6.12 USGS Regression Equations – Rural Areas (English Units)

6.12.1 Introduction

The USGS Regression Equations for computing peak flows from ungaged basins in Connecticut were developed by Log-Pearson Type III multiple regression analysis from records of 105 stream gaging stations with 10 to 45 years of continuous records. Rainfall data was taken from 28 precipitation gaging stations of the National Weather Service with 10 to 40 years of records.

The regression equations relate a dependent variable (peak discharge) to independent variables associated with physical and climatic basin characteristics. These independent variables include drainage areas, streambed length and slope, 24 hour rainfall amounts and areas of coarse-grained stratified drift.

The USGS Regression Equations for Connecticut from Weiss, 1983, Conn. Water Resources Bulletin No. 36.

6.12.2 Limits

THE ENGINEER MUST ASSURE THAT THE FOLLOWING CRITERIA ARE MET IN ORDER TO APPLY THE EQUATIONS:

1) The drainage area must be greater than one (1) square mile and less than one thousand (1000) square miles.
2) The drainage basin must not be significantly affected by flood control impoundments or by storage facilities having 4.5 million cubic feet (103 AF) or more of storage per square mile.
3) The watershed must not exhibit a significant degree of development. If more than 30 percent of the drainage basin is urbanized, an adjustment to the rural peak discharge will be required, see Section 6.13 USGS REGRESSION/EQUATIONS-ADJUSTMENT for basin urbanization.

PROCEDURES FOR THE APPLICATION OF THE USGS EQUATIONS

1) Determine if drainage basins usable storage is less than 4.5 million cubic feet per square mile.

   a) If the storage in the upper reach is greater than 4.5 million cubic feet per square mile, this area can be eliminated from the effective drainage area as above storage.
   b) If the storage is located in the central portion or at the design point of the watershed and is greater than 4.5 million cubic feet per square mile, this procedure cannot be used.

2) Obtain the following drainage basin characteristics:

   A = Drainage area in square miles from topographic mapping or an appropriate alternate source.
   L = Stream length in miles from the design point to the extreme rim of the basin divide (from topographic mapping).
   S_m = Streambed slope expressed in feet/mile between points 10 percent and 85 percent of the distance from the study site to the basin divide.
   $\%A_{SD}$ = Percentage of drainage area underlain by coarse-grained stratified drift (from surficial geology maps copies available from Hydraulics and Drainage Section). This is expressed as a whole number.

I_X = 24-hour rainfall, in inches. (See Figures 6.2 – 6.6)

3) Apply the appropriate equation for the desired return frequency (See Table 6.6.)

4) Check degree of development in the watershed and adjust for urbanization, if required (Section 6.13).

6.12.3 Calibration

The results obtained from the application of USGS regression equations can be calibrated to stream gage information when the ungaged stream has watershed characteristics (drainage area, length, slope, coarse-grained stratified drift, urbanization, etc.) which are similar to a gaged watershed. A step by step calibration procedure is outlined below.

1. Compute the frequency-discharges at the site of interest using the USGS regression equations (Section 6.12).
2. Check USGS gage records to determine if a gaged watershed has similar characteristics (drainage area, length, slope, etc.) to the ungaged watershed. Table 3 of the publication entitled "Evaluation and Design of a Streamflow-Data Network for Connecticut" by L.A. Weiss, 1983 (see reference list), provides a listing of the basin characteristics for the gages used in the development of the regression equations. However, since considerable time has elapsed since the completion of the regression study, the USGS must be consulted regarding the most current streamflow information. If homogeneity of the watersheds is determined, obtain the necessary streamflow data. If discharge-frequency information has not been developed from the streamflow data, see Section 6.10.
3. Compute the frequency-discharges at the gage using the USGS regression equations.
4. Compare the computed discharges (Step 3) to the discharges determined from actual gage records (Step2). An adjustment factor for a given storm frequency can be determined as the ratio of the computed discharge (Step 3) to the gage discharge (Step 2).
5. Multiply the frequency-discharges for the site (Step 1) by the corresponding adjustment factor as determined in Step 4. The resulting discharges represent the adjusted or calibrated discharges for the site based on a comparative gaged watershed.
6. The determination of similarity between watersheds and the use of the unadjusted or adjusted discharges requires considerable judgement of the engineer and should be clearly documented in the hydrologic report.

