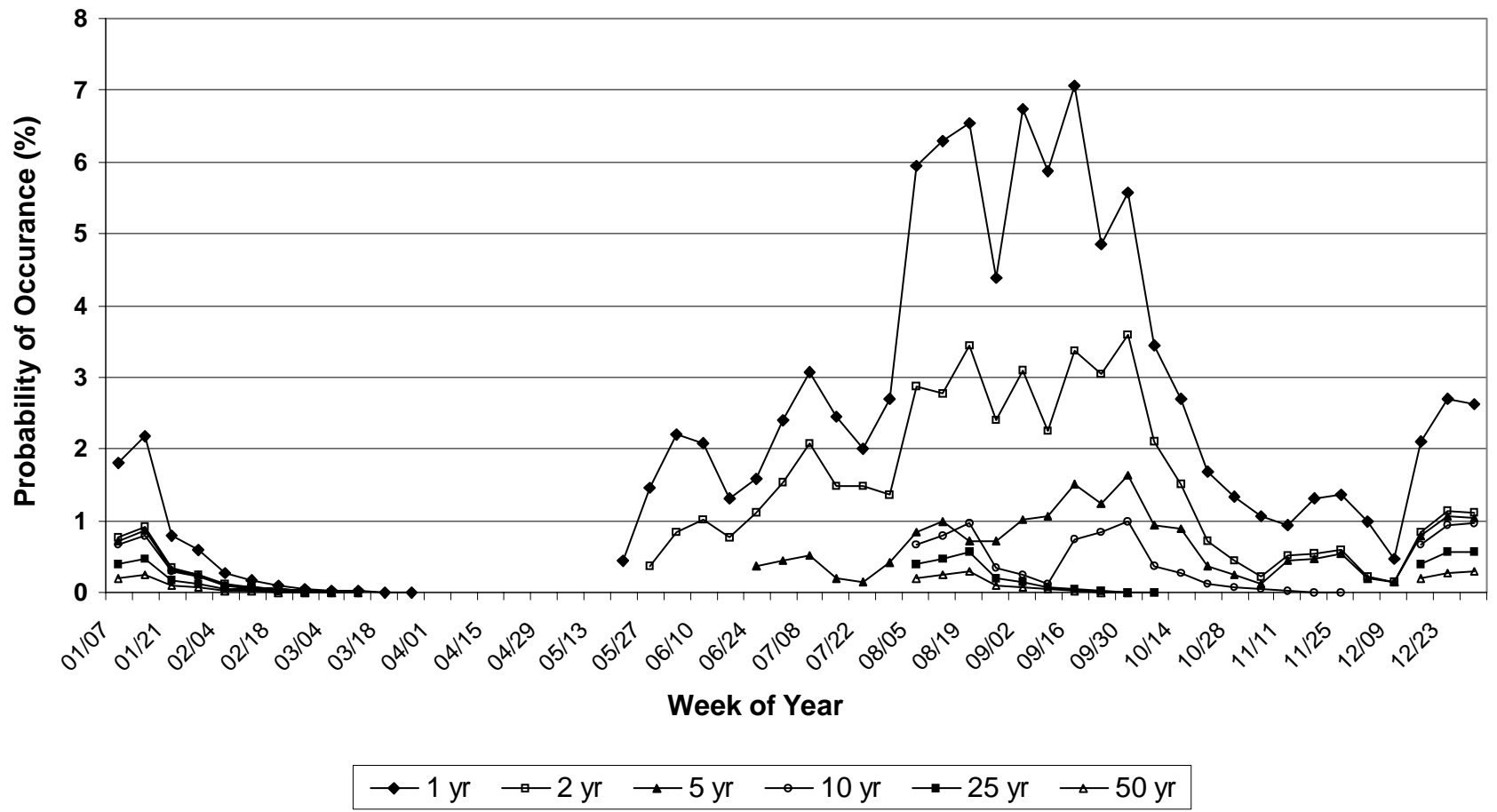


Figure 7b. Weekly Distribution of 6 hr Extreme Precipitation. Region 1.

