RATIONAL METHOD

DETERMINATION OF STORM FLOWS

To determine stormwater quantities within the Town, three methods are applicable. The first is the Rational Method, which is used for basins less than 160 acres. It is assumed that the majority of the developments will fall within this size. The second method is the CUHP, which is designed for large basins which will undergo significant urbanization in the future. The third method is the SCS, which is designed for large basins containing large areas of undeveloped and/or farmland. Other methods which will produce similar results and accuracy will be accepted on a case by case basis.

RATIONAL METHOD

For simple basins less than 160 acres, this method provides for a rapid solution and provides accurate values when correctly applied. The basic formula used is:

$$Q = CIA$$

with "Q" being the storm flow in cubic feet per second. "C" is the coefficient of runoff and can be taken from the enclosed table. "I" is the rainfall intensity in inches per hour and "A" is the basin size in acres. Weighted "C" values will be required for all commercial establishments which provide onsite parking. The 5-year, 10-year and 100-year-time-intensity-frequency curves for the area are enclosed within the supplementary section of this chapter.

The main assumptions on which this method is based are as follows:

1. Rain fall will be uniform over the site.

2. All areas of the site will contribute equally to the peak flow.

3. The maximum rainfall occurs during the time of concentration.

The time of concentration is the time required for rainfall at the furthest part of the basin to travel to the discharge point. This is a summation of separate values for different basin characteristics. Topographic maps provide for general characteristics of the basin but do not provide adequate information for determining the vegetation characteristics. For design purposes, they should therefore be supplemented with pertaining soils and vegetation data.

That portion of the concentration time which is most open to variation is the so-called "overland" part. For undeveloped conditions, the "overland" flow length should not be greater than 500 feet nor less than 100 feet.

Said "overland" can either be taken from the enclosed graph or be calculated by means of the formula:

$$T_c = \frac{1.8\,(1.1 - C)\,\sqrt{D}}{\sqrt[3]{S}}$$

In this formula, T_C is the overland of concentration, "C: is the runoff coefficient, "D" is the distance of flow in feet and "S" is the slope over this distance in percent. the minimum time for overland flow will be 10 minutes under undeveloped conditions, and 5 minutes for developed conditions.

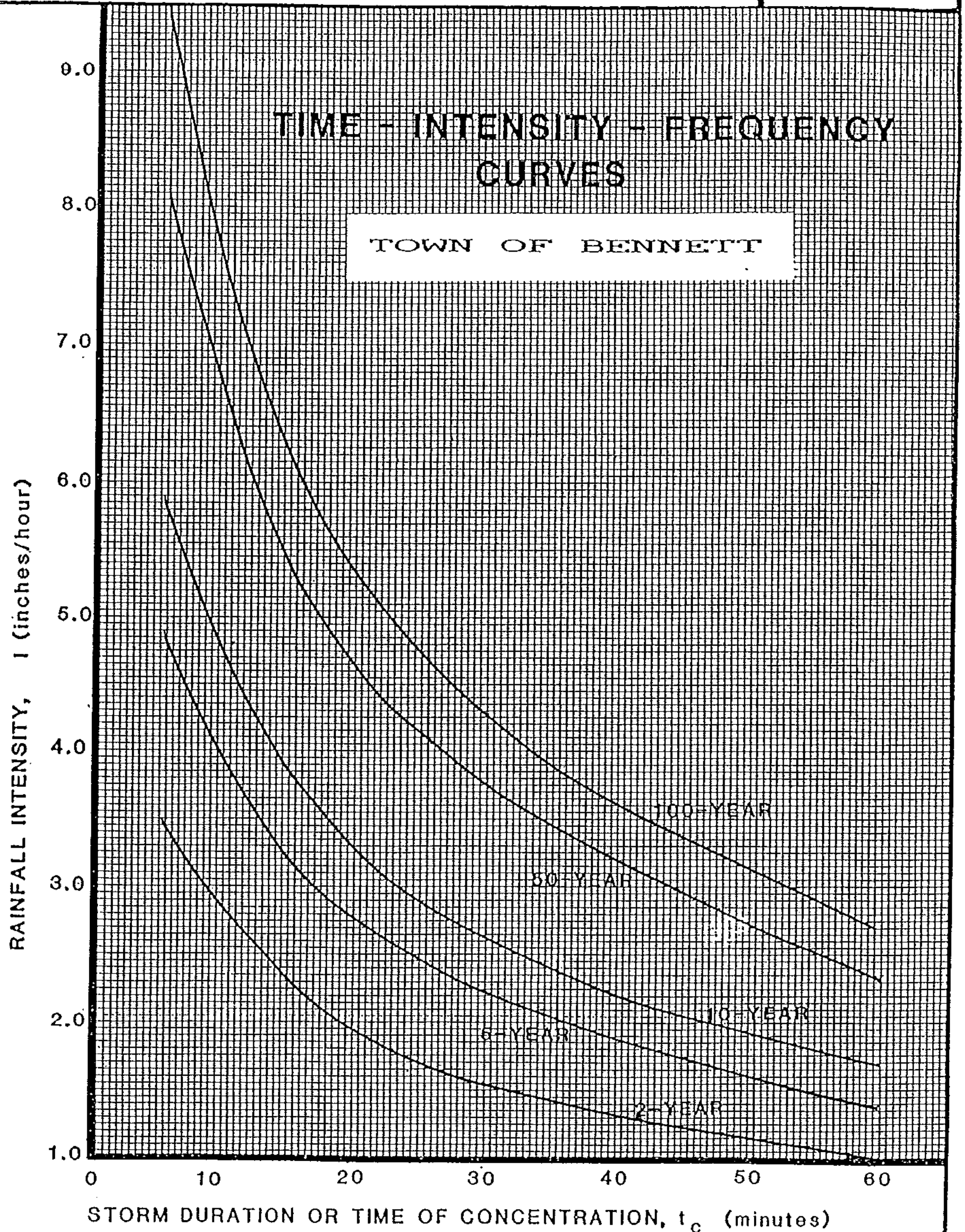
The remainder of the total time of concentration is determined by the overall basin and its associated collector swale characteristics.