6.12.4 500 Year Flood

Use Frequency-Discharge Curve using a straight line approximation plotted on Log-Probability paper.

Standard Error of Estimate

$$Q_2 = \frac{7.6(A)^{0.97}(I_2)^2}{(\frac{L}{\sqrt{S_m}})^{0.17}(\%A_{sd}+1)^{0.2}}$$

+/- 36.7% **(6.13)**

$$Q_{10} = \frac{6.6(A)^{1.0}(I_{10})^{1.89}}{(\frac{L}{\sqrt{S_m}})^{0.22}(\%A_{sd}+1)^{0.19}}$$

+/- 39.2% **(6.14)**

$$Q_{25} = \frac{21.2(A)^{1.0}(I_{25})^{1.21}}{(\frac{L}{\sqrt{S_m}})^{0.23}(\%A_{sd}+1)^{0.2}}$$

+/- 42.2% **(6.15)**

$$Q_{50} = \frac{23.2(A)^{1.03}(I_{50})^{1.14}}{(\frac{L}{\sqrt{S_m}})^{0.26}(\%A_{sd}+1)^{0.2}}$$

+/- 44.2% **(6.16)**

$$Q_{100} = \frac{28.7(A)^{1.04}(I_{100})^{1.08}}{(\frac{L}{\sqrt{S_m}})^{0.27}(\%A_{sd}+1)^{0.22}}$$