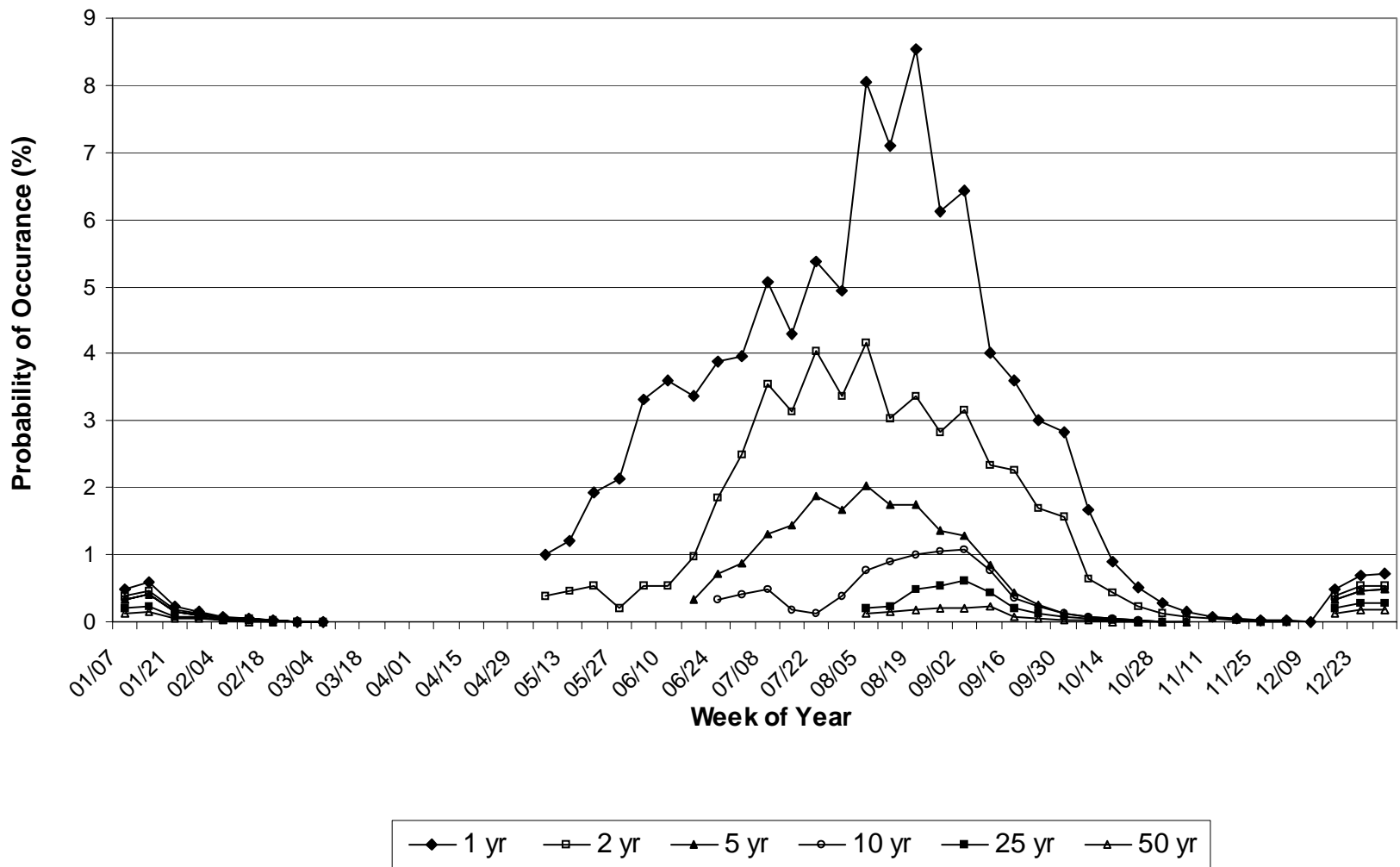


Figure 7c. Weekly Distribution of 1 hr Extreme Precipitation. Region 1.

