USDA Natural Resources Conservation Service
National Employee Development Center

Module 206C

Peak Discharge, Tabular Method, TR55

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Engineering Hydrology Training Series

Module 206C—Peak Dischage Tabular Method, TR55

National Employee Development Center
Natural Resources Conservation Service
United States Department of Agriculture

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Preface

This module consists of a study guide which contains a step by step process for calculating peak discharge and developing hydrographs from rural or urban areas using the TR55 tabular method. This procedure is found in Chapter 5 of Technical Release 55, Urban Hydrology for Small Watersheds (TR55).

Proceed through this module at your own pace. Be sure you completely understand each section before moving on. If you have questions or need help, please request assistance from your supervisor. If your supervisor cannot clear up your problems, he/she will contact the state appointed resource person. The resource person is familiar with the material and should be able to answer any questions you may have.

Be sure to write out your answers to the included activities. This will help to reinforce your learning. After completing each activity, compare your answers with the included solution.

Acknowledgment

The design and development of this engineering module is the result of a concerted effort by practicing engineers in the Natural Resources Conservation Service. The contributions from many technical and procedural reviews have helped make this module one that will provide needed knowledge of hydrology/hydraulic skills to NRCS employees.

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Module Description

Overview

This module presents the peak discharge equation, input requirements, peak discharge computations, and limitations.

Objectives

Upon completion of this module, you will be able to:

- Describe when complex hydrographs are needed.
- Compute peak discharge and develop hydrographs using TR55, Chapter 5, Tabular Peak Discharge Method.
- Be able to perform at ASK Level 3 (Perform with Supervision).

Prerequisites

Modules 101—Introduction to Hydrology; 102—Precipitation; 103—Runoff Concepts; 104—Runoff Curve Number Computation, 106—Peak Discharge, and 206A—Time of Concentration.

Duration

Participant should take as long as necessary to complete the module. Training time for the module is approximately two hours.

Who May Take This Module

All Area-level engineers and technicians and others who compute peak discharge from areas greater than 2,000 acres and from urban watersheds.

Method of Completion

This module is self-paced, but states should select a resource person to answer any questions the participant's supervisor cannot handle.

Module 206C—Peak Discharge Tabular Method, TR55

Introduction

This training module describes when complex hydrographs are needed. It presents the Tabular Peak Discharge Method (Tabular Method) for computing peak discharges from rural and urban areas by using time of concentration (T_c) and travel time (T_t) from a subarea as inputs. The procedure is found in Chapter 5 of Technical Release 55, Urban Hydrology for Small Watersheds (TR55).

Uses

The Tabular method can be used to develop hydrographs at any point in a watershed by dividing the watershed into homogeneous subareas. Thus, the method can be used to estimate runoff and peak discharges from a nonhomogeneous watershed. By developing hydrographs for each subarea, the effects of the contribution of a subarea can be quantified. The method can be used to estimate the effects of land use change in a portion of a watershed. In addition, it can be used to estimate the effects of proposed structures or channel modifications.

Limitations

In the Tabular Method, the maximum subarea time of concentration is two hours, and the maximum travel time from a subwatershed outlet to downstream estimate point is three hours.

Complex Hydrographs

Complex hydrographs are needed for the following conditions:

- The watershed is not hydrologically homogeneous. Therefore, it cannot be described using a single value curve number or a single T_c. The nonhomogeniety in the watershed can be of the following types:
  - — Slope—the average watershed slope or channel hydraulic gradient for the subareas varies significantly.
  - — Land use, soils, and cover are not distributed uniformly throughout the watershed. Example—one area in woods on "a" soils and the other in high density urban on "d" soils.
  - — Shape—the length/width ration (l/w) for a subarea is much different than the l/w for the whole watershed.
- Subareas are needed because the watershed has more than one main stream or branch.
- Valley storage is involved—there is a significant routing effect because of the large volume of storage in a low gradient channel reach.
- Reservoir storage—the effects of a reservoir in a subarea need to be quantified.

Tabular Peak Discharge Method

Method Development

The Tabular Method was developed from hydrograph analysis using TR20, Computer Program for Project Formulation—Hydrology. The tabular hydrograph tables were developed by computing hydrographs for one square mile of drainage area at selected T_c's and routing them through stream reaches with different travel times. The Modified Att-Kin method was used for reach routings. A curve number (CN) of 75 and rainfall amounts generating the appropriate initial abstraction to rainfall (Ia/P) ratio were used. The resulting estimated runoff was used to convert the hydrographs to unit hydrograph values (cubic feet per second per square mile per inch of runoff).

The discharge at any hydrograph time t is:

$$q = q_t A_m Q$$

where,

q = discharge, cfs for the hydrograph coordinate at time t;

q_t = tabular hydrograph unit discharge at time t;

A_m = drainage area of individual subarea (mi^2); and

Q = storm runoff, inches.

When to Use The Tabular Method

The tabular method is used when:

- A heterogeneous watershed can be subdivided into homogeneous areas.
- The watershed has more than one main stem.
- Valley or reservoir storage is involved.
- Other.
  - — You are concerned either with peak discharges or the hydrographs occurring at several locations within the watershed.
  - — A hydrograph is needed to look at timing of a peak flow, or for duration of flow above a base level.

Input Requirements

In order to use the Tabular Method, the watershed must be subdivided into areas that are relatively homogeneous and have convenient routing reaches.

The input requirements are:

- Drainage area (A_m), mi^2, for each subarea.
- Weighted runoff curve number (CN) for each subarea, obtained by using the procedure shown in Module 104 Runoff Curve Number Computation.
- Time of concentration (T_c), hr, for each subarea obtained by using the procedure shown in Module 206A, Time of Concentration.

- Travel time (T_t), hr., through each downstream subarea, obtained by using the procedure shown in Module 206A. Travel time through a routing reach is computed using either shallow concentrated and/or open channel flow.
- Appropriate SCS rainfall distribution, Type I, IA, II, or III.
- 24-hour rainfall, in., for the desired frequency.

Activity 1

At this time, complete Activity 1 in your Study Guide to review the material just covered. When you are finished, compare your answers with the solution provided near the back of this module. When you are sure you understand the material, continue with the Study Guide text.

Activity 1

1. When should the tabular peak discharge method be used?

2. What are the six input requirements for each subarea in the Tabular Peak Discharge Method?

   a.

   b.

   c.

   d.

   e.

   f.

Procedure for Using the Tabular Method

The general steps in developing a hydrograph using the tabular method are:

Step 1

For the watershed location selected, find the appropriate rainfall distribution from Figure B-2, page 34.

Step 2

For a selected rainfall frequency, find the 24-hour rainfall amount (P) from the appropriate precipitation-frequency data.