+/- 46.8% **(6.17)**

Table 6-6 USGS Regression Equations For Connecticut

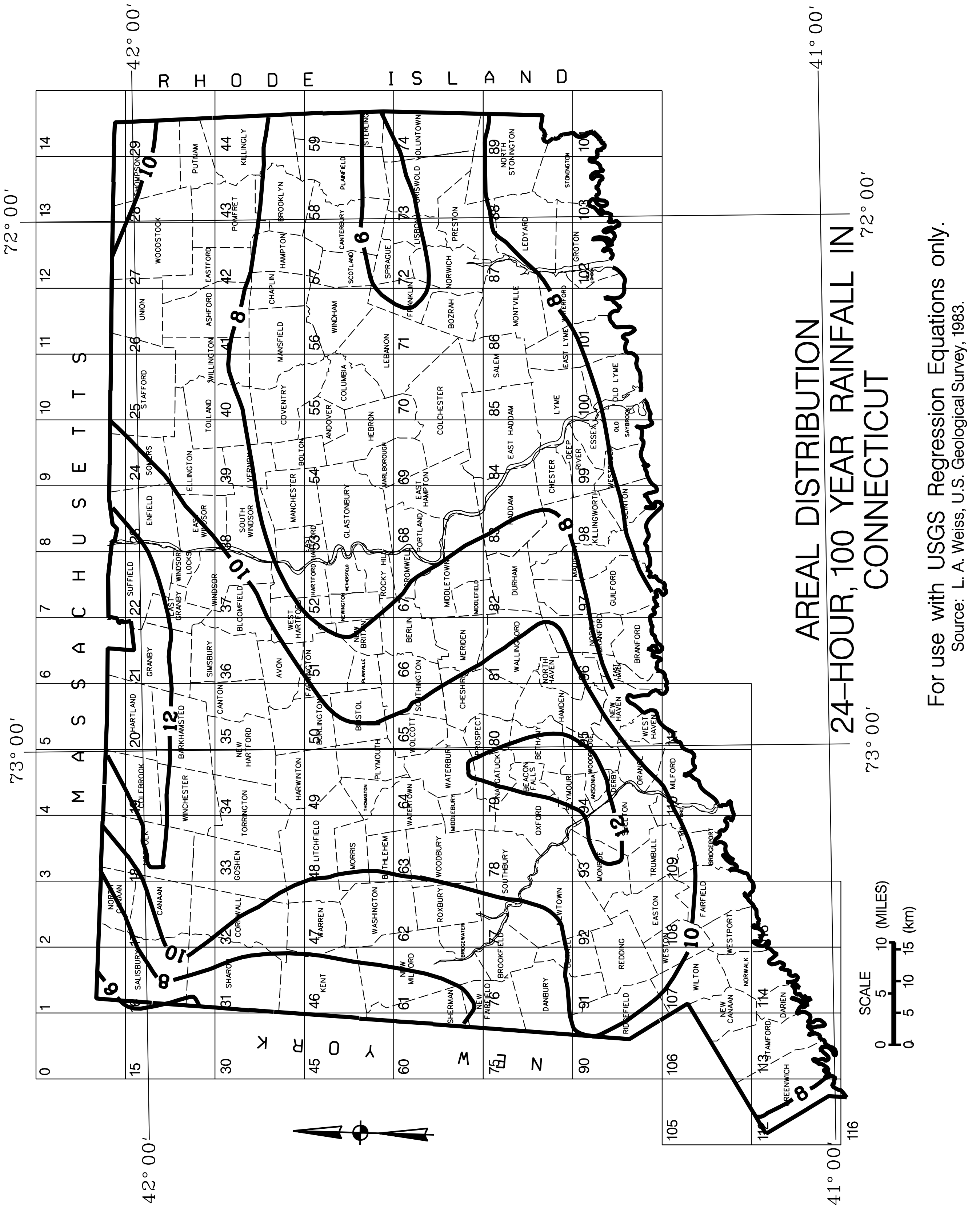
AREAL DISTRIBUTION
24-HOUR, 100 YEAR RAINFALL IN
CONNECTICUT
For use with USGS Regression Equations only.
Source: L. A. Weiss, U.S. Geological Survey, 1983.
RHODE ISLAND
MASSACHUSETTS
NEW YORK
SCALE
(MILES)
(km)

