CHAPTER 2. STORMWATER RUNOFF

2.1 Rational Method (Preferred Method for Drainage Areas less than 200 Acres)

The basic formula for the Rational Method is: $Q = CiA$

Where Q is the peak rate of runoff in cubic feet per second, C is the runoff coefficient, i is the average intensity of rainfall in inches per hour for the time of concentration (T_C) for a selected frequency of occurrence or return period, and A is the drainage area in acres.

2.1.1 Adopted Runoff Coefficients

Table 2-1 lists the runoff coefficients adopted for use in the Rational Method for stormwater drainage in Newark. These are based on average land use patterns and hydrologic soil group C.

Table 2-1

Runoff Coefficients for the Rational Method

Land Use	Runoff Coefficient by Storm Frequency		
	1-year thru 25-year	50-year	100-year
Residential	0.50	0.54	0.57
Multi-family	0.60	0.63	0.66
Commercial and Business Districts	0.85	0.85	0.86
Industrial Districts	0.75	0.76	0.78
Open Space (parks, golf courses, cemeteries, meadows, grass, woods, lawns, etc.)	0.30	0.36	0.41
Impervious Areas (parking lots, roads, rooftops)	0.90	0.90	0.90
Steep wooded hillside slope > 10 percent	0.50	0.54	0.57

2.1.2 Composite Runoff Coefficients

If the runoff coefficient varies over a subarea, a composite coefficient can be calculated as an average, weighted by area of the various runoff coefficients.

2.1.3 Time of Concentration

The minimum time of concentration used shall be 10 minutes.

The time of concentration is the estimated time required for runoff to flow from the most remote part of the drainage area under consideration to the point under consideration. It consists of the total time for overland sheet flow, shallow concentrated flow, natural channel flow, open channel flow, and

pipe flow. Overland sheet flow time for overland flow from the most remote part of the drainage area until a dry channel is present (contours forming a U shape) or up to 300 feet in length may be estimated from the chart (Exhibit II-1, page 2-3). The time of flow in shallow concentrated flow from overland sheet flow until a channel is shown to carry an intermittent or perennial stream (a stream symbol indicated on a topographic map) may be estimated by applying the chart (Exhibit II-2, page 2-4). The time of flow in natural channels, open channels, or pipes may be estimated by applying the Manning Formula (Exhibit II-3, page 2-5).

Care should be taken to avoid excessive time of concentration caused by long overland sheet flow time. To insure that the peak rate of runoff at a particular location is correct, the peak discharge shall be calculated twice--once including the overland sheet flow area and time and once omitting the overland sheet flow area and time. The larger peak discharge shall be used.