All tables, graphs and standard forms allowing for the calculation of such and the resultant peak flows by means of the "Rational Method", are enclosed within the pertaining "Tables and Figures" section of this chapter.

TABLES & FIGURES

(RATIONAL METHOD)

STORM DRAINAGE DESIGN | FIGURE 01



Date:
Rev:

REFERENCE:

RECOMMENDED RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY 2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	70	.60	.65	.70	.80
Residential:					
Single-Family	*	.40	.45	.50	.60
Multi-Unit (detached)	50	.45	.50	.60	.70
Multi-Unit (attached)	70	.60	.65	.70	.80
1/2 Acre Lot or Larger	*	.30	.35	.40	.60
Apartments	70	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Acres	90	.80	.80	.85	.90
Parks, Cemetaries:	7	.10	.10	.35	.60
Playgrounds:	13	.15	.25	.35	.65
Schools:	50	.45	.50	.60	.70
Railroad Yard Areas	40	.40	.45	.50	.60
Undeveloped Areas:					
Historic Flow Analysis- Greenbelts, Agricultural	2	(See "Lawns")			
Offsite Flow Analysis (when land use not defined)	45	.43	.47	.55	.65
Streets:					
Paved	100	.87	.88	.90	.93
Gravel	13	.15	.25	.35	.65
Drive and Walks:	96	.87	.87	.88	.89
Roofs:	90	.80	.85	.90	.90
Lawns, Sandy Soil	0	.00	.01	.05	.20
Lawns, Clayey Soil	0	.05	.10	.20	.40

NOTE: These Rational Formula coefficients may not be valid for large basins.

*See Figure 2-1 for percent impervious.