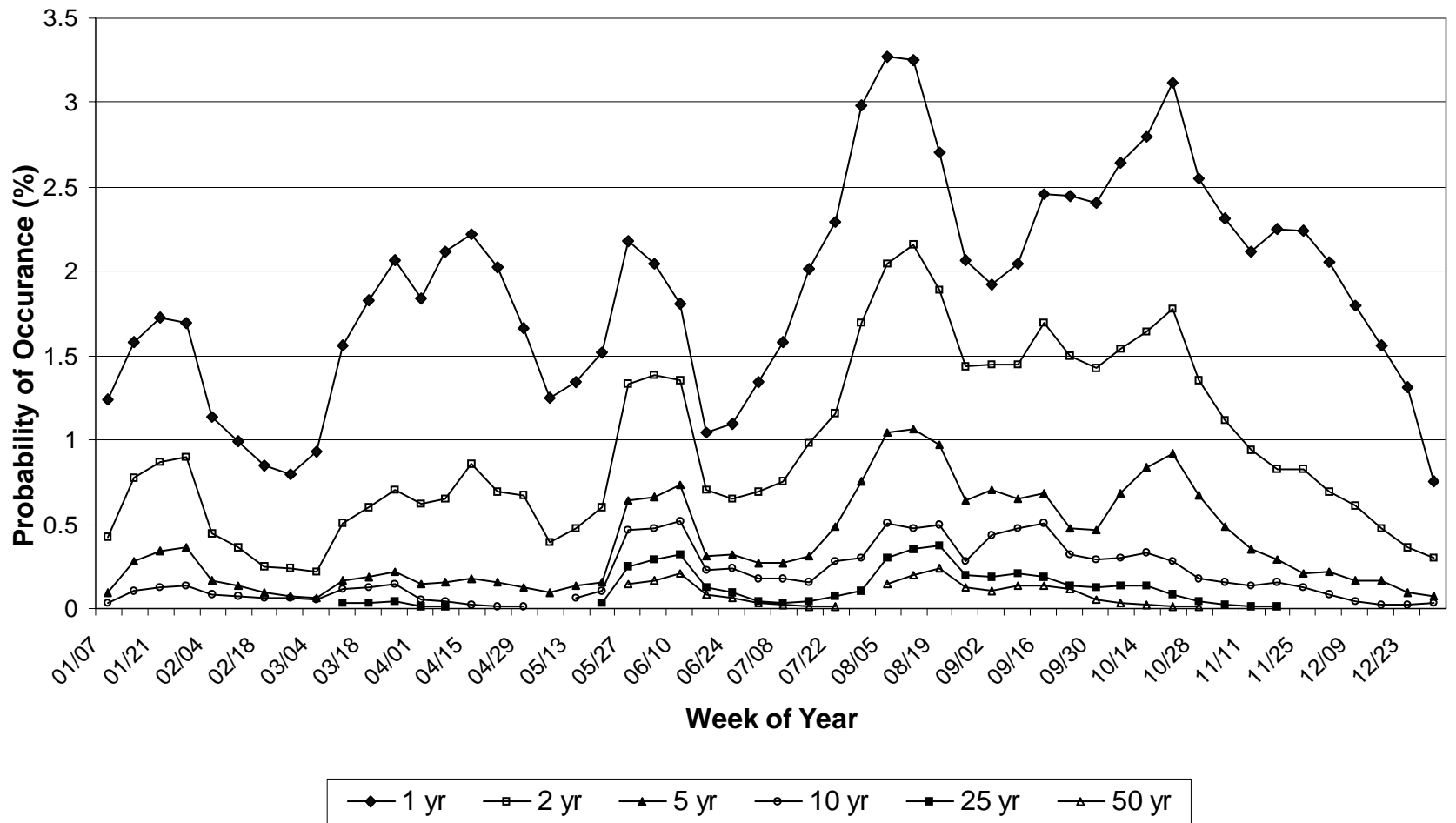


Figure 7d. Weekly Distribution of 24 hr Extreme Precipitation. Region 2.

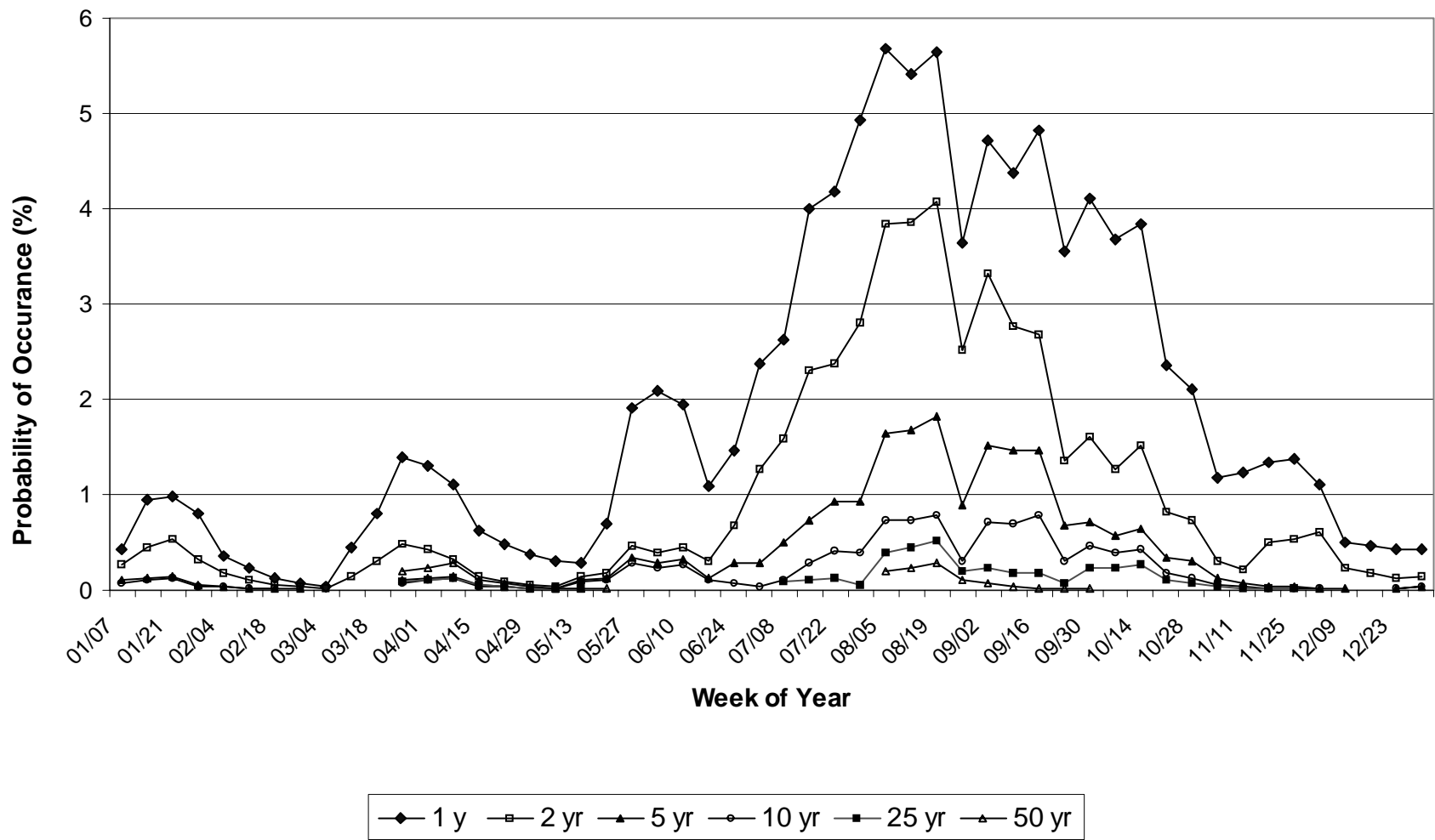


Figure 7e. Weekly Distribution of 6 hr Extreme Precipitation. Region 2.

