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Article 167

HEIGHT-FREQUENCY RELATIONS FOR NEW JERSEY FLOODS

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Abstract.—Regional relations among height, discharge, and frequency are defined for New Jersey floods having annual recurrence intervals of 1.5 to 50 years. Separate relations are shown for Coastal Plain and non-Coastal Plain streams, and they can be used to predict flood heights at sites where mean annual flood discharge is known or can be estimated.

Regional relations among height, discharge, and frequency have been defined for New Jersey floods. These relations, which were developed from a study of stream-gaging station records, can be used to predict flood heights at sites where mean annual flood discharge is known or can be estimated. The relations are similar to the depth-discharge-frequency relations found by Leopold and Maddock (1953).

Leopold and Maddock (1953) determined for less than bankfull streamflow that a basin-wide relation exists between stream depth and discharge when discharge is of equal frequency of occurrence at all sites. They showed this relation as a simple power function of the form $d = c\ Q^f$, where d is average cross-section depth, Q is discharge of a given frequency at the section, and c and f are constants for a given frequency.

The simple power function also proved satisfactory for defining the New Jersey flood relations. However, for ease of field application, different measures of the two variables were used. Flood height (h) was used rather than average cross-section depth (d) because it is simply measured as a vertical distance. Flood height is defined as height of the water surface above the average channel bottom determined at time of median (50-percent duration) discharge. Mean annual flood discharge ($Q_{2.33}$) was found to be a satisfactory index of flood sizes for the desired flood-frequency range, and it was used for all frequencies rather than actual discharge (Q). With these variables the equation of the New Jersey flood height-frequency relations is $h = cQ^t_{2.33}$.

Records of 46 stream-gaging stations were used to define the flood-height-frequency relations by evaluating the c and f constants for annual flood recurrence intervals of 1.5 to 50 years. These gaging stations, which have mean annual flood discharges ranging from 117 to 140,000 cubic feet per second, are located at sites where natural flood flows and flood heights could be determined. Thirteen of the gaging stations are in the Coastal Plain physiographic province of southern New Jersey. Different c values were determined for these gaging stations than for the gaging stations outside the Coastal Plain. For the Coastal Plain, c ranged from 0.49 for a 1.5-year flood to 1.35 for a 50-year flood, while for the non-Coastal Plain sites c ranged from 0.33 for a 1.5-year flood to 0.90 for a 50-year flood. The f values for both Coastal Plain and non-Coastal Plain sites ranged from 0.360 for a 1.5-year flood to 0.314 for a 50-year flood. Figures 167.1 and 167.2 show graphically the defined relations.