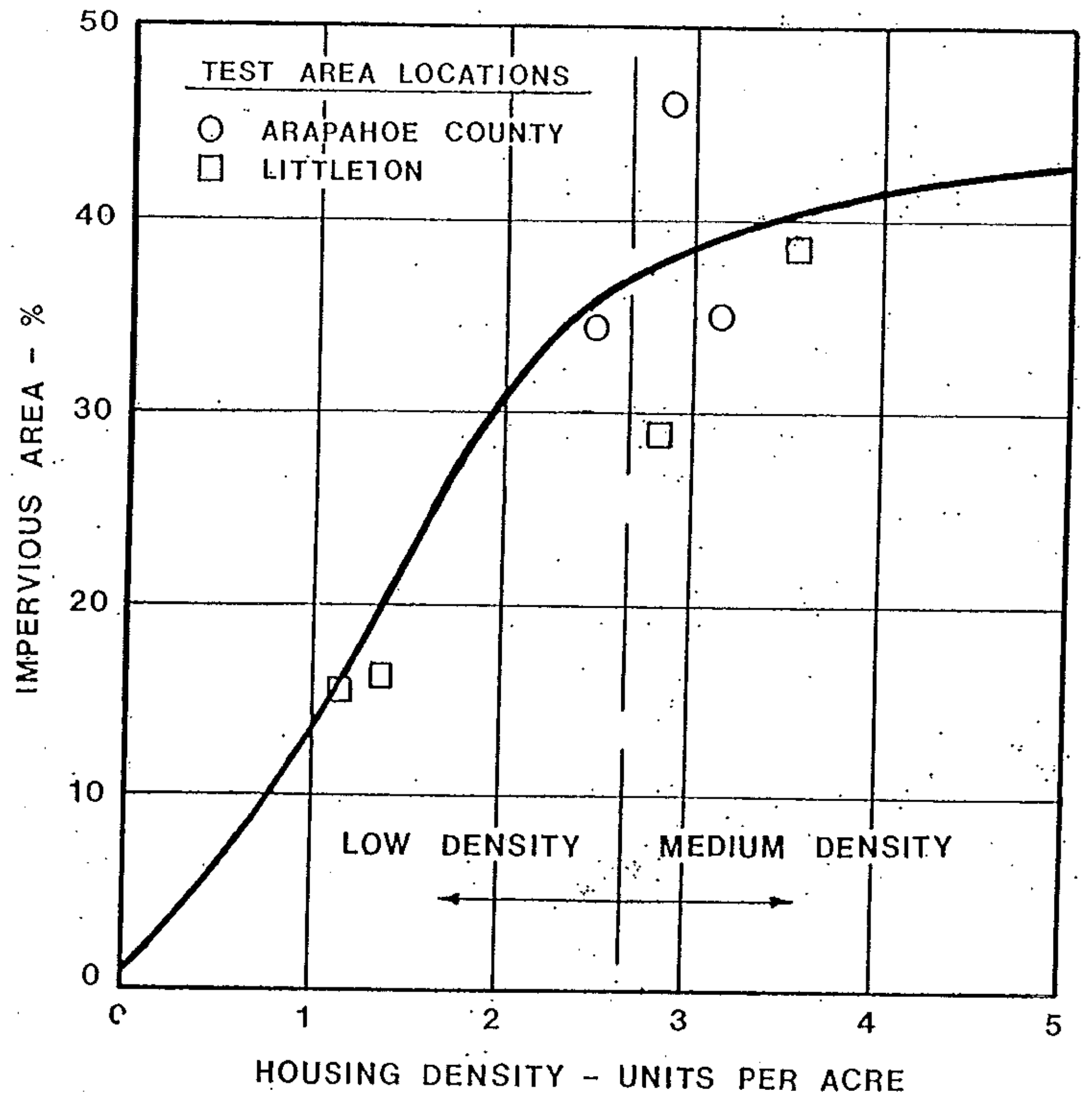