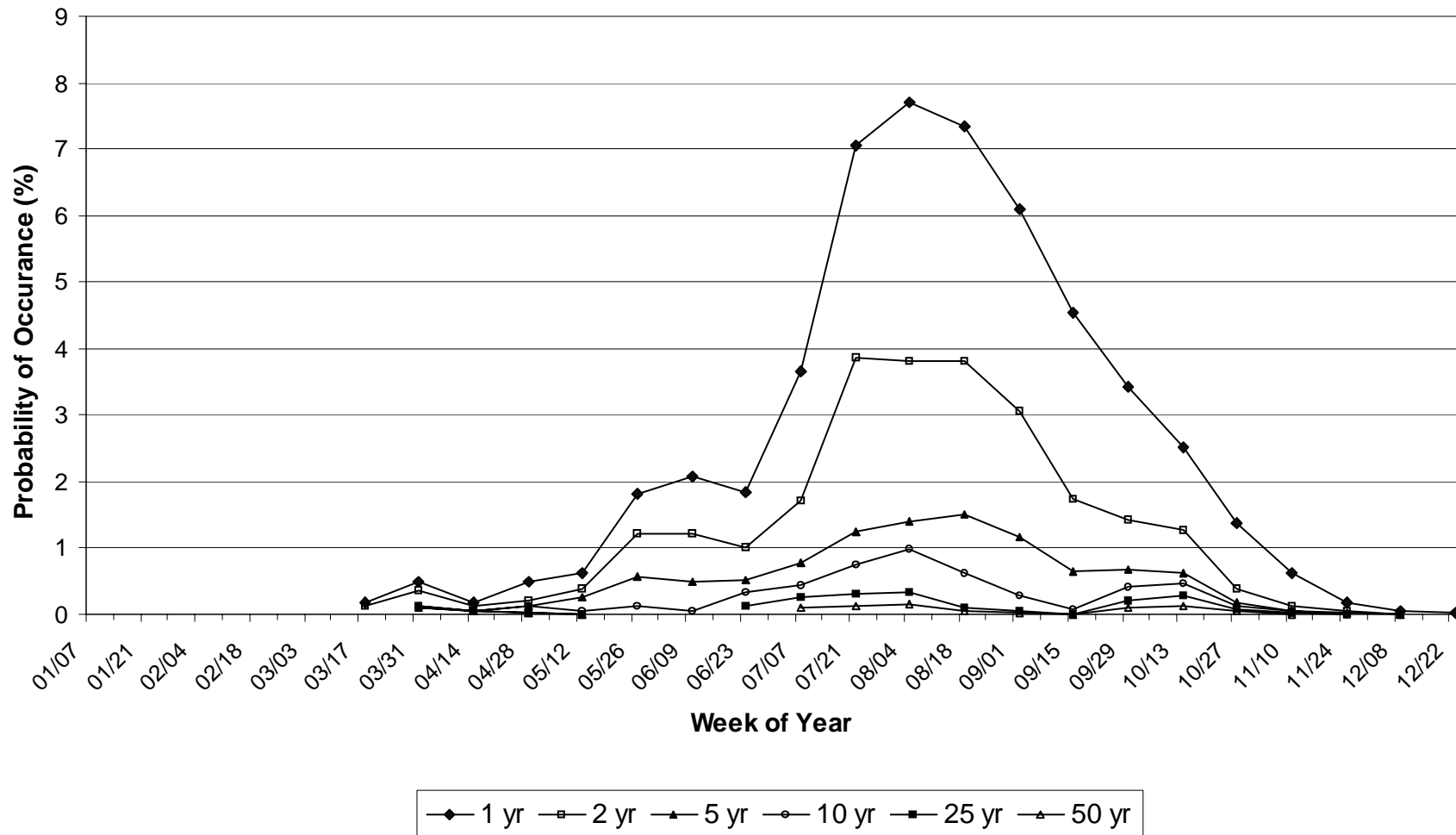


Figure 7f. Weekly Distribution of 1 hr Extreme Precipitation. Region 2.

