

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \quad [\text{eq. 4-1}]$$

where:

- $q_p$  = peak discharge (cfs)
- $q_u$  = unit peak discharge (csm/in)
- $A_m$  = drainage area (mi<sup>2</sup>)
- $Q$  = runoff (in)
- $F_p$  = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1)  $T_c$  (hr), (2) drainage area (mi<sup>2</sup>), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the  $T_c$  computation, an adjustment for pond and swamp areas is also needed.

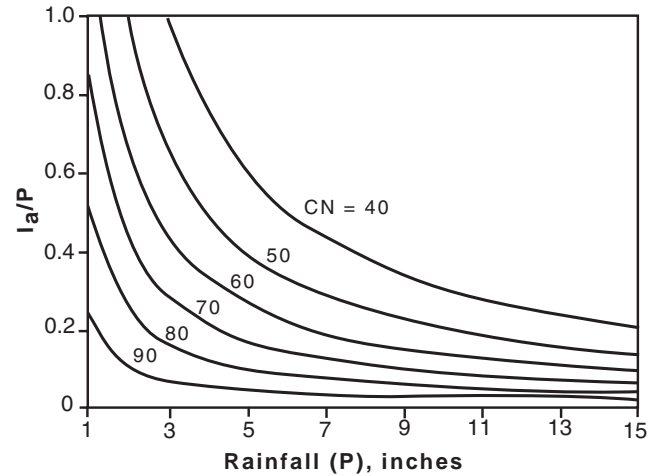
## Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction ( $I_a$ ) from table 4-1.  $I_a / P$  is then computed.

If the computed  $I_a / P$  ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of  $I_a / P$  to CN and P.

Peak discharge per square mile per inch of runoff ( $q_u$ ) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using  $T_c$  (chapter 3), rainfall distribution type, and  $I_a / P$  ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

**Figure 4-1** Variation of  $I_a / P$  for P and CN



**Table 4-1**  $I_a$  values for runoff curve numbers

Curve number	$I_a$ (in)	Curve number	$I_a$ (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

**Table 4-2** Adjustment factor ( $F_p$ ) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	$F_p$
0 .....	1.00
0.2 .....	0.97
1.0 .....	0.87
3.0 .....	0.75
5.0 .....	0.72

## Limitations

The Graphical method provides a determination of peak discharge only. If a hydrograph is needed or watershed subdivision is required, use the Tabular Hydrograph method (chapter 5). Use TR-20 if the watershed is very complex or a higher degree of accuracy is required.

- The watershed must be hydrologically homogeneous, that is, describable by one CN. Land use, soils, and cover are distributed uniformly throughout the watershed.
- The watershed may have only one main stream or, if more than one, the branches must have nearly equal  $T_C$ 's.
- The method cannot perform valley or reservoir routing.
- The  $F_p$  factor can be applied only for ponds or swamps that are not in the  $T_C$  flow path.
- Accuracy of peak discharge estimated by this method will be reduced if  $I_a/P$  values are used that are outside the range given in exhibit 4. The limiting  $I_a/P$  values are recommended for use.
- This method should be used only if the weighted CN is greater than 40.

- When this method is used to develop estimates of peak discharge for both present and developed conditions of a watershed, use the same procedure for estimating  $T_C$ .

- $T_C$  values with this method may range from 0.1 to 10 hours.

## Example 4-1

Compute the 25-year peak discharge for the 250-acre watershed described in examples 2-2 and 3-1. Figure 4-2 shows how worksheet 4 is used to compute  $q_p$  as 345 cfs.

**Example 4-1** Worksheet 4 for example 4-1

**Worksheet 4: Graphical Peak Discharge method**

Project <i>Heavenly Acres</i>	By <i>RHM</i>	Date <i>10/15/85</i>
Location <i>Dyer County, Tennessee</i>	Checked <i>NM</i>	Date <i>10/17/85</i>

Check one:  Present  Developed

1. Data

Drainage area .....  $A_m = \underline{0.39}$  mi<sup>2</sup> (acres/640) \_\_\_\_\_