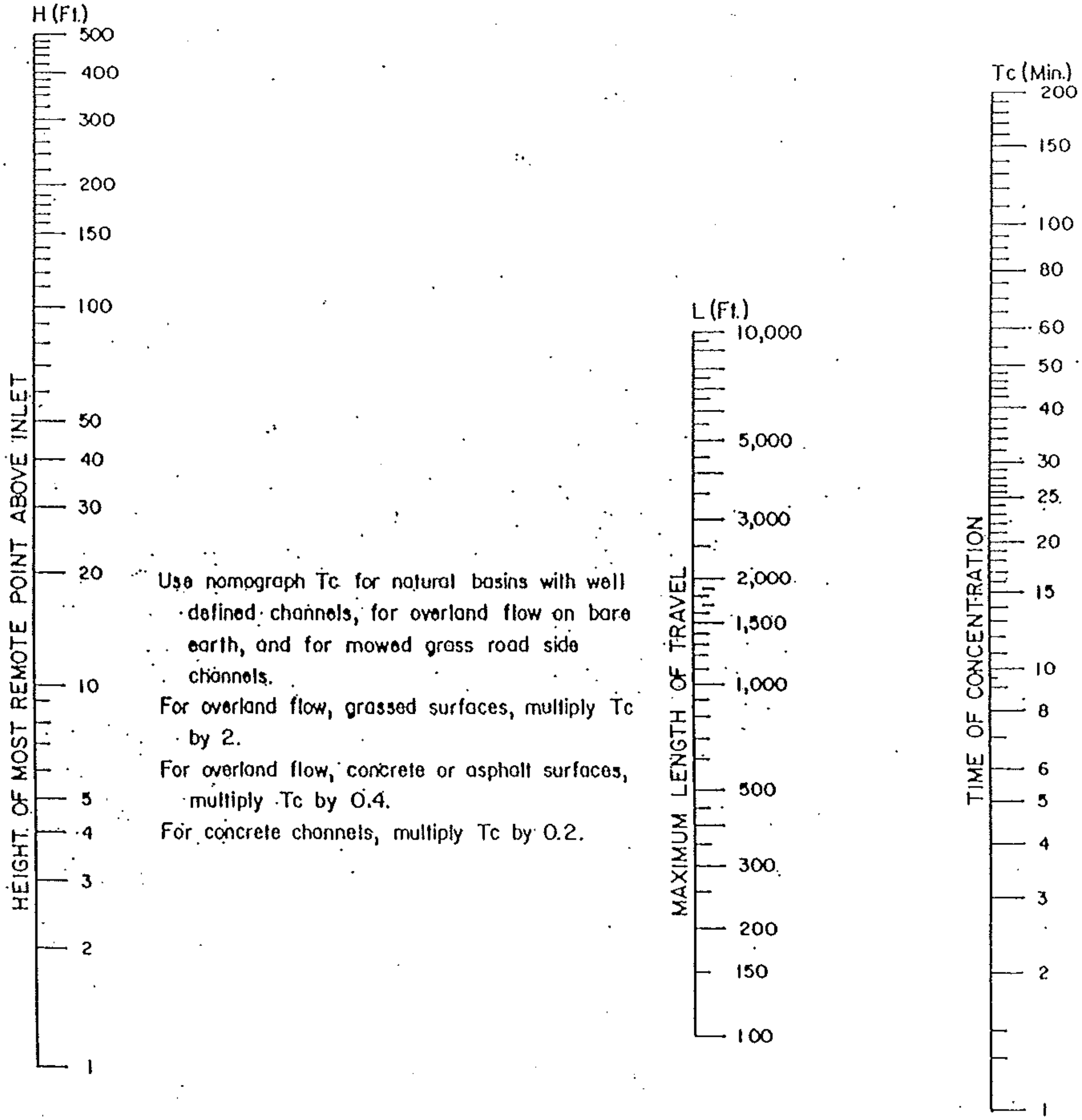