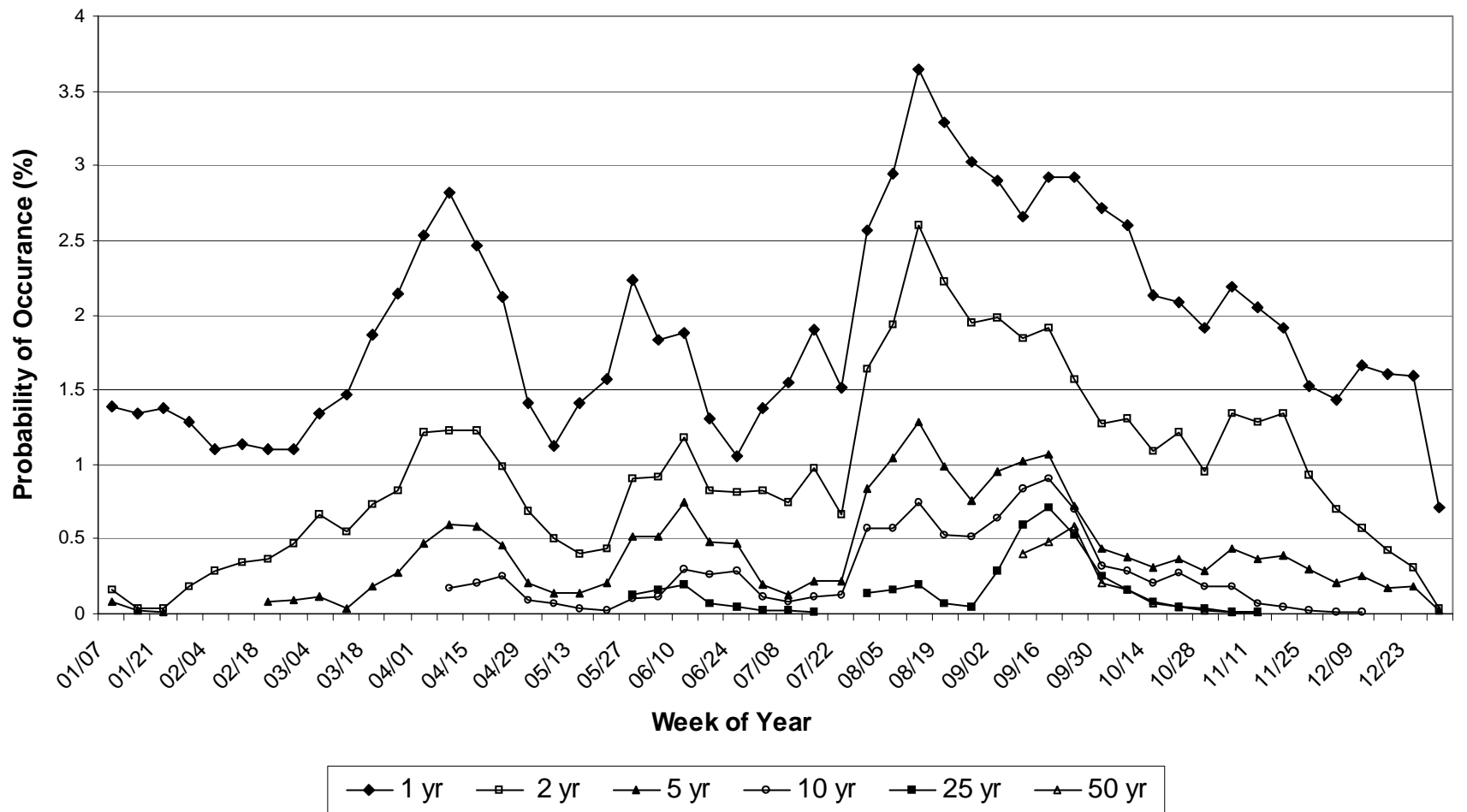


Figure 7g. Weekly Distribution of 24 hr Extreme Precipitation. Region 3.

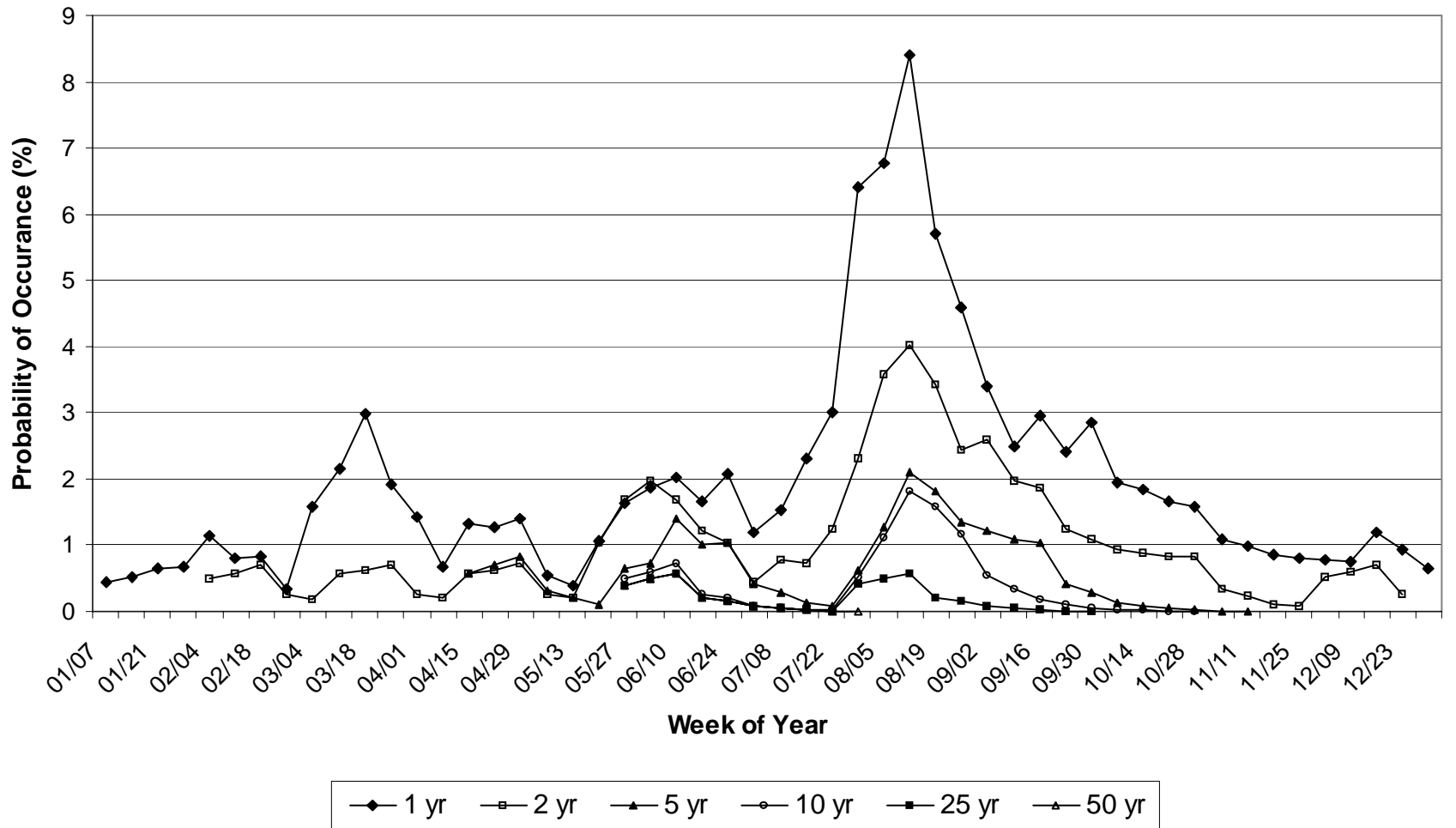


Figure 7h. Weekly Distribution of 6 hr Extreme Precipitation. Region 3.