Runoff curve number ..... CN = 75 (From worksheet 2), *Figure 2-6*

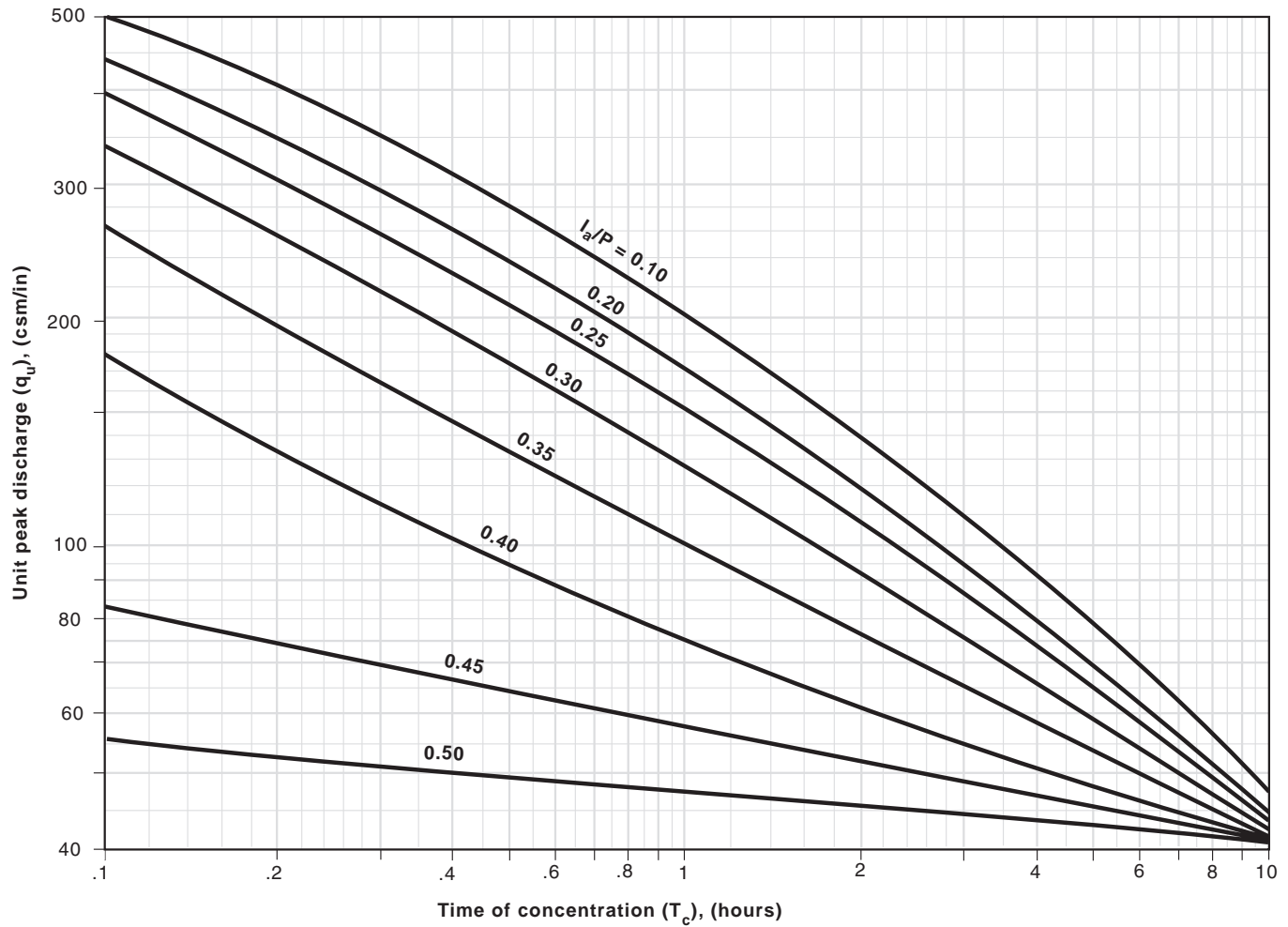
Time of concentration .....  $T_c = \underline{1.53}$  hr (From worksheet 3), *Figure 3-2*