FIGURE 2-1. RESIDENTIAL HOUSING DENSITY vs. IMPERVIOUS AREA



Use nomograph Tc for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass road side channels.

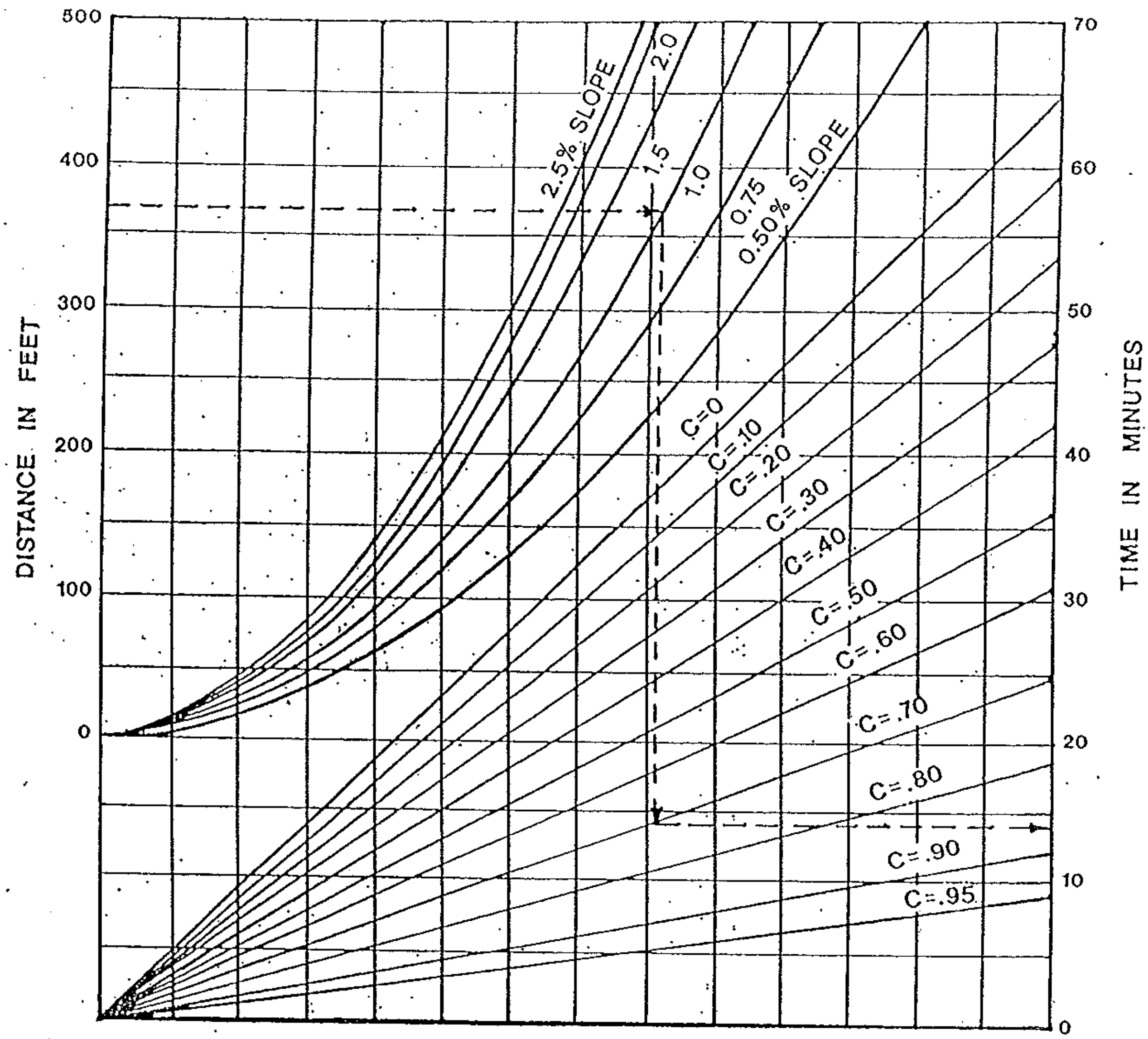
For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Based on study by P.Z. Kirpich, Civil Engineering, Vol. 10, No. 6, June 1940, p. 362.