Step 3

Compute the weighted CN for each subarea using procedures in Module 104. CN and P are used to obtain the total storm runoff (Q).

Step 4

Using the weighted CN, obtain an initial abstraction (Ia) for each subarea from Table 5-1, page 35. The Ia/P ratio is then computed for each subarea.

Step 5

Calculate a T_c value for each subarea and a T_t value for each downstream subarea using Module 206A.

Step 6

On worksheet 5A, page 23, record subarea name and measured drainage area size, T_c, T_t, P, CN, Q, Ia, and Ia/P values. Then, for each subarea, the downstream subareas are listed and the T_t value for each listed downstream subarea are summed and recorded in the summation of T_t column. Also, A_m times Q is multiplied for each subarea and recorded.

Step 7

Round the calculated values of T_c and T_t for the subareas to the given Exhibit 5 table values. For each subarea, take the T_c value and the sum of the T_t values to the watershed point of interest. Then use the following three rounding operations, and choose the pair of rounded T_c and T_t values whose sum is closest to the actual sum. If the two operations produce sums equally close to the actual sum, use the pair in which the rounded T_c is closest to actual T_c.

a. Round T_c and T_t separately to the nearest table value and sum;

b. Round T_c down and T_t up to the nearest table value and sum;

c. Round T_c up and T_t down to the nearest table value and sum.

Example

Table value by rounding method

	Actual Value	**a**	**b**	**c**
T_c	1.1	1.0	1.0	1.25
T_t	1.1	1.0	1.5	1.00
Sum	2.2	2.0	2.5	2.25

Select the rounded values by method c as the sum closest to the actual sum of T_c and T_t.

Step 8

Round the computed Ia/P values to the nearest Ia/P value in the tables.

Step 9

Develop individual subarea hydrographs using Worksheet 5b. For the appropriate rainfall distribution curve and selected rounded values of T_c, T_t, and Ia/P, and selected hydrograph times, the table tabular unit hydrograph value is multiplied by $A_m Q$ and the discharge value is entered.

Step 10

Develop a composite hydrograph which is the summation of all the subarea hydrograph discharge values for each hydrograph time.

Limitations

The following limitations should be kept in mind when using the Tabular Method for computing peak discharge and hydrographs.

- The accuracy of the hydrographs produced by the Tabular Method decreases as the complexity of the watershed increases.
- Maximum T_c is two hours.
- Maximum T_t is three hours.
- Only a partial hydrograph is developed.
- Not accurate if there is a difference in drainage area size for the individual subareas that exceed a ratio of five.
- The reach routings were done assuming the same velocity for all discharges.

Example 1

Given

A watershed in Dyer County, Tennessee that has been subdivided into seven subareas (see Figure 1 below).

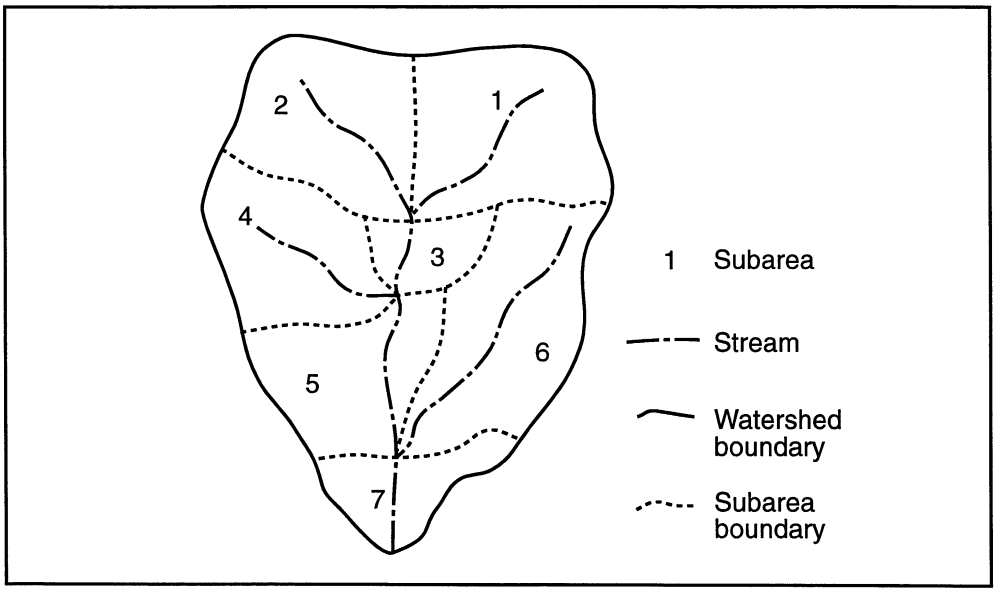


Figure 1. Fallswood Project

Subarea Data

Subarea Name	Drainage Area (mi^2)	Time of Concentration (hr)	Travel Time Through Subarea	Runoff curve number
1	0.30	1.50	-	65
2	0.20	1.25	-	70
3	0.10	0.50	0.50	75
4	0.25	0.75	-	70
5	0.20	1.50	1.25	75
6	0.40	1.50	-	70
7	0.20	1.25	0.75	75

Rainfall distribution = Type II; P_{25} = 6.0 in.

Find

The 25-year peak discharge at the downstream end of subarea seven using worksheets 5a and 5b (Figures 2 and 3).

Solution

Step 1

Record given data of subarea name, drainage area, time of concentration, travel time through subarea, 24-hour rainfall, and runoff curve number on Worksheet 5a (Fig 2).

Step 2

For each subarea, list the downstream names in column 5.

Step 3

Sum the travel time for each subarea in column 5 and record in ΣT_t, column 6.

Step 4

For rainfall P (column 7) and runoff curve number (column 8) use Figure 2-1, page 34, to determine runoff Q and record in column 9.

Step 5

Column 10, multiply A_m (column 2) times Q (column 9).

Step 6

Ia (column 11) from Table 5-1, page 35, for CN (column 8).

Step 7

Ia/P (column 12) equals column 11 divided by column 7.

Step 8

Transfer subarea name, T_c, ΣT_t, Ia/P, and A_mQ to Worksheet 5b (Fig 3).

Step 9

With T_c and ΣT_t, enter exhibit 5-I, pages 36-45, and for each selected hydrograph time, multiply the unit hydrograph value by A_mQ to get the hydrograph discharge value.

Step 10

Sum each of the subarea hydrograph columns (individually) on Worksheet 5b to get the composite hydrograph.