Figure 6-2

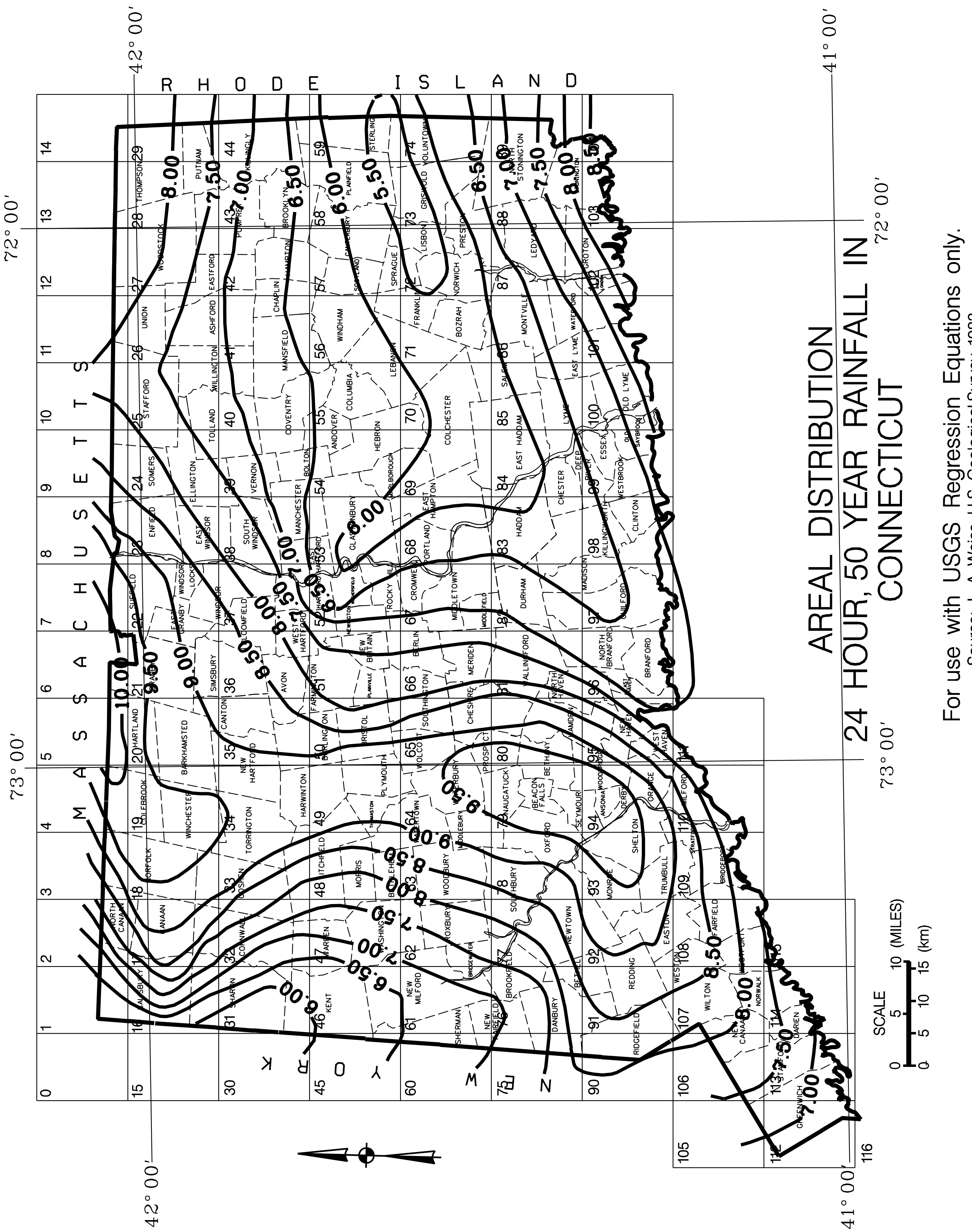
AREAL DISTRIBUTION
24 HOUR, 50 YEAR RAINFALL IN
CONNECTICUT
For use with USGS Regression Equations only.
Source: L. A. Weiss, U.S. Geological Survey, 1983.
RHODE ISLAND
MASSACHUSETTS
NEW YORK
SCALE
0 5 10 (MILES)
0 5 10 15 (km)
42° 00′
41° 00′
72° 00′
73° 00′