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

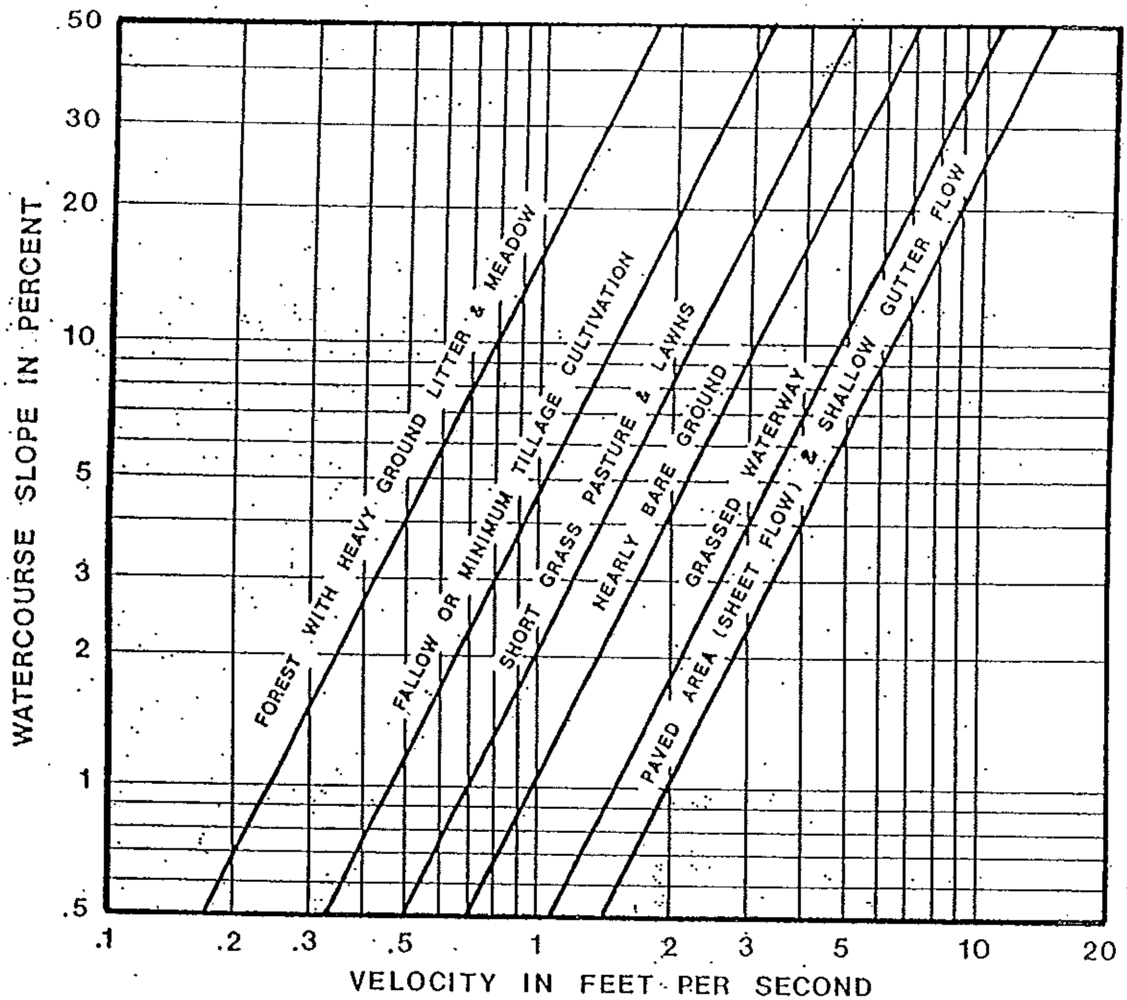