Project Fallswood Location Dyer County, Tennessee By ____ Date ____

Circle one: (Present) Developed ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.50	—			6.0	65				
2	0.20	1.25	-			6.0	70				
3	0.10	0.50	0.50			6.0	75				
4	0.25	0.75	-			6.0	70				
5	0.20	1.50	1.25			6.0	75				
6	0.40	1.50	-			6.0	70				
7	0.20	1.25	0.75			6.0	75				

From worksheet 3 — From worksheet 2 — From table 5-1

Figure 2. Worksheet 5a: Basic watershed data.

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5- 2/											
	Sub-area T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi^2-in)	Discharges at selected hydrograph times 3/ -(cfs)-											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Figure 3. Worksheet 5b: Tabular hydrograph discharge summary.

Project Fallswood Location Dyer County, Tennessee By DW Date 10/1/85

Circle one: (Present) Developed _____ Frequency (yr) 25 Checked TH Date 10/3/85

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.50	--	3,5,7	2.50	6.0	65	2.35	0.71	1.077	0.18
2	0.20	1.25	--	3,5,7	2.50	6.0	70	2.80	0.56	0.857	0.14
3	0.10	0.50	0.50	5,7	2.00	6.0	75	3.28	0.33	0.667	0.11
4	0.25	0.75	--	5,7	2.00	6.0	70	2.80	0.70	0.857	0.14
5	0.20	1.50	1.25	7	0.75	6.0	75	3.28	0.66	0.667	0.11
6	0.40	1.50	--	7	0.75	6.0	70	2.80	1.12	0.857	0.14
7	0.20	1.25	0.75	--	0	6.0	75	3.28	0.66	0.667	0.11

From worksheet 3 | From worksheet 2 | From table 5-1

Figure 4. Worksheet 5a for example one.

Project Fallswood Location Dyer County, Tennessee By DW Date 10/11/85

Circle one: (Present) Developed Frequency (yr) 25 Checked JJM Date 10/31/85

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Sub-area T_c (hr)	ΣT_c to outlet (hr)	I_a/P	$A_m Q$ (mi^2-in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.50	2.50	0.10	0.71	4	4	5	6	6	8	10	13	24	49	100	149
2	1.25	2.50	0.10	0.56	3	4	4	6	7	8	11	16	32	64	110	127
3	0.50	2.00	0.10	0.33	5	5	6	8	12	21	41	67	98	92	60	29
4	0.75	2.00	0.10	0.70	8	9	11	14	20	34	62	106	172	192	149	81
5	1.50	0.75	0.10	0.66	21	28	50	83	118	147	158	154	127	98	67	44
6	1.50	0.75	0.10	1.12	36	47	85	140	200	249	269	261	216	166	114	75
7	1.25	0	0.10	0.66	169	187	205	176	140	108	85	69	51	40	31	24
Composite hydrograph at outlet					246	284	366	433	503	575	636	686	720	701	631	529

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is $A_m Q$ multiplied by tabular discharge from appropriate exhibit 5.

Figure 5. Worksheet 5b for example one.

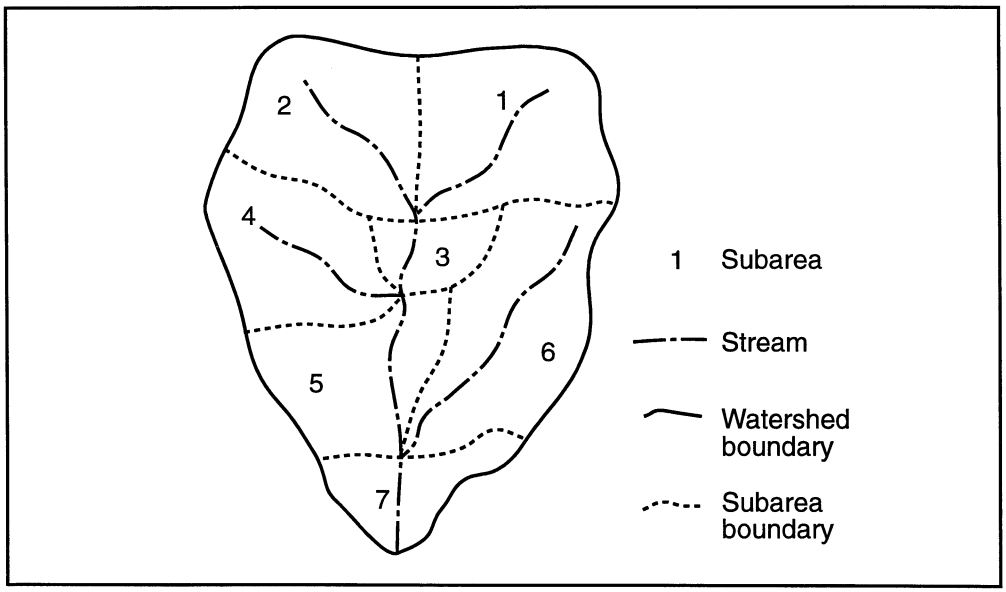
Activity 2

At this time, complete Activity 2, in your Study Guide to review the material just covered. When you are finished, compare your answers with the solution provided. When you are sure you understand the material, continue with the Study Guide text.

Activity 2

Given

The subdivided watershed in Dyer County, Tennessee (see sketch).



Subarea Data

Subarea Name	Drainage Area (mi^2)	Time of Concentration (hr)	Travel Time Through Subarea	Runoff curve number
1	0.30	1.4	-	65
2	0.27	1.2	-	70
3	0.10	0.6	0.45	75
4	0.18	0.9	-	70
5	0.20	1.3	1.10	75
6	0.34	1.6	-	70
7	0.12	1.0	0.80	75

Rainfall distribution = Type II; P_{25} = 6.0 in.

Find

The 25-year hydrograph at downstream end of subarea seven using worksheets 5a and 5b. Use the 3 rounding methods to select T_c and T_t for each subarea.

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	$A_m Q$ (mi^2-in)	Initial abstraction I_a (in)	I_a/P

From worksheet 3 | From worksheet 2 | From table 5-1

Worksheet 5a. Basic watershed data.

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5- 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	$A_m Q$ (mi^2-in)	Discharges at selected hydrograph times 3/ (cfs)											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is $A_m Q$ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Solution

Activity 3

At this time, complete Activity 3, in your Study Guide to review the material just covered. When you are finished, compare your answers with the solution provided. When you are sure you understand the material, continue with the Study Guide text.

Activity 3

Given

The watershed in activity two. A retarding structure has been constructed that controls subarea four with an average release of 5 cfs.

Find

The effect of the retarding structure on the 25-year peak discharge at the downstream end of subarea seven using Worksheet 5b. Use hydrograph data for subareas 1-3, and 5-7 from activity two.

Solution

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5- 2/											
	Sub-area T_c (hr)	ET_t to outlet (hr)	I_a/P	A_mQ (mi^2-in)	Discharges at selected hydrograph times 3/ (cfs)											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Activity 4

At this time, complete Activity 4, in your Study Guide to review the material just covered. When you are finished, compare your answers with the solution provided. When you are sure you understand the material, continue with the Study Guide text.

Activity 4

Given

The subdivided watershed in Dyer County described in activity two. A developer proposes to put a subdivision into subareas 1, 2, and 4.

Estimated data for subarea 1, 2, and 4:

Subarea Data

Subarea Name	Drainage Area (mi^2)	Time of Concentration (hr)	Travel Time Through Subarea	Runoff curve number
1	0.30	1.1	-	75
2	0.27	0.8	-	80
4	0.18	0.6	-	85

Rainfall distribution = Type II; P_{25} = 6.0 in.

Find

The effect of the subdivision on the 25-year peak discharge at the downstream end of subarea seven.

Solution

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	$A_m Q$ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
		↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑					↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑			↑ ↑ ↑ ↑	
		From worksheet 3					From worksheet 2			From table 5-1	

Worksheet 5a. Basic watershed data.

Project _____ Location _____ By _____ Date _____

Circle one: Present Developed _____ Frequency (yr) _____ Checked _____ Date _____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5- 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	$A_m Q$ (mi^2-in)	Discharges at selected hydrograph times 3/ -(cfs)-											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is $A_m Q$ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Summary

In summary, you have learned how to use the TR55, Tabular Method to compute peak discharges and develop hydrographs.

Remember that there are certain limitations to using the Tabular Method. Do not abuse these limitations or your results may be in error.

Retain this Study Guide as a reference until you are satisfied that you have successfully mastered all the methods covered. It will provide an easy review at any time if you should encounter a problem.

If you have had problems understanding the module or if you would like to take additional, related modules, contact your supervisor.

When you are satisfied that you have completed this module, remove the Certificate of Completion sheet (last page of the Study Guide), fill it out, and give it to your supervisor to submit, through channels, to your Training Officer.

Activity Solutions

Activity 1

1. When should the tabular peak discharge method be used?

   The tabular peak discharge method can be used when (1) watersheds are nonhomogeneous because of slope, land use, soils, cover, and shape, (2) watersheds have more than one main stream, (3) watersheds have valley or reservoir storage involved, or (4) watershed hydrographs are required.

2. What are the six input requirements for each subarea in the Tabular Peak Discharge Method?

   a. *Drainage area*

   b. *Runoff curve number*

   c. T_c

   d. T_t *for each downstream subarea*

   e. *Rainfall distribution type*

   f. *24-hour rainfall for the desired frequency*

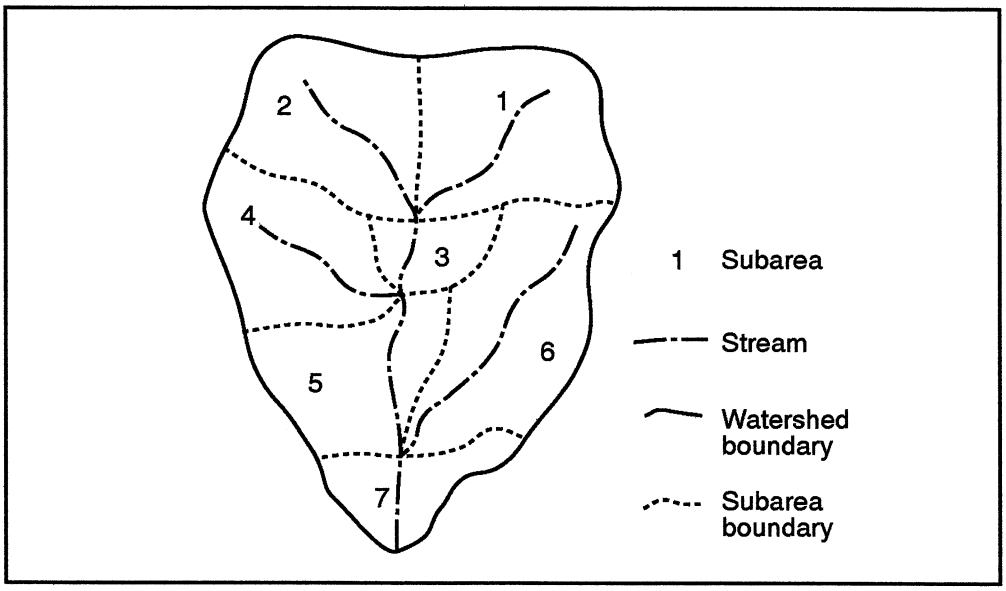
Activity 2

Given

The subdivided watershed in Dyer County, Tennessee (see sketch).

Find

The 25-year hydrograph at downstream end of subarea seven using worksheets 5a and 5b. Use the three rounding methods to select T_c and T_t.



Subarea Data

Subarea Name	Drainage Area (mi^2)	Time of Concentration (hr)	Travel Time Through Subarea	Runoff curve number
1	0.30	1.4	-	65
2	0.27	1.2	-	70
3	0.10	0.6	0.45	75
4	0.18	0.9	-	70
5	0.20	1.3	1.10	75
6	0.34	1.6	-	70
7	0.12	1.0	0.80	75

Rainfall distribution = Type II; P_{25} = 6.0 in.

Solution

The 25-year peak discharge is 681 cfs at 14.6 hours for Activity 2.

Selecting T_c and T_t		Actual Values	Table values by rounding method		
			a	b	c
Subarea 1	T_c	1.40	1.50	1.25	1.50
	T_t	2.35	2.50	2.50	2.00
	Sum	3.75	4.00	3.75	3.50
				use	
2	T_c	1.20	1.25	1.00	1.25
	T_t	2.35	2.50	2.50	2.00
	Sum	3.55	3.75	3.50	3.25
				use	
3	T_c	0.60	0.50	0.50	0.75
	T_t	1.90	2.00	2.00	1.50
	Sum	2.50	2.50	2.50	2.25
			use		
4	T_c	0.90	1.00	0.75	1.00
	T_t	1.90	2.00	2.00	1.50
	Sum	2.80	3.00	2.75	2.50
				use	
5	T_c	1.30	1.25	1.25	1.50
	T_t	0.80	0.75	1.00	0.75
	Sum	2.10	2.00	2.25	2.25
			use		
6	T_c	1.60	1.50	1.50	2.00
	T_t	0.80	0.75	1.00	0.75
	Sum	2.40	2.25	2.50	2.75
				use	

Project Activity 2 Location Dyer County, Tennessee By ____ Date ____

Circle one: (Present) Developed ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.4	-	3,5,7	2.35	6.0	65	2.35	0.71	1.077	0.18
2	0.27	1.2	-	3,5,7	2.35	6.0	70	2.81	0.76	0.857	0.14
3	0.10	0.6	0.45	5,7	1.9	6.0	75	3.28	0.33	0.667	0.11
4	0.18	0.9	-	5,7	1.9	6.0	70	2.81	0.51	0.857	0.14
5	0.20	1.3	1.1	7	0.8	6.0	75	3.28	0.66	0.667	0.11
6	0.34	1.6	-	7	0.8	6.0	70	2.81	0.96	0.857	0.14
7	0.12	1.0	0.8	-	-	6.0	75	3.28	0.39	0.667	0.11

From worksheet 3 | From worksheet 2 | From table 5-1

Worksheet 5a. Basic watershed data.

Project Activity 2 Location Dyer County, Tennessee By ____ Date ____

Circle one: (Present) Developed ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5- II 2/											
	Sub-area T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi^2-in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.25	2.50	0.10	0.71	4	5	6	7	9	10	13	20	41	81	140	160
2	1.0	2.50	0.10	0.76	5	5	6	8	9	11	14	21	44	91	163	183
3	0.5	2.0	0.10	0.33	5	5	6	8	12	22	41	67	98	92	60	29
4	0.75	2.0	0.10	0.51	6	7	8	10	14	24	45	77	125	140	109	59
5	1.25	0.75	0.10	0.66	37	51	92	137	168	175	162	137	100	73	50	34
6	1.50	1.00	0.10	0.96	17	21	33	57	97	146	193	227	221	185	130	83
7	1.0	-	0.10	0.39	128	139	122	93	68	52	40	32	25	19	16	13
Composite hydrograph at outlet					202	233	273	320	377	440	511	581	654	681	668	561

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Activity 3

Given

The watershed in activity two. A retarding structure has been constructed that controls subarea four with an average release of 5 cfs.

Find

The effect of the retarding structure on the 25-year peak discharge at the downstream end of subarea seven using Worksheet 5b. Use hydrograph data for subareas 1-3, and 5-7 from activity two.

Solution

The effect of the retarding structure for subarea four was to decrease the 25-year peak discharge of 681 cfs at 14.6 hours to 564 cfs at 15.0 hours.

Project Activity 3 Location Dyer County, Tennessee By ____ Date ____

Circle one: Present Developed ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Sub-area T_c (hr)	ET_t to outlet (hr)	I_a/P	A_mQ (mi^2-in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.25	2.50	0.10	0.71	4	5	6	7	9	10	13	20	41	81	140	160
2	1.0	2.50	0.10	0.76	5	5	6	8	9	11	14	21	44	91	163	183
3	0.5	2.0	0.10	0.33	5	5	6	8	12	22	41	67	98	92	60	29
4	0.75	2.0	0.10	0.51	5	5	5	5	5	5	5	5	5	5	5	5
5	1.25	0.75	0.10	0.66	37	51	92	137	168	175	162	137	100	73	50	34
6	1.50	1.00	0.10	0.96	17	21	33	57	97	146	193	227	221	185	130	83
7	1.0	-	0.10	0.39	128	139	122	93	68	52	40	32	25	19	16	13
Composite hydrograph at outlet					201	231	270	315	368	421	468	509	534	546	564	507

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Activity 4

Given

The subdivided watershed in Dyer County described in activity two. A developer proposes to put a subdivision into subareas 1, 2, and 4.

Estimated data for subarea 1, 2, and 4:

Subarea Data

Subarea Name	Drainage Area (mi^2)	Time of Concentration (hr)	Travel Time Through Subarea	Runoff curve number
1	0.30	1.1	-	75
2	0.27	0.8	-	80
4	0.18	0.6	-	85

Rainfall distribution = Type II; P_{25} = 6.0 in.

Find

The effect of the subdivision on the 25-year peak discharge at the downstream end of subarea seven.

Solution

The effect of the subdivision would be to increase the 25-year peak discharge of 681 cfs at 14.6 hours to 876 cfs at 14.6 hours.

Project Activity 4 Location Dyer County, Tennessee By ____ Date ____

Circle one: Present (Developed) ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q (in)	A_mQ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
1	0.30	1.1	-	3,5,7	2.35	6.0	75	3.28	0.98	0.667	0.11
2	0.27	0.8	-	3,5,7	2.35	6.0	80	3.78	1.02	0.500	0.08
3	0.10	0.6	0.45	5,7	1.9	6.0	75	3.28	0.33	0.667	0.11
4	0.18	0.6	-	5,7	1.9	6.0	85	4.30	0.77	0.353	0.06
5	0.20	1.3	1.1	7	0.8	6.0	75	3.28	0.66	0.667	0.11
6	0.34	1.6	-	7	0.8	6.0	70	2.81	0.96	0.857	0.14
7	0.12	1.0	0.8	-	-	6.0	75	3.28	0.39	0.667	0.11

From worksheet 3 | From worksheet 2 | From table 5-1

Worksheet 5a. Basic watershed data.

Project Activity 4 Location Dyer County, Tennessee By ____ Date ____

Circle one: Present (Developed) ____ Frequency (yr) 25 Checked ____ Date ____

Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Sub-area T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi^2-in)	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5
					Discharges at selected hydrograph times 3/ (cfs)											
1	1.0	2.5	0.10	0.98	7	7	8	10	12	15	19	26	57	118	210	236
2	0.75	2.5	0.10	1.02	8	8	10	12	14	17	24	38	88	173	265	223
3	0.5	2.0	0.10	0.33	5	5	6	8	12	22	41	67	98	92	60	29
4	0.5	2.0	0.10	0.77	11	12	14	18	27	50	95	156	229	216	139	68
5	1.25	0.75	0.10	0.66	37	51	92	137	168	175	162	137	100	73	50	34
6	1.50	1.00	0.10	0.96	17	21	33	57	97	146	193	227	221	185	130	83
7	1.0	-	0.10	0.39	128	139	122	93	68	52	40	32	25	19	16	13
Composite hydrograph at outlet					213	243	285	335	398	477	574	683	818	876	870	686

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 5b. Tabular hydrograph discharge summary.

Appendix A
Charts and Tables

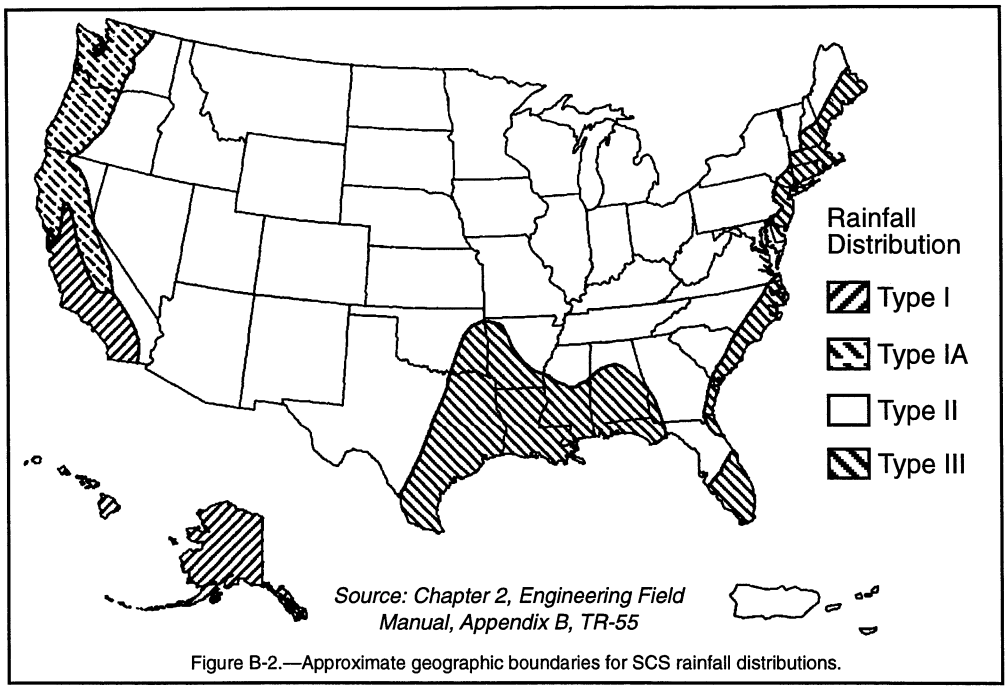


Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.

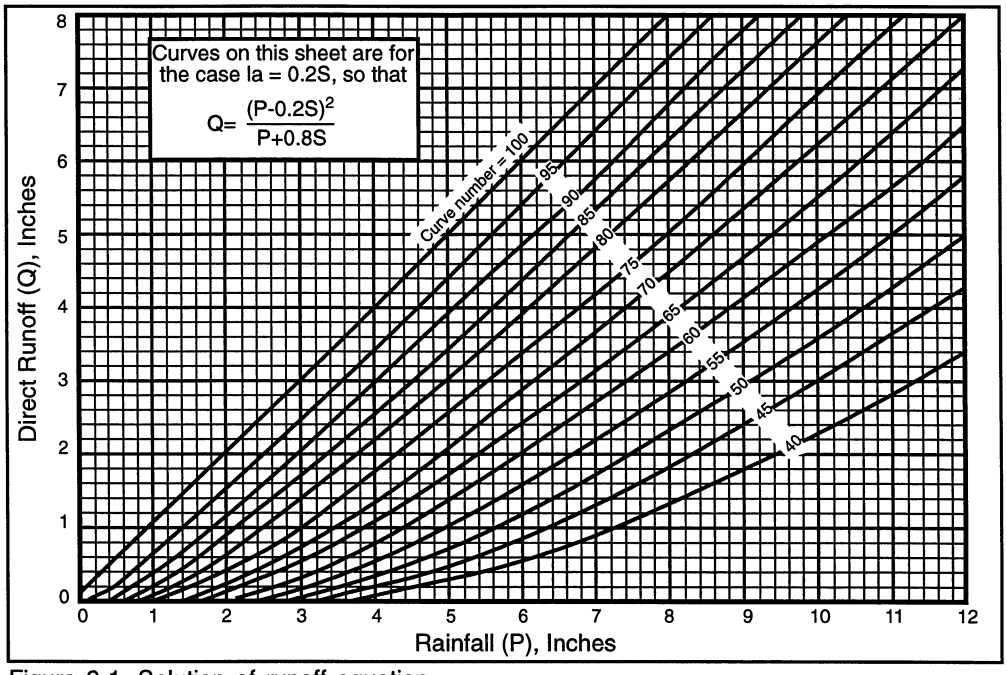


Figure 2-1. Solution of runoff equation.

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	1.992	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 5-1. I_a values for runoff curve numbers.

Exhibit 5-11: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

TRVL TIME (HR)	HYDROGRAPH TIME (HOURS) 11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
	IA/P = 0.10										* * * TC =0.3 HR * * *																				
0.0	20	28	41	118	235	447	676	676	459	283	196	146	114	80	66	57	51	46	42	37	33	31	28	24	22	20	19	18	16	13	12	0
.10	19	26	39	99	189	361	571	641	520	362	251	181	136	89	70	60	53	48	43	37	34	31	28	25	22	21	19	18	16	14	12	0
.20	17	23	32	53	83	154	292	478	587	542	422	308	223	127	86	68	58	52	46	40	35	32	29	26	23	21	20	19	16	14	12	0
.30	16	22	30	49	72	127	237	398	524	536	460	359	268	151	97	73	61	53	48	41	36	32	29	26	23	21	20	19	16	14	12	0
.40	14	19	25	37	45	63	105	193	330	459	510	477	398	237	139	92	70	59	52	44	38	34	30	27	24	21	20	19	17	14	12	0
.50	13	18	24	35	42	56	89	158	272	397	472	475	424	274	163	104	76	62	54	46	39	34	30	27	24	22	20	19	17	15	12	0
.75	11	14	19	26	30	34	42	59	95	160	250	339	417	398	299	196	128	89	69	54	45	37	32	29	26	23	21	20	17	15	12	0
1.0	9	11	14	19	21	24	27	30	36	46	68	109	174	328	396	346	248	163	109	70	54	43	35	31	28	24	22	20	19	16	12	0
1.5	6	8	10	13	14	15	17	19	21	23	26	31	38	77	169	282	347	330	264	158	94	58	42	35	31	27	24	22	19	17	13	3
2.0	4	5	7	8	9	10	11	12	14	15	16	18	23	32	57	116	205	285	317	239	128	64	44	36	31	28	25	20	18	14	9	
2.5	2	4	5	6	6	7	7	8	9	9	10	11	12	15	18	23	33	60	113	223	293	245	125	65	44	35	31	27	22	19	15	11
3.0	1	2	3	4	4	4	5	5	6	6	7	7	8	9	11	13	16	20	27	61	138	275	246	139	72	46	36	31	25	21	16	11
	IA/P = 0.30										* * * TC =0.3 HR * * *																				
0.0	0	0	0	11	64	251	525	574	454	303	221	173	140	104	88	77	70	64	58	51	47	44	40	36	32	31	29	28	24	21	19	0
.10	0	0	0	0	7	45	183	411	520	476	360	268	205	133	101	85	76	69	62	55	49	45	41	37	33	31	30	28	25	22	19	0
.20	0	0	0	0	5	32	132	318	452	468	396	310	240	151	109	90	78	70	63	56	50	46	42	38	33	31	30	28	25	22	19	0
.30	0	0	0	0	3	22	96	244	383	440	411	344	217	142	105	87	76	69	60	53	47	43	39	35	32	30	29	26	22	19	0	
.40	0	0	0	0	0	2	16	69	186	317	399	407	365	246	160	115	92	79	71	61	54	48	43	39	35	32	30	29	26	22	19	0
.50	0	0	0	0	0	0	2	11	50	140	258	352	389	327	223	149	110	89	77	66	57	50	45	41	36	33	31	29	26	23	19	0
.75	0	0	0	0	0	0	1	4	20	63	135	219	290	335	281	205	146	110	89	72	62	52	46	42	38	34	31	30	27	23	19	0
1.0	0	0	0	0	0	0	0	2	9	32	78	216	320	306	243	176	128	90	72	59	49	44	40	36	33	31	28	24	19	1		
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	20	84	185	264	281	246	168	112	77	58	49	44	40	36	32	29	26	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	50	121	200	257	224	141	83	61	50	44	40	36	31	28	21	14	
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	51	145	239	223	137	82	60	50	44	40	33	29	22	17	
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19	74	184	224	146	89	63	51	45	36	31	24	18	
	IA/P = 0.50										* * * TC =0.3 HR * * *																				
0.0	0	0	0	0	1	25	151	299	277	219	187	162	141	113	100	90	84	78	72	65	61	58	53	48	44	42	41	39	35	31	28	0
.10	0	0	0	0	1	17	106	235	263	234	202	175	152	120	104	93	85	79	73	66	61	58	54	49	44	42	41	39	35	31	28	0
.20	0	0	0	0	0	12	75	182	236	234	213	188	144	116	101	91	84	78	70	63	59	55	50	45	43	41	40	36	31	28	0	
.30	0	0	0	0	0	8	52	138	203	224	217	197	154	123	105	94	86	79	71	64	59	55	51	46	43	42	40	36	32	28	0	
.40	0	0	0	0	0	5	37	105	170	206	213	203	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0	
.50	0	0	0	0	0	4	26	78	140	184	203	191	155	126	107	95	86	76	69	62	57	53	48	44	42	41	37	33	28	0		
.75	0	0	0	0	0	1	10	34	73	117	153	184	173	146	122	105	94	82	73	64	58	54	49	45	43	41	37	33	28	0		
1.0	0	0	0	0	0	0	0	4	17	42	114	168	178	159	134	114	94	82	70	61	57	52	47	44	42	39	35	28	0			
1.5	0	0	0	0	0	0	0	0	0	0	0	1	10	44	98	144	163	157	130	105	84	69	61	56	52	47	44	40	36	29	6	
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	44	87	127	153	141	110	83	69	61	56	51	47	42	38	30	17	
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	42	97	138	145	107	82	68	60	55	51	43	40	32	25	
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	27	71	127	139	105	81	68	60	55	46	41	33	27	
	RAINFALL TYPE = II										* * * TC = 0.3 HR * * *																				

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

TRVL TIME (HR)	HYDROGRAPH TIME (HOURS)																									
	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
	IA/P = 0.10																									
	* * * TC =0.4 HR * * *																									
0.0	18	25	36	77	141	271	468	592	574	431	298	216	163	104	77	63	55	49	44	38	34	31	28	25	22	21	20	18	16	14	12	0
.10	18	24	34	67	116	219	385	523	557	473	357	263	196	119	84	67	57	51	46	39	35	32	29	25	22	21	20	19	16	14	12	0
.20	15	20	28	44	59	97	179	316	454	523	489	401	309	178	112	81	65	56	49	42	37	33	30	26	23	21	20	19	17	14	12	0
.30	15	20	27	41	53	82	147	260	389	478	486	429	349	210	129	89	69	58	51	43	38	33	30	27	24	21	20	19	17	14	12	0
	IA/P = 0.10																									
	* * * TC =0.4 HR * * *																									
.40	13	17	23	33	38	48	71	121	214	331	429	467	442	308	189	120	85	66	56	47	41	35	31	28	24	22	20	19	17	15	12	0
.50	12	16	22	31	36	44	62	102	176	279	379	438	440	339	218	137	94	71	59	49	42	35	31	28	25	22	21	19	17	15	12	0
.75	10	13	17	24	26	30	35	45	65	106	170	251	326	393	341	245	164	112	81	59	48	39	33	30	26	23	21	20	18	15	12	0
1.0	8	10	13	17	19	21	24	27	31	37	50	75	118	251	360	376	292	205	138	83	60	45	36	32	28	25	22	21	18	16	12	1
	IA/P = 0.30																									
	* * * TC =0.4 HR * * *																									
1.5	6	7	9	12	13	14	15	17	19	21	23	26	31	56	121	224	311	333	293	192	115	66	45	36	31	28	25	22	19	17	13	4
2.0	4	5	6	8	8	9	10	11	12	14	15	16	20	27	43	85	159	243	306	264	154	74	47	37	32	28	25	21	18	14	9	
2.5	2	3	4	5	6	6	7	7	8	9	9	10	11	13	16	20	27	46	85	184	285	262	147	74	47	37	32	28	22	19	15	11
3.0	1	2	2	3	4	4	4	5	5	6	6	7	7	8	10	12	14	17	23	47	109	227	268	160	83	50	38	32	25	21	16	11
	IA/P = 0.30																									
	* * * TC =0.4 HR * * *																									
0.0	0	0	0	4	26	113	296	480	495	413	306	234	186	127	100	84	74	67	61	54	49	45	41	37	33	31	29	28	25	21	19	0
.10	0	0	0	0	2	18	81	224	395	462	430	347	272	172	121	96	82	73	66	57	51	46	42	38	34	31	30	28	25	22	19	0
.20	0	0	0	0	2	13	59	169	320	414	424	373	305	196	134	103	85	75	67	59	52	47	43	39	34	32	30	29	25	22	19	0
.30	0	0	0	0	1	9	42	127	255	361	403	383	274	181	127	99	83	73	63	55	48	44	40	36	32	30	29	26	23	19	0	
	IA/P = 0.30																									
	* * * TC =0.4 HR * * *																									
.40	0	0	0	0	0	1	6	30	94	202	308	372	379	298	203	141	106	87	76	65	56	49	44	40	36	32	31	29	26	23	19	0
.50	0	0	0	0	0	0	4	21	70	158	258	334	364	270	187	133	102	85	70	60	51	46	41	37	33	31	30	26	23	19	0	
.75	0	0	0	0	0	0	2	8	30	76	145	219	321	305	241	177	130	102	78	65	55	47	43	38	34	32	30	27	24	19	0	
1.0	0	0	0	0	0	0	0	1	4	15	42	150	267	308	272	209	154	103	79	62	51	45	41	37	33	31	28	25	19	1		
	IA/P = 0.50																									
	* * * TC =0.4 HR * * *																									
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	51	136	226	274	263	195	131	85	62	51	45	41	36	33	29	26	20	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	31	86	162	252	239	162	93	64	52	45	41	37	31	28	21	15
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	33	112	202	235	155	92	64	52	45	41	33	29	23	18	
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	21	76	182	221	148	90	63	51	45	36	31	24	18		
	IA/P = 0.50																									
	* * * TC =0.4 HR * * *																									
C.0	0	0	0	0	0	0	7	59	168	245	257	213	186	163	128	109	96	88	81	75	67	62	58	54	50	45	43	41	39	35	31	28	0
.10	0	0	0	0	0	0	5	41	125	205	240	222	198	154	123	106	94	86	79	71	64	60	56	51	46	43	42	40	36	32	28	0
.20	0	0	0	0	0	0	3	28	93	168	216	220	205	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0
.30	0	0	0	0	0	0	2	20	69	135	189	209	192	155	126	107	95	86	77	69	62	57	53	48	44	42	41	37	33	28	0	
	IA/P = 0.50																									
	* * * TC =0.4 HR * * *																									
.40	0	0	0	0	0	0	0	1	14	50	106	161	193	202	163	133	112	98	89	78	70	62	58	53	48	44	42	41	37	33	28	0
.50	0	0	0	0	0	0	0	1	9	37	83	135	174	194	171	140	117	102	91	80	71	63	58	54	49	45	43	41	37	33	28	0
.75	0	0	0	0	0	0	0	0	3	15	40	76	147	177	169	146	124	107	90	79	68	60	56	51	47	43	42	38	34	28	0	
1.0	0	0	0	0	0	0	0	0	1	7	21	78	141	173	167	146	125	101	86	73	63	58	53	48	45	42	39	35	28	1		
	* * * TC = 0.4 HR * * *																									
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	26	71	121	153	159	139	113	89	72	63	57	53	48	44	40	37	29	7
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	45	86	138	150	125	93	74	64	58	53	48	42	39	31	20	
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	17	59	112	143	121	91	73	63	57	53	45	40	32	26	
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	40	101	138	117	90	73	63	57	48	42	34	27	

RAINFALL TYPE = II

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

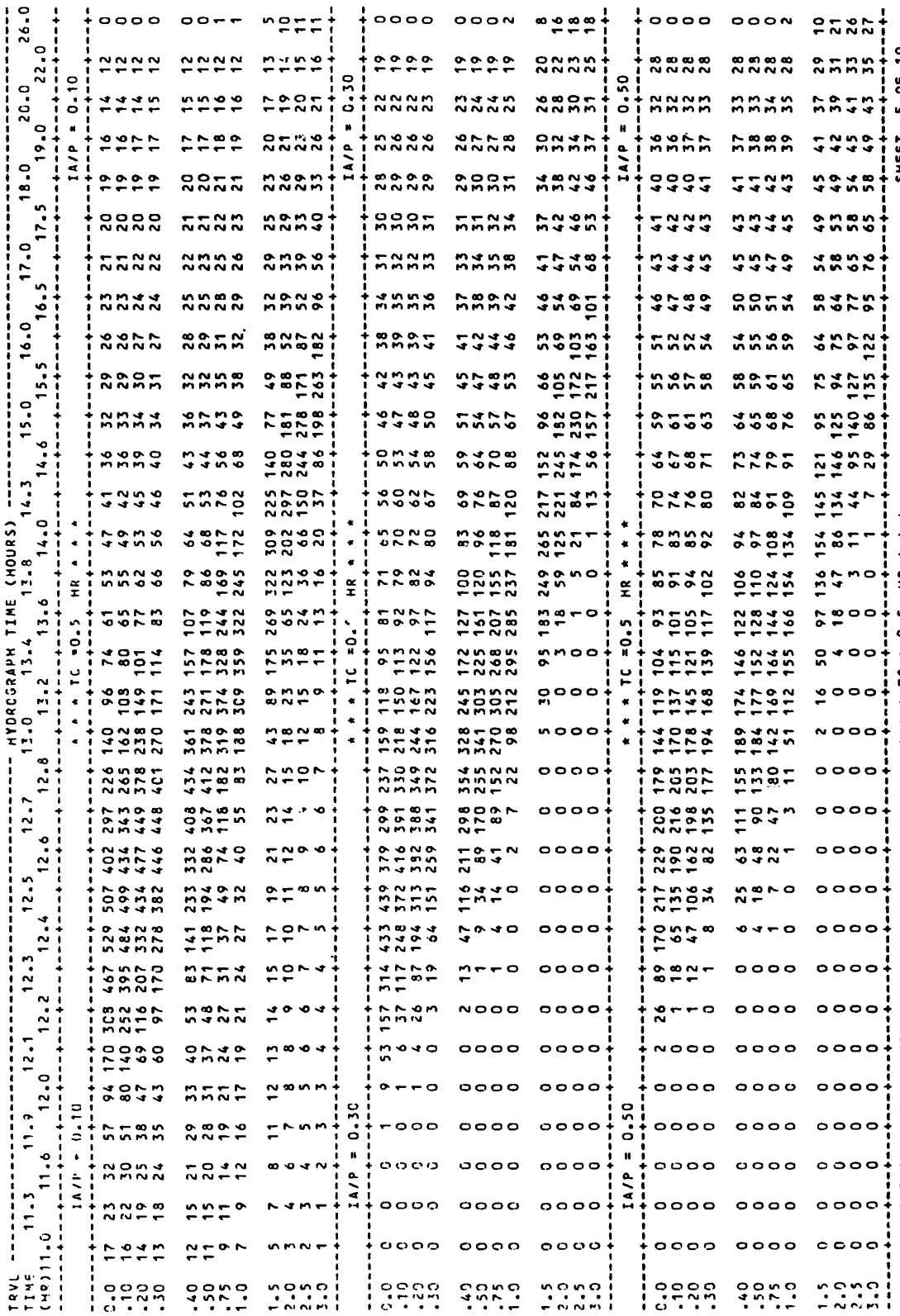


Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