2.1.4 Example - Rational Method

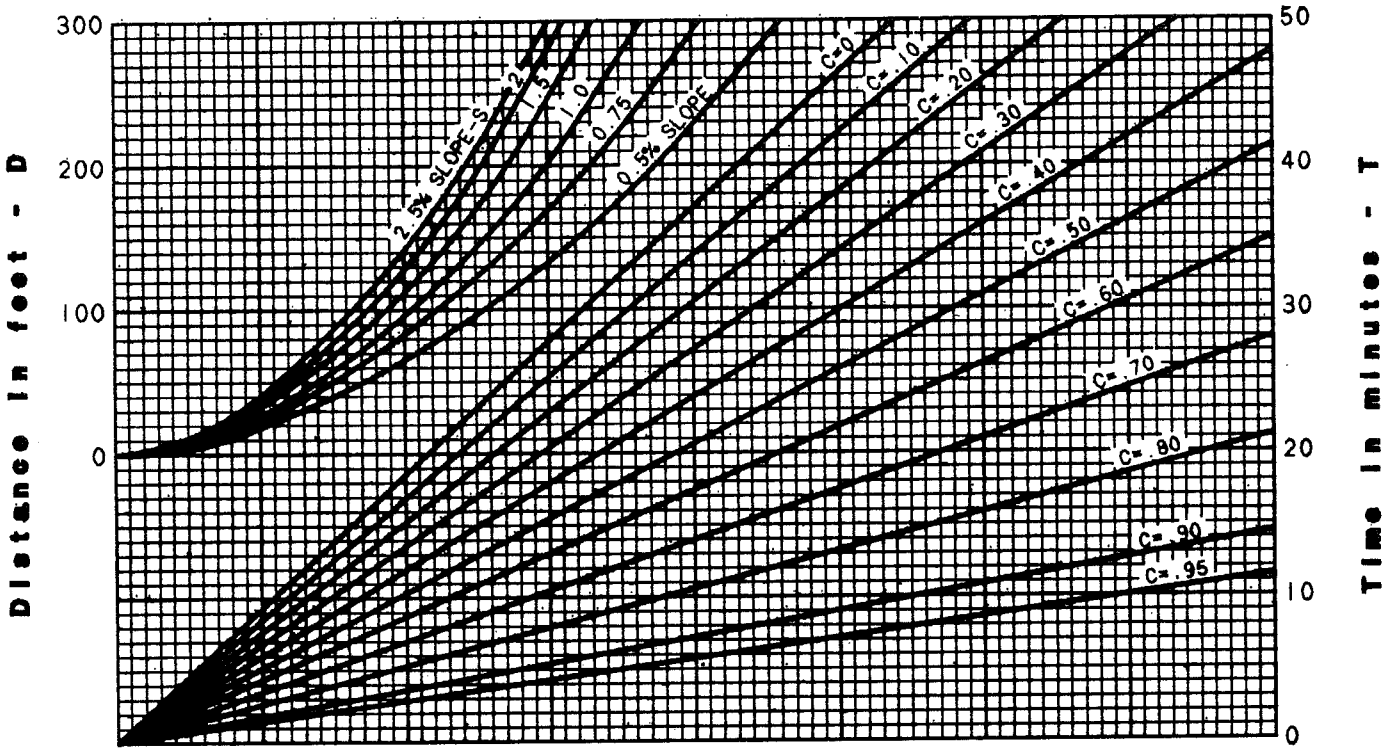
Determine the 10-year discharge from a 10-acre watershed assuming a runoff coefficient of 0.3 and a time of concentration of 12.0 minutes.

Step 1. Use Exhibit I-1 (page 1-2), locate a duration of 12.0 minutes, and read: 10-year rainfall intensity = 5.02 inches per hour.

Step 2. Calculate the 10-year discharge $Q = CiA = 0.3 \times 5.02 \times 10 = 15.1$ cubic feet per second (cfs).