Accuracy of the defined relations was checked by using them to estimate flood heights at the 46 gaging stations and comparing the estimated and measured values. As a check on the accuracies expected at ungaged sites, the flood heights were estimated using mean annual flood discharges computed from drainage-basin characteristics by preliminary methods developed in another study. Two out of three estimates at gaging stations agreed with measured flood heights within ±23 percent for a 2.33-year flood, within ±16 percent for both a 10-year and a 25-year flood, and within ±21 percent for a 50-year flood. Maximum errors for a 2.33-year flood were +54 percent and −47 percent, and maximum errors for a 50-year flood were +36 percent and −49 percent. No significant accuracy differences appeared between estimates for Coastal Plain and non-Coastal Plain streams.
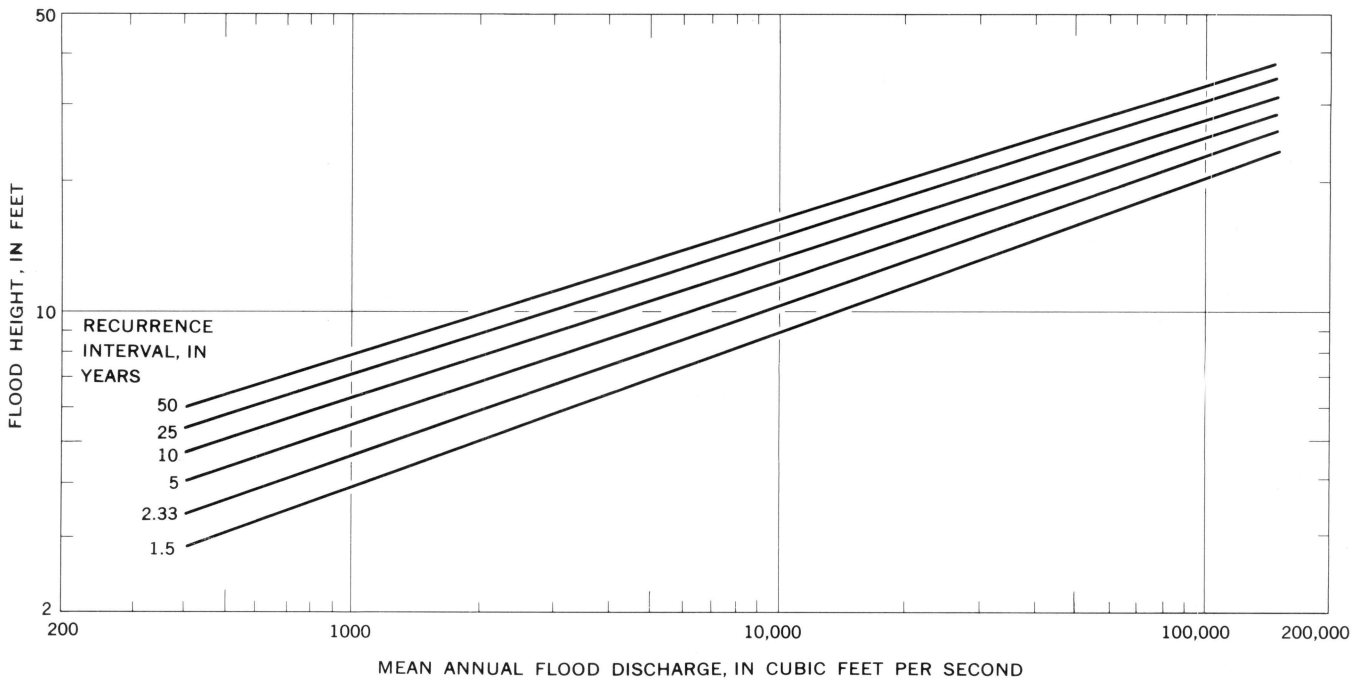
FIGURE 167.1.—Flood height-discharge-frequency relations for non-Coastal Plain streams in New Jersey.
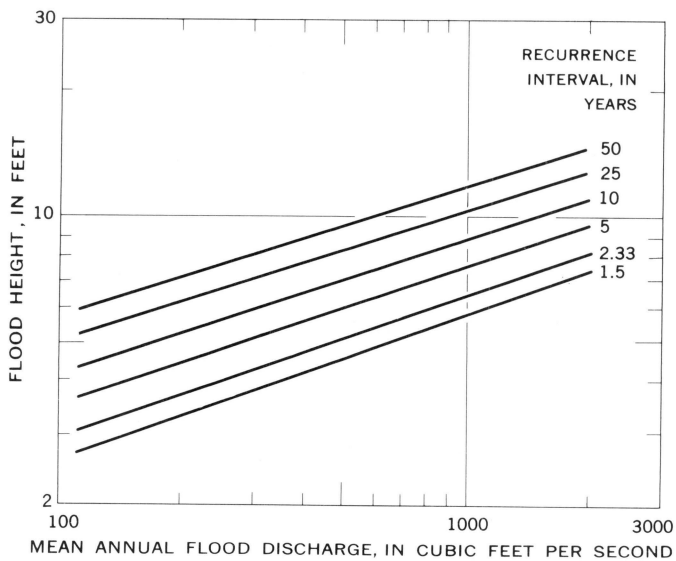

FIGURE 167.2.—Flood height-discharge-frequency relations for Coastal Plain streams in New Jersey.

Although flood heights estimated by the areal relations are considered less reliable than those obtained from field surveys and hydraulic computations, the ease and simplicity of their determination are expected to make them useful for many purposes.

REFERENCE

Leopold, Luna B., and Maddock, Thomas, Jr., 1953, The hydraulic geometry of stream channels and some physiographic implications: U.S. Geol. Survey Prof. Paper 252.