ESTIMATING RUNOFF AND PEAK DISCHARGES

1. Introduction

The official Minnesota hydrology policy is in the National Engineering Manual 530.11 as a Minnesota supplement. The information here is design guidance.

Type II rainfall distribution will be used for designs in Minnesota.

Time of concentration may be determined by the method in Engineering Field Handbook, Chapter 2 (EFH2), by methods in Chapter 15 of NEH Part 630-Hydrology, or by applying the Folmar & Miller (F&M) equation (reference: Folmar, Norman D. and Arthur C. Miller, "Development of an Empirical Lag Time Equation", Journal of Irrigation and Drainage Engineering – American Society of Civil Engineers, July/August 2008, pages 501 to 506.) The F&M Tc formula is:

$$\mathbf{Tc = (LHL)^{0.65}/108.3}$$

For HEC-HMS, the F&M Lag formula would be:

$$\mathbf{Lag = (LHL)^{0.65}/180.5}$$

LHL is in units of feet, and the Lag and Tc results are in units of hours.

Testing has shown that the EFH2 method is conservative for typical watersheds in Minnesota where storage in microtopography is present. When the F&M equation for Tc is utilized with the EFH2 method, peak discharges are much closer to observed values. It is recommended that the F&M Tc be used with the EFH2 method for typical Minnesota watersheds with some storage present.

The F&M Tc formula was not developed using any urban watersheds so its use is limited to rural watersheds. The watersheds examined in their analysis had watershed slopes of 2.9% and greater so this does not apply in watersheds with less than 1% slope, and with watersheds between 1% and 2% slope, the procedure should be used with caution. For watersheds less than 2% it is recommended to increase the EFH2 Tc by a factor of 1.65 in order to obtain peak discharges in line with observed values. Another option for flat watersheds that are large or contain considerable storage would be to model them with software such as WinTR-20, HEC-HMS, or WinTR-55.

Watersheds exceeding 1500 acres in size need to be broken into appropriate subareas and modeled in software such as WinTR-55, WinTR-20, or HEC-HMS to obtain a realistic discharge. For watersheds less than 1500 acres, modeling can also be used where storage exists behind roads or in natural or constructed depressions to reduce design discharges.

Non-contributing portions of a watershed may be removed from the total drainage area where appropriate. A clear explanation must be given in project documentation for why the area is non-contributing.

Watersheds with potential storage locations will be modeled using such programs as Win TR-55, WinTR-20, and HEC-HMS in order to account for the storage. Generally if at least 10% of the runoff volume has the potential to be impacted by storage in the watershed, the watershed should be modeled to determine peak discharge. If storage is ignored a conservative peak discharge will be computed.

Example:
A watershed in Lyon County, Minnesota has a drainage area of 170 acres, RCN = 77, average watershed slope = 4.8%, and the longest hydraulic length (LHL) for the watershed is 4670 feet. The time of concentration is calculated by EFH2 as 0.91 hour. Using Type 2 rainfall of 4.07 inches for a 10-year return period event, the peak discharge in EFH2 is calculated at 180 cfs. However, this watershed has some storage in its microtopography so the time of concentration is computed with the Folmar & Miller equation:

$Tc = (LHL)^{0.65}/108.3$ $Tc = 2.24$ hours

Thus the peak discharge (determined by overriding the calculated Tc in EFH2) is 99 cfs.

(For comparison, using a Type 1 storm distribution with the Tc calculated by EFH2 (0.91 hr) the peak discharge is 98 cfs.)