2.2 Other Methods

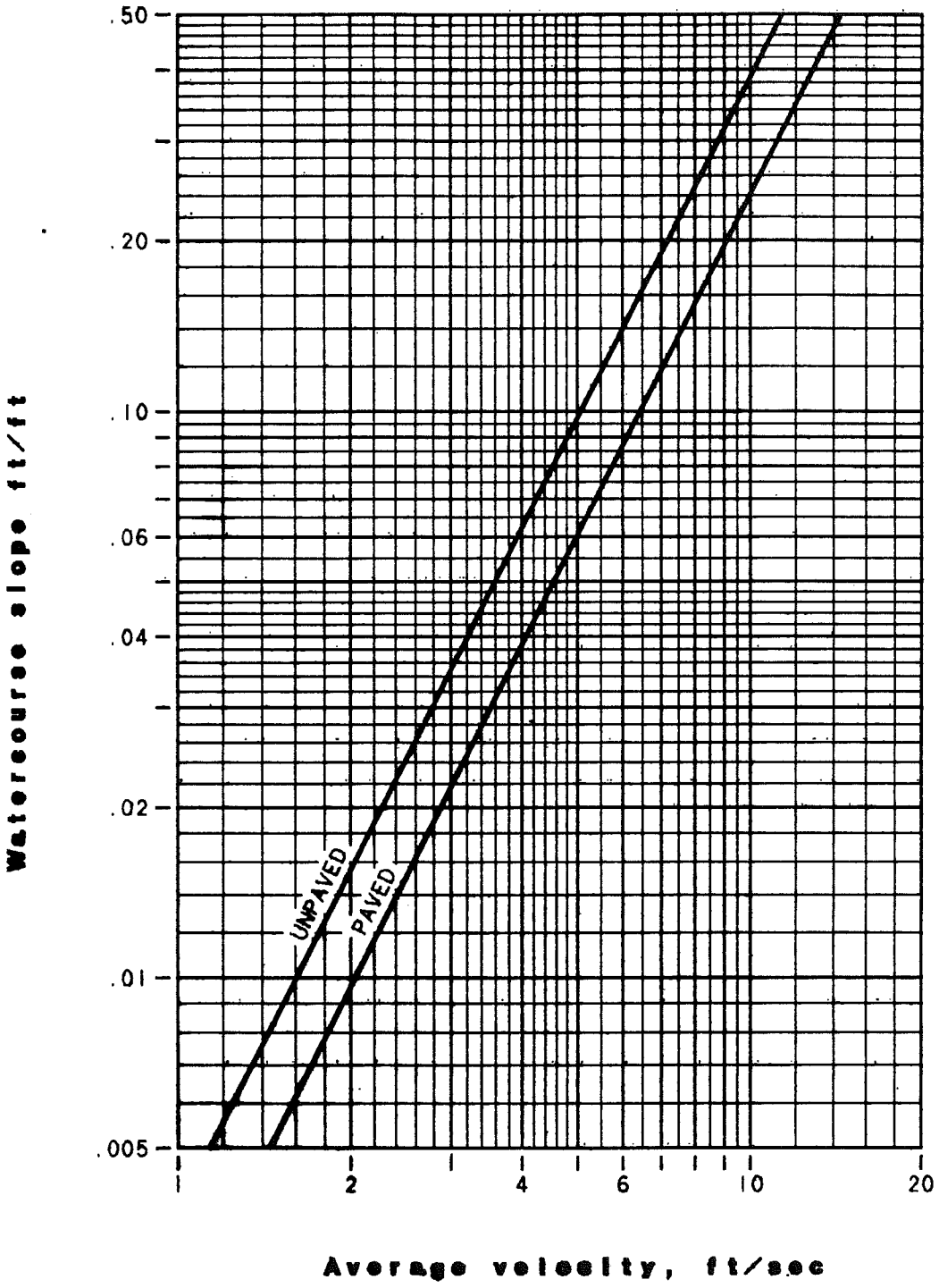
For areas between 200 and 640 acres, the preferred hydrograph method of calculation is the Soil Conservation Service, Technical Release No. 55 Graphical Peak Discharge method or tabular hydrograph method if there are subareas with varing curve numbers. For areas greater than 640 acres, the preferred hydrograph method of calculation is the Soil Conservation Service, Technical Release No. 20 method.