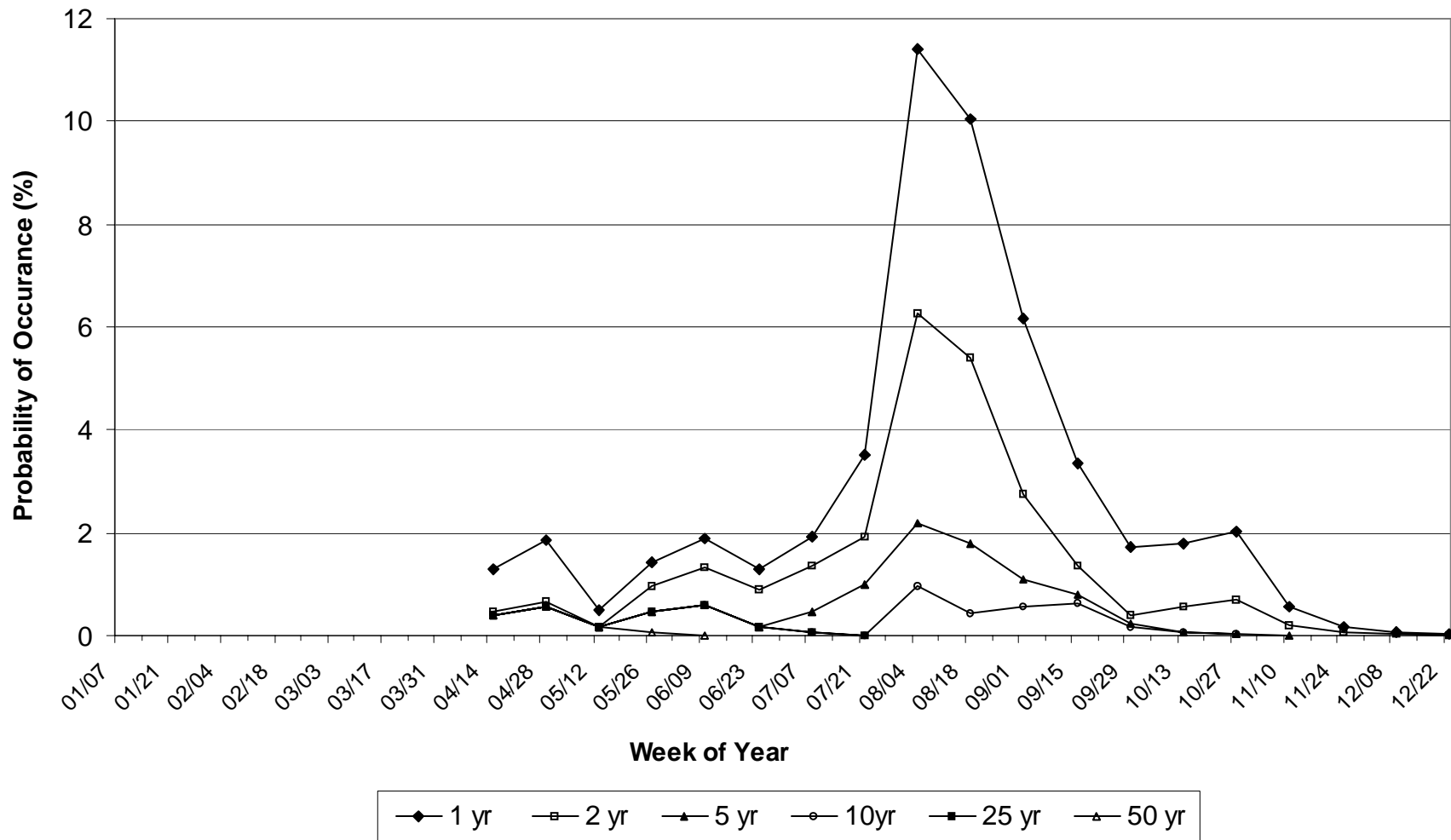


Figure 7i. Weekly Distribution of 1 hr Extreme Precipitation. Region 3.