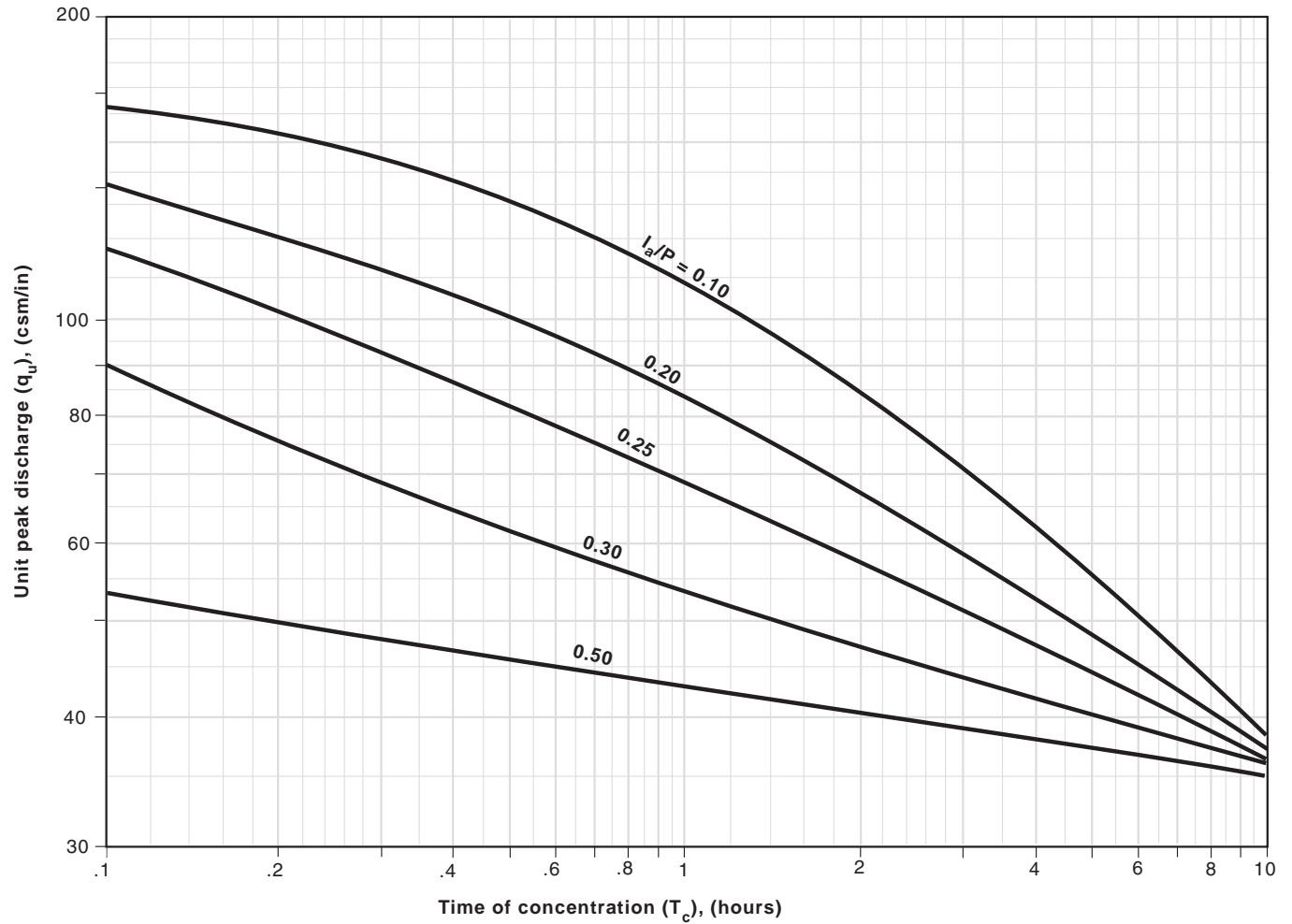
Rainfall distribution ..... = II (I, IA, II III) \_\_\_\_\_

Pond and swamp areas spread throughout watershed ..... = --- percent of  $A_m$  ( --- acres or mi<sup>2</sup> covered)