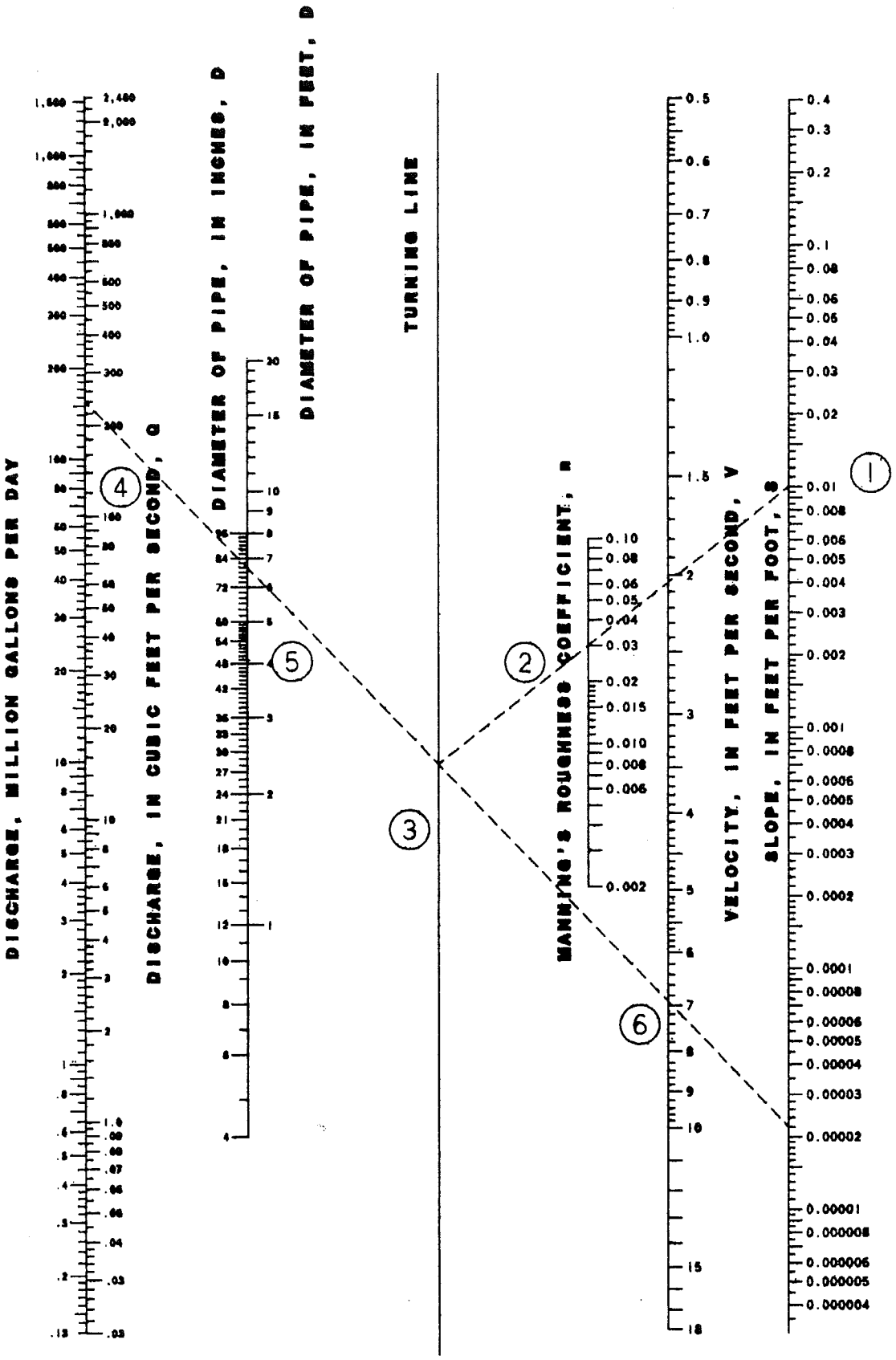
OVERLAND SHEET FLOW

CITY OF NEWARK

EXHIBIT II-1



SHALLOW CONCENTRATED FLOW



NOMOGRAPH FOR SOLUTION OF THE MANNING FORMULA

$$Q = AV = A \frac{1.49}{n} r^{2/3} s^{1/2}$$

STORMWATER RUNOFF
GRAPHICAL PEAK DISCHARGE COMPUTATIONS

PROJECT _____ DESIGNER _____ DATE _____

1) DATA: WATERSHED CONDITION = _____ (PRESENT OR FUTURE) TYPE II STORM

DRAINAGE AREA (DA) = _____ ACRES.

Hydrologic Soil Group Exhibit II-3	Land Use Description Include Treatment, Practice & Condition Exhibit II-5	CN Exhibit (3) II-5	CN Exhibit (3) II-11	Area (acres)	Area (%) (4)	Product (3) x (4) (5)
			Totals =		100	

CN (weighted) = $\frac{\text{total col. (5)}}{\text{total col. (4)}}$ [_____] = _____ ; use CN = [ ]

Ponding and Swampy areas (PND) = _____ acres, _____ % of DA

Time of Concentration (TC) = _____ minutes _____ hours

		1st Storm	2nd Storm	3rd Storm	
2)	Rainfall Frequency (F)				yrs.
	Rainfall Depth (P) From Table 5-1				inches
3)	Initial Abstraction (Ia) $Ia = 0.2 \left[\frac{1000}{\text{weighted CN}} - 10 \right]$				
4)	(Ia) / (P)				
5)	Unit Peak Discharge Use TC, Ia/P				CFS/Square Mile-Inch
6)	Runoff Depth (Q) Use P, CN				inches
7)	Ponding and Swampy Area Adjustment Factor Use % PND				
8)	Adjusted Peak Discharge (q_g) Drainage area x step 5 x (step 6 x step 7) / 640				cfs
9)	Total Runoff Volume Step 6 x Drainage Area / 12				acre-feet