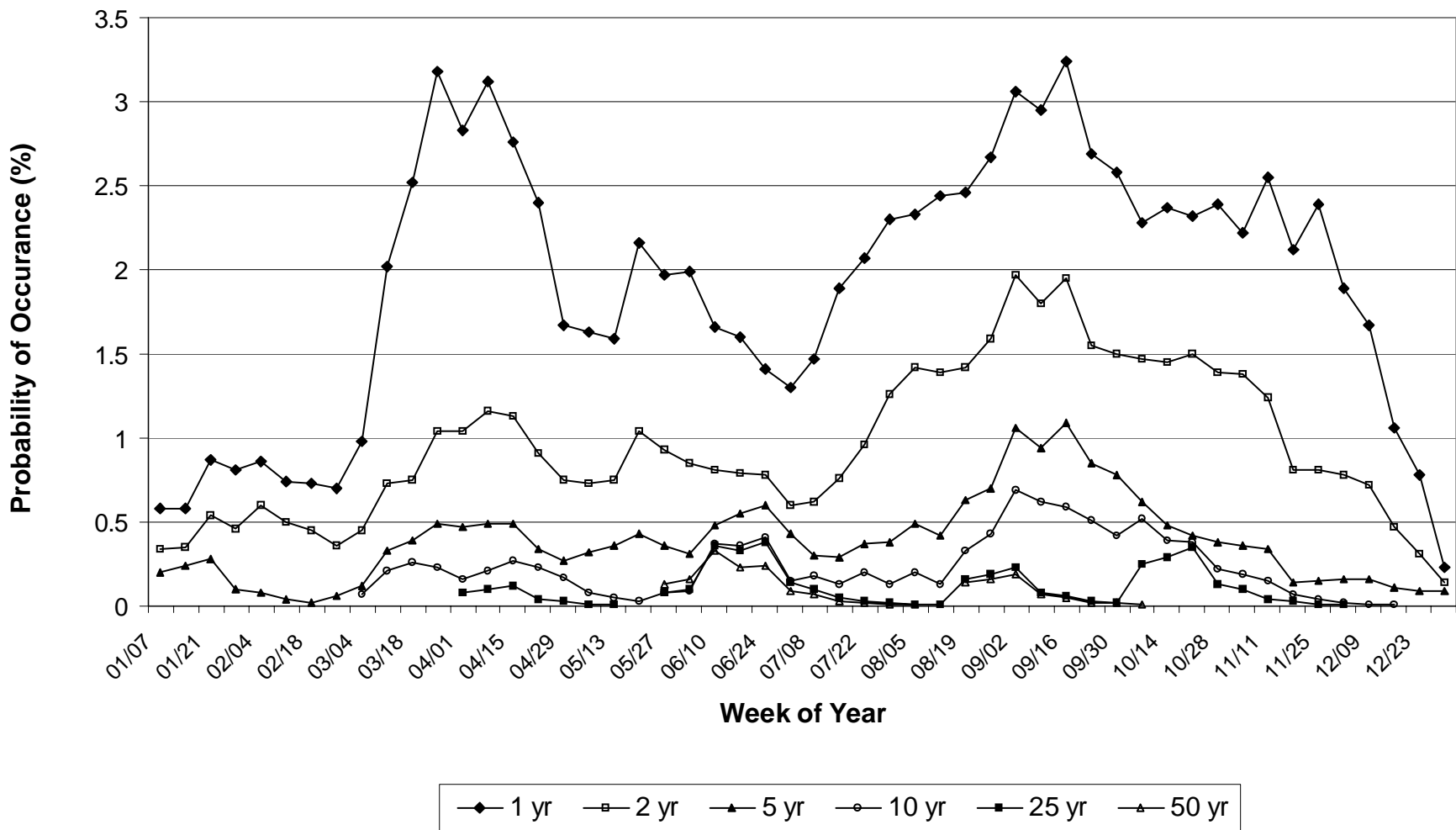


Figure 7j. Weekly Distribution of 24 hr Extreme Precipitation. Region 4.