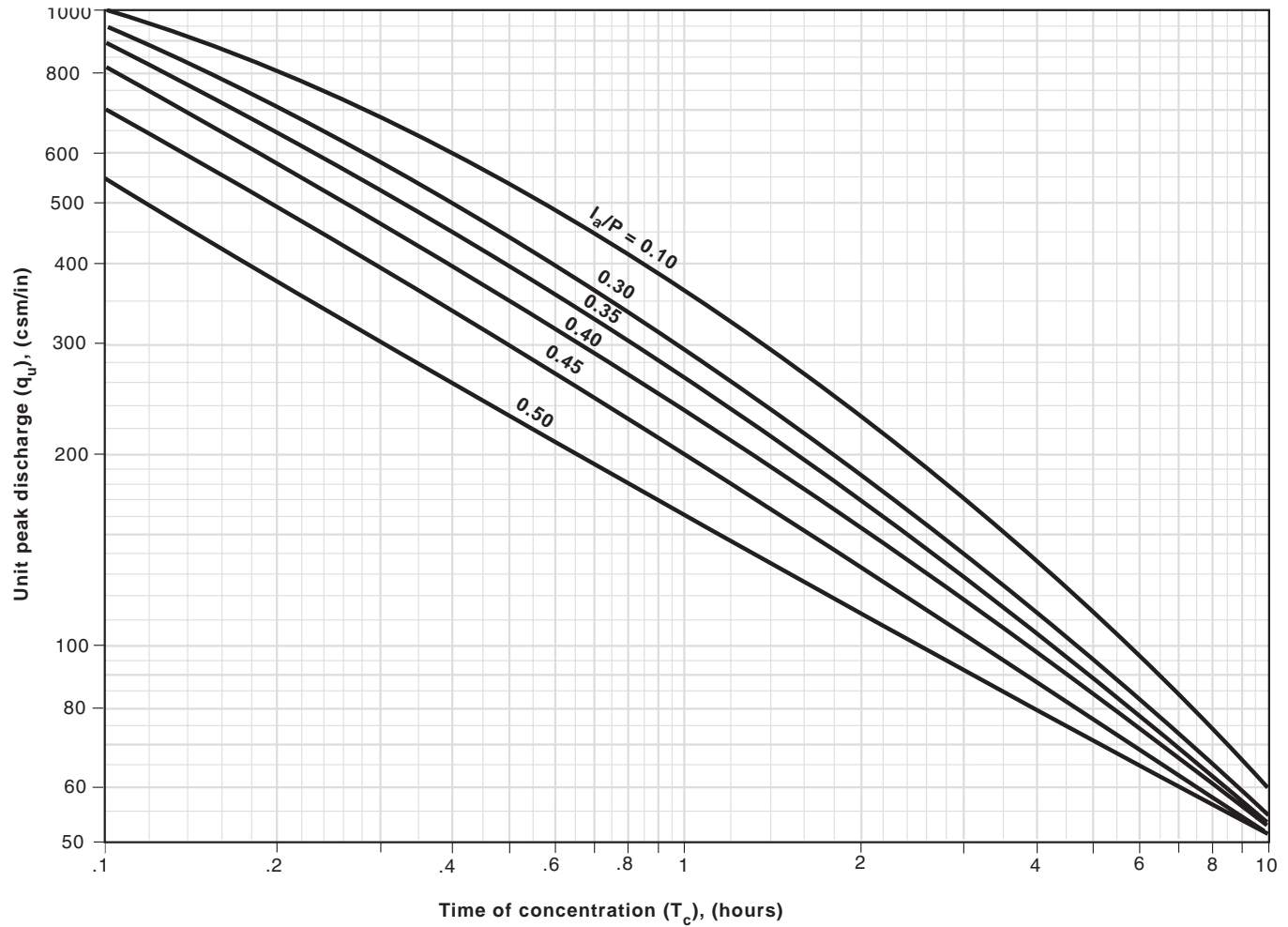
	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr	25		
3. Rainfall, P (24-hour) ..... in	6.0		
4. Initial abstraction, $I_a$ ..... in (Use CN with table 4-1)	0.667		
5. Compute $I_a/P$ .....	0.11		
6. Unit peak discharge, $q_u$ ..... csm/in (Use $T_c$ and $I_a/P$ with exhibit 4- <u>II</u> )	270		
7. Runoff, Q ..... in (From worksheet 2). <i>Figure 2-6</i>	3.28		
8. Pond and swamp adjustment factor, $F_p$ ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	1.0		
9. Peak discharge, $q_p$ ..... cfs  ( Where $q_p = q_u A_m Q F_p$ )	345		

**Exhibit 4-I** Unit peak discharge ( $q_{u}$ ) for NRCS (SCS) type I rainfall distribution



**Exhibit 4-1A** Unit peak discharge ( $q_{u}$ ) for NRCS (SCS) type IA rainfall distribution

**Exhibit 4-II** Unit peak discharge ( $q_u$ ) for NRCS (SCS) type II rainfall distribution



**Exhibit 4-III** Unit peak discharge ( $q_u$ ) for NRCS (SCS) type III rainfall distribution