$$Tc = \frac{1.8 \ (1.1 - C)\sqrt{D}}{\sqrt[3]{S}}$$

OVERLAND TIME OF FLOW CURVES

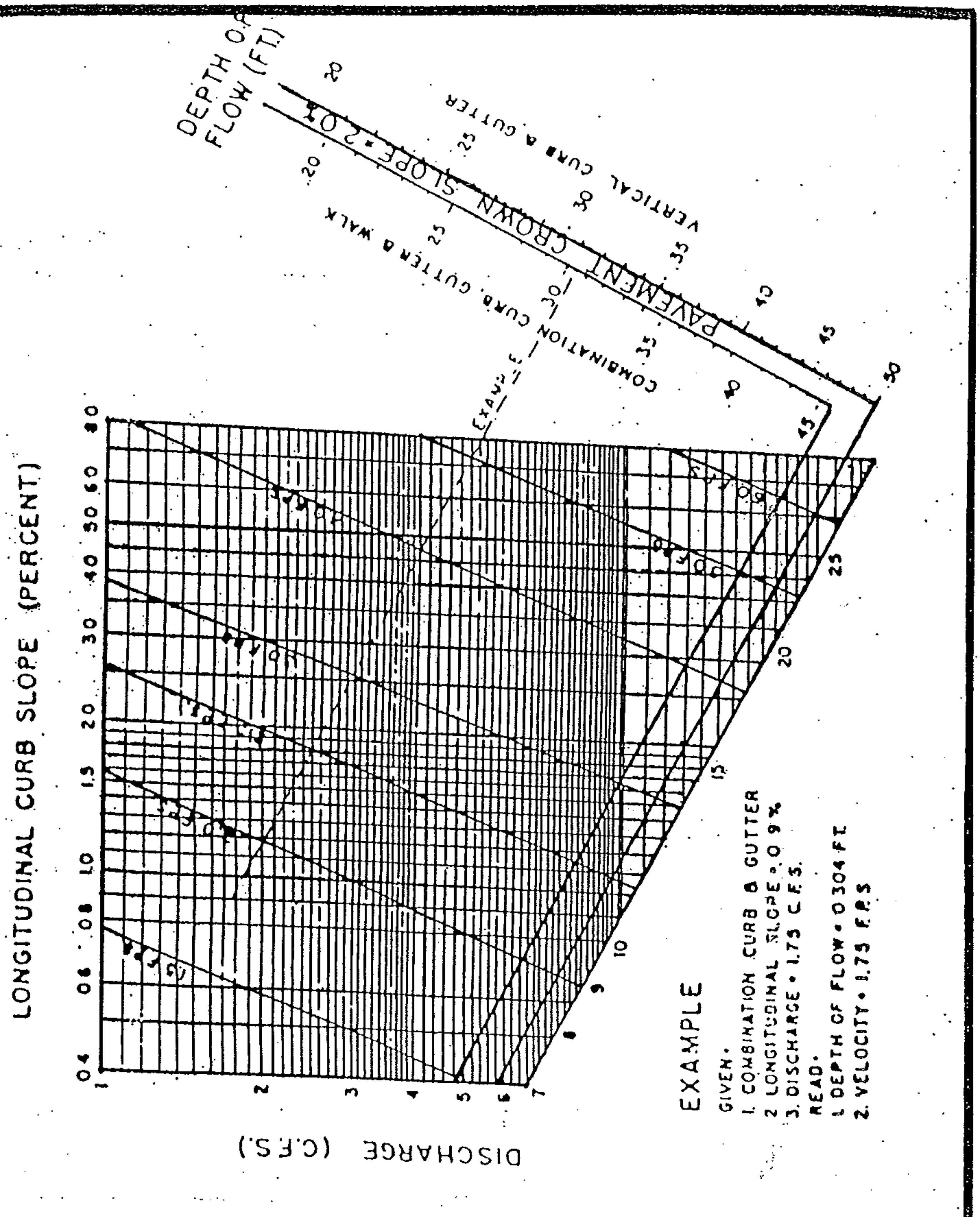
NOTE:

Minimum Tc undeveloped = 10 minutes
Minimum Tc developed = 5 minutes

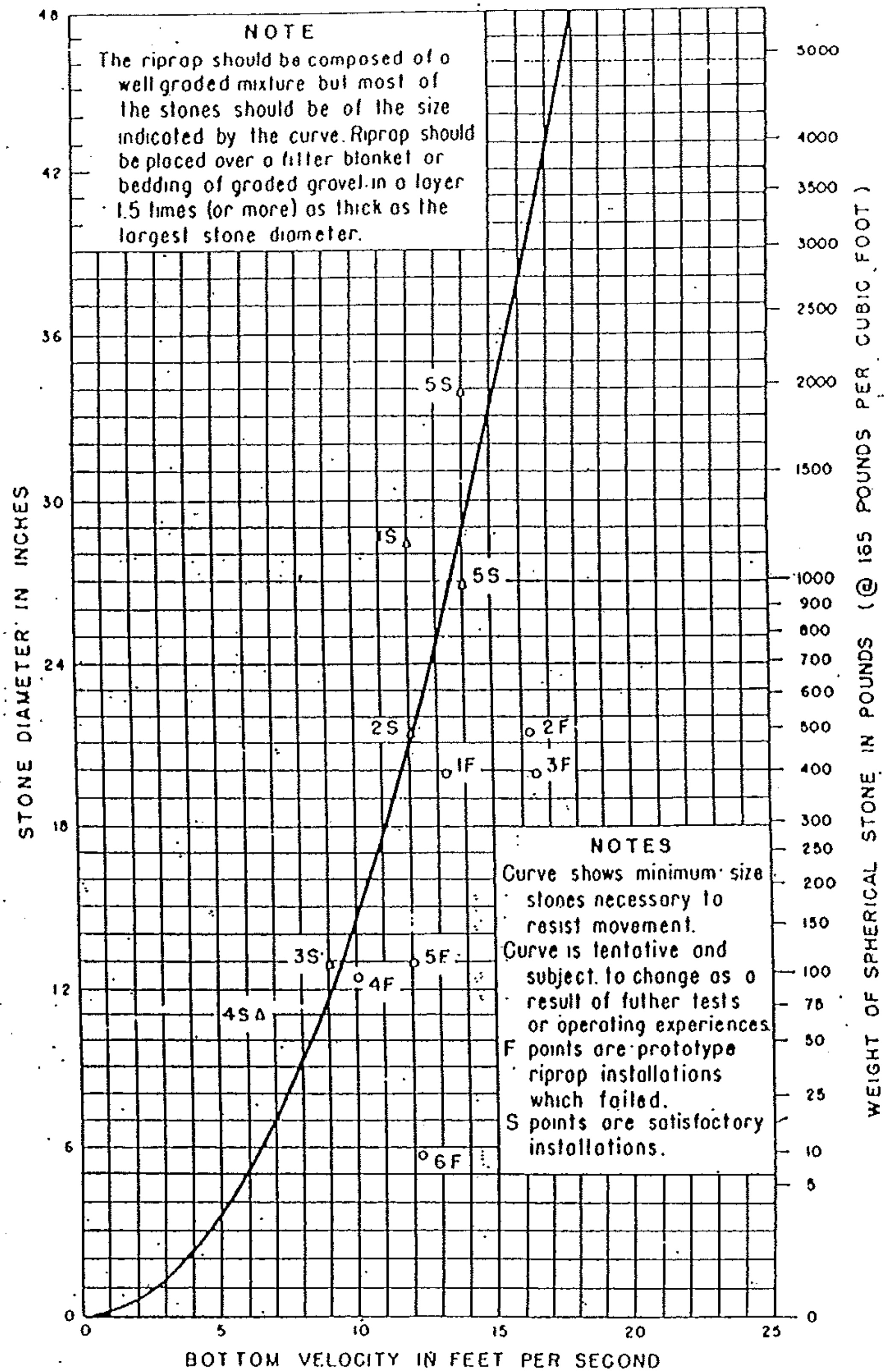


ESTIMATE OF AVERAGE FLOW VELOCITY FOR USE WITH THE RATIONAL FORMULA.

REFERENCE: "Urban Hydrology For Small Watersheds" Technical Release No. 55, USDA, SCS Jan. 1975.



CURB CAPACITY NOMOGRAPH



RIPRAP SIZING

Table 5-1

CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (Inches)	d_{50}* (Inches)
Type VL	70-100	12	
	50-70	9	
	35-50	6	6**
	2-10	2	
Type L	70-100	15	
	50-70	12	
	35-50	9	9**
	2-10	3	
Type M	70-100	21	
	50-70	18	
	35-50	12	12
	2-10	4	
Type H	100	30	
	50-70	24	
	35-50	18	18
	2-10	6	
Type VH	100	42	
	50-70	33	
	35-50	24	24
	2-10	9	

Table 5-5

RIPRAP REQUIREMENTS FOR CHANNEL LININGS **

$VS^{0.17}/(S_s-1)^{0.66}$* ($ft^{1/2}$/sec)	Rock Type ***
1.4 to 3.2	VL
3.3 to 3.9	L
4.0 to 4.5	M
4.6 to 5.5	H
5.6 to 6.4	VH

* Use S_s = 2.5 unless the source of rock and its densities are known at the time of design.

** Table valid only for Froude number of 0.8 or less and side slopes no steeper than 2h:1v.

*** Type VL and L riprap shall be buried after placement to reduce vandalism.
SM9 slope mattress with toe protection may be substituted for Type VL or L riprap.
G12 gabion with toe protection may be substituted for Type M and Type H riprap.

RATIONAL METHOD

SUBDIVISION: ______________________ DESIGN STORM ____ YR. RECURRENCE INTERVAL

LOCATION ____________ COMPUTED BY: ____________ DATE: ____________ PAGE ___ OF ___

Street	Design Point	Area Desig.	A (acres)	C	CA (acres)	Σ CA (acres)	t_i	t_o	Tc (min.)	i (in/hr)	Q (cfs)	Slope (%)	Leng. L (feet)	VEL. V (fps)	Δt (min.)	Remarks

Storm drainage system design