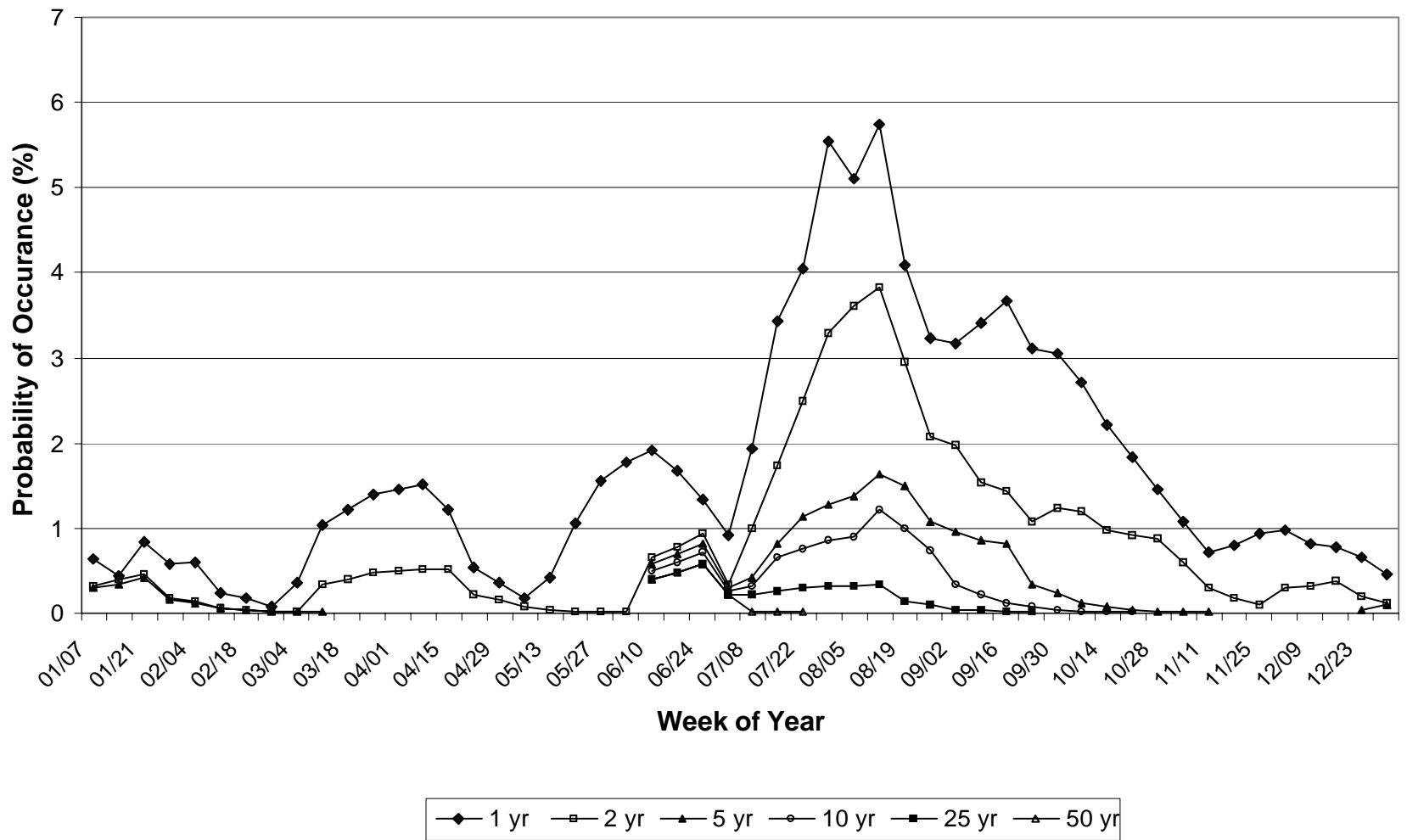


Figure 7k. Weekly Distribution of 6 hr Extreme Precipitation. Region 4.

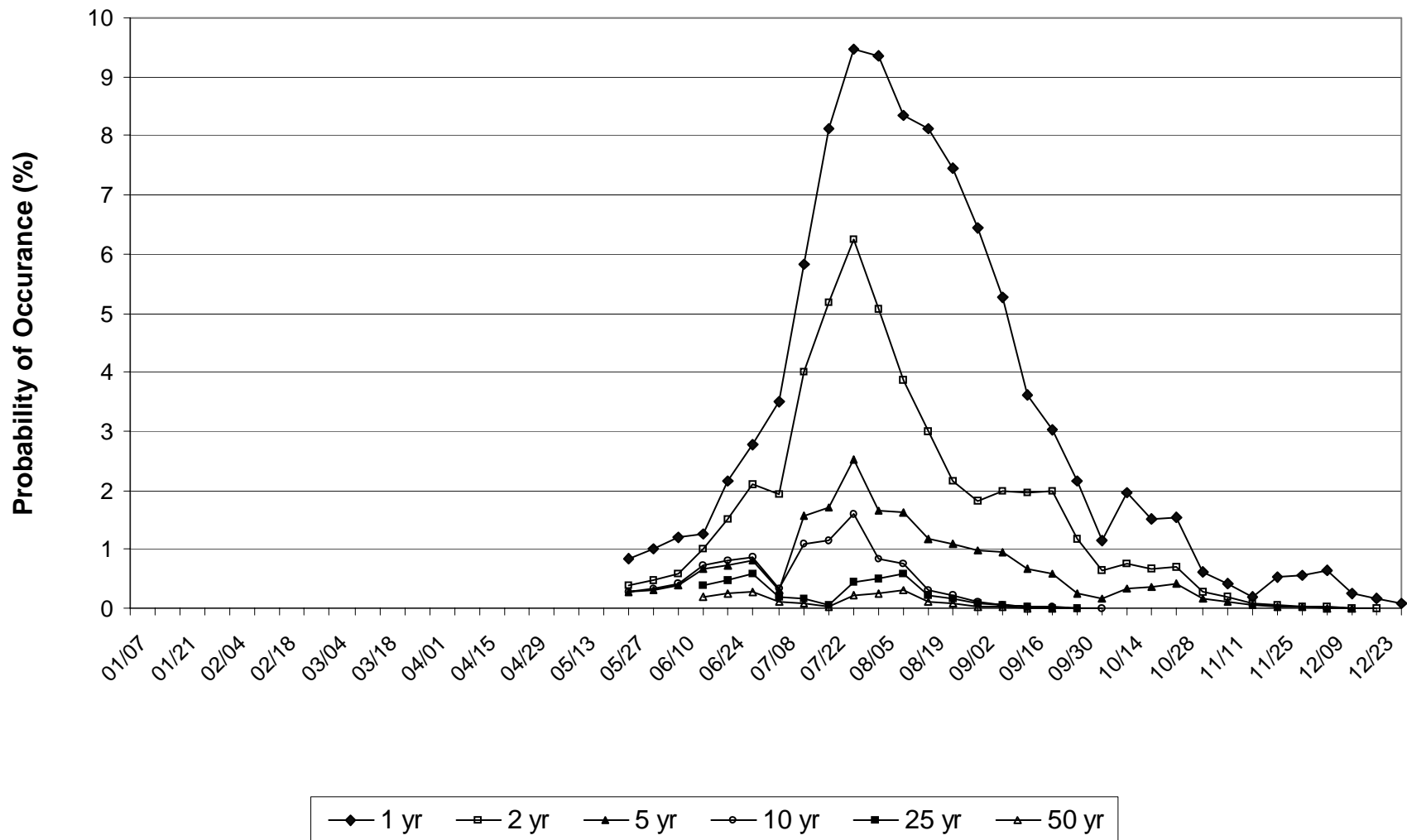


Figure 7I. Weekly Distribution of 1 hr Extreme Precipitation. Region 4.