Figure 6-3

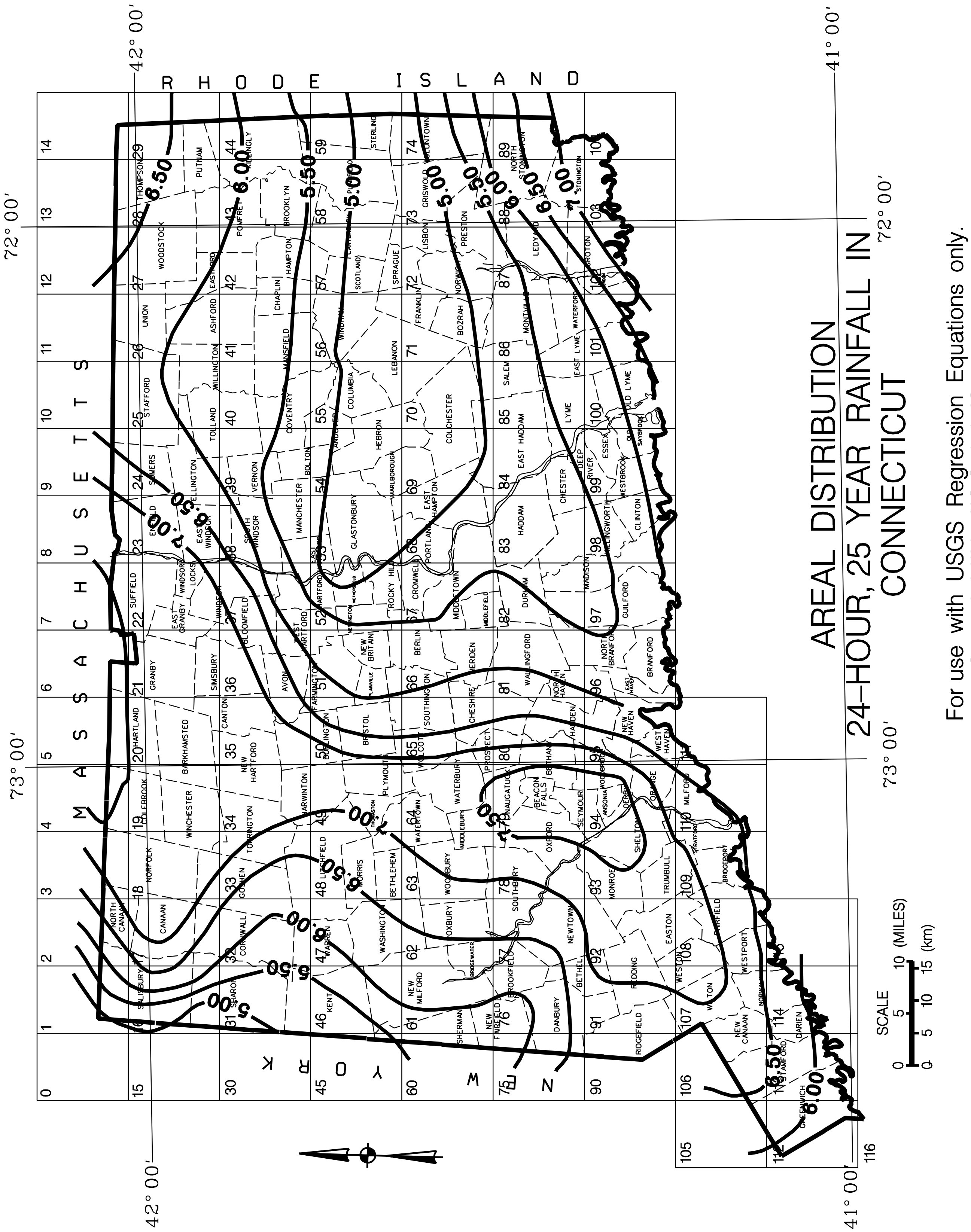
AREAL DISTRIBUTION
24–HOUR, 25 YEAR RAINFALL IN
CONNECTICUT
For use with USGS Regression Equations only.
Source: L. A. Weiss, U.S. Geological Survey, 1983.
RHODE ISLAND
MASSACHUSETTS
NEW YORK
SCALE
(MILES)
(km)

Figure 6-4

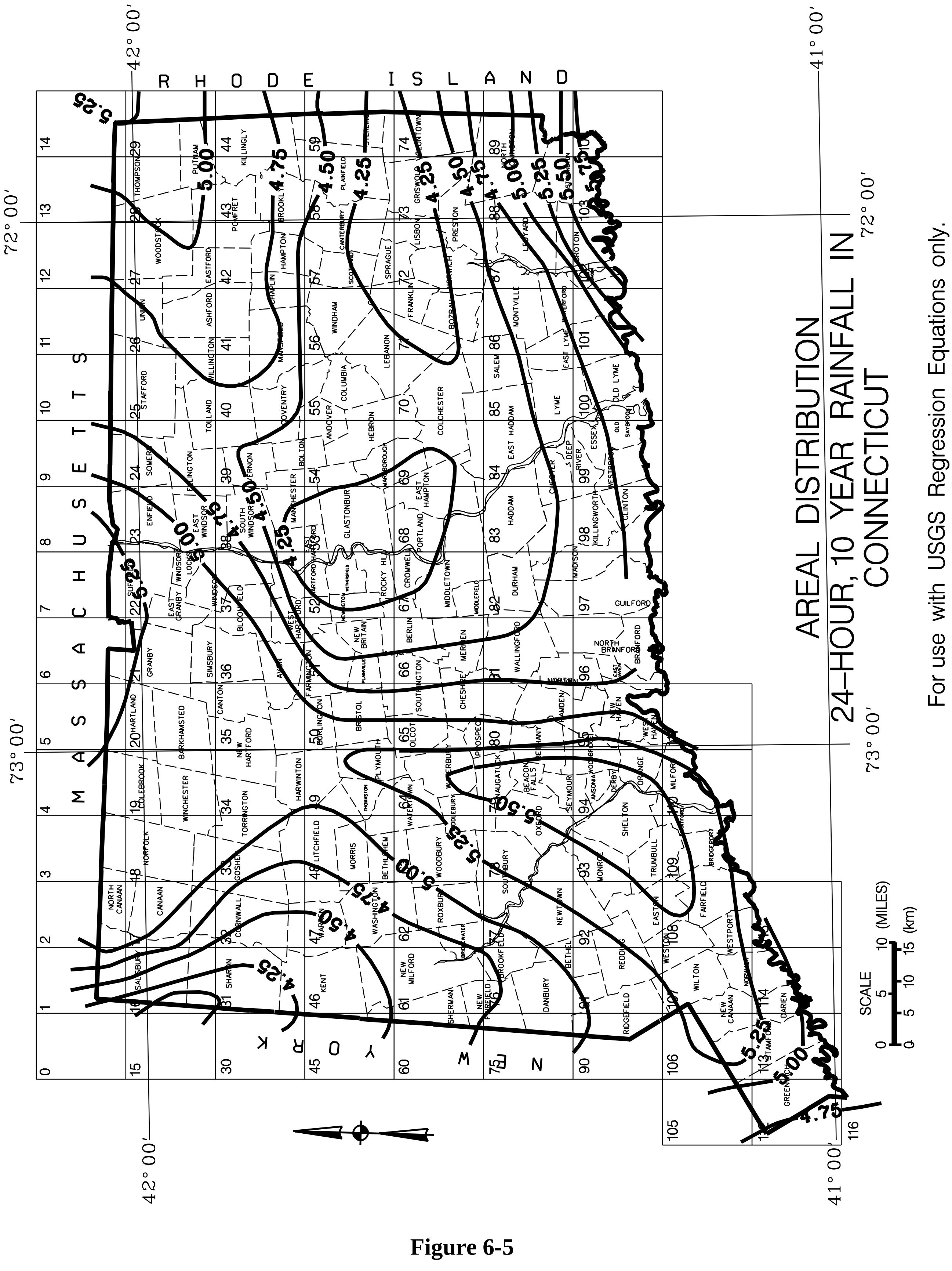
AREAL DISTRIBUTION
24-HOUR, 10 YEAR RAINFALL IN
CONNECTICUT
For use with USGS Regression Equations only.
Source: L. A. Weiss, U.S. Geological Survey, 1983.
RHODE ISLAND
MASSACHUSETTS
NEW YORK
SCALE
0 5 10 (MILES)
0 5 10 15 (km)
42° 00′
41° 00′
72° 00′
73° 00′

Figure 6-5

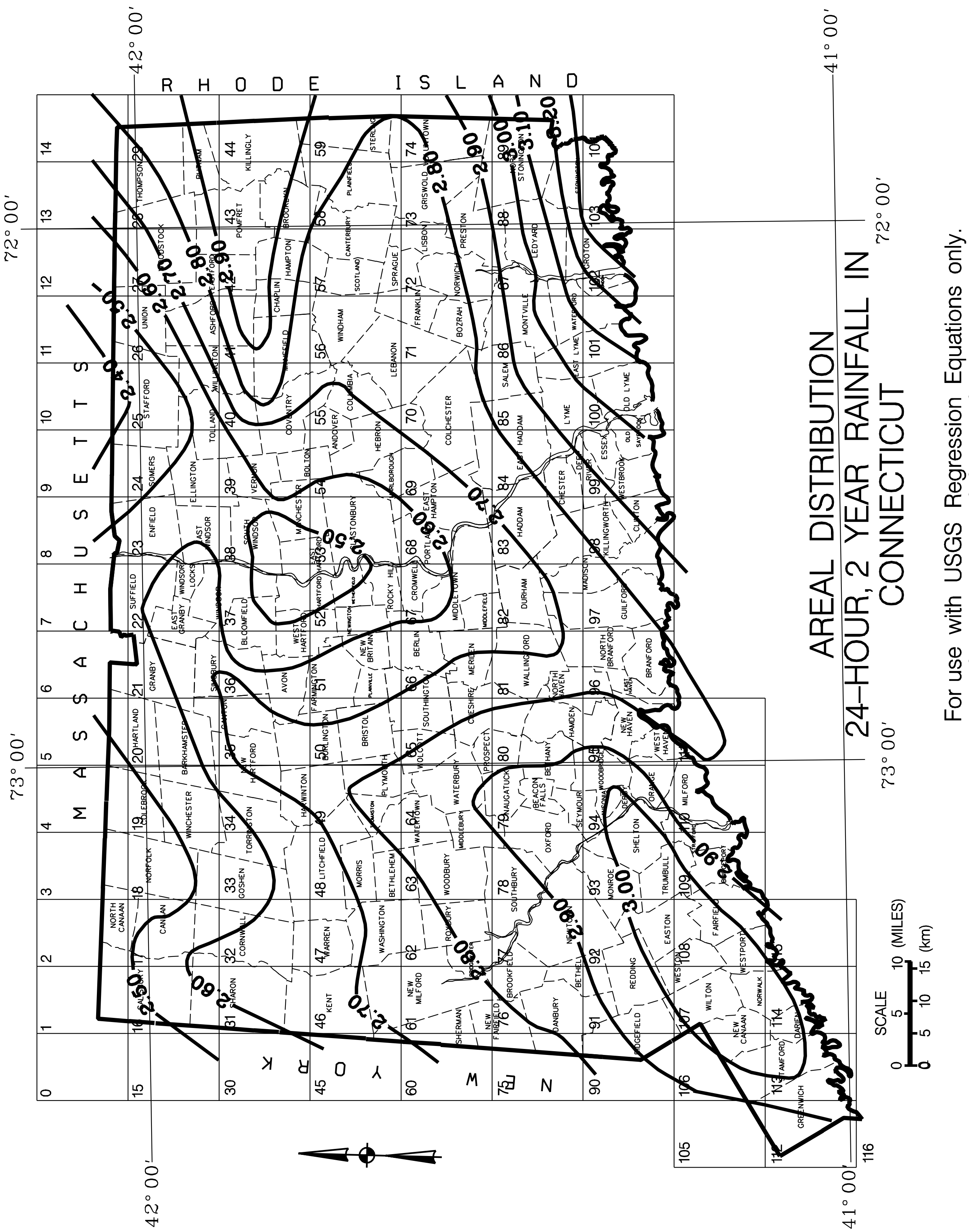
AREAL DISTRIBUTION
24-HOUR, 2 YEAR RAINFALL IN
CONNECTICUT
For use with USGS Regression Equations only.
Source: L. A. Weiss, U.S. Geological Survey, 1983.
RHODE ISLAND
MASSACHUSETTS
NEW YORK
SCALE
(MILES)
(km)

Figure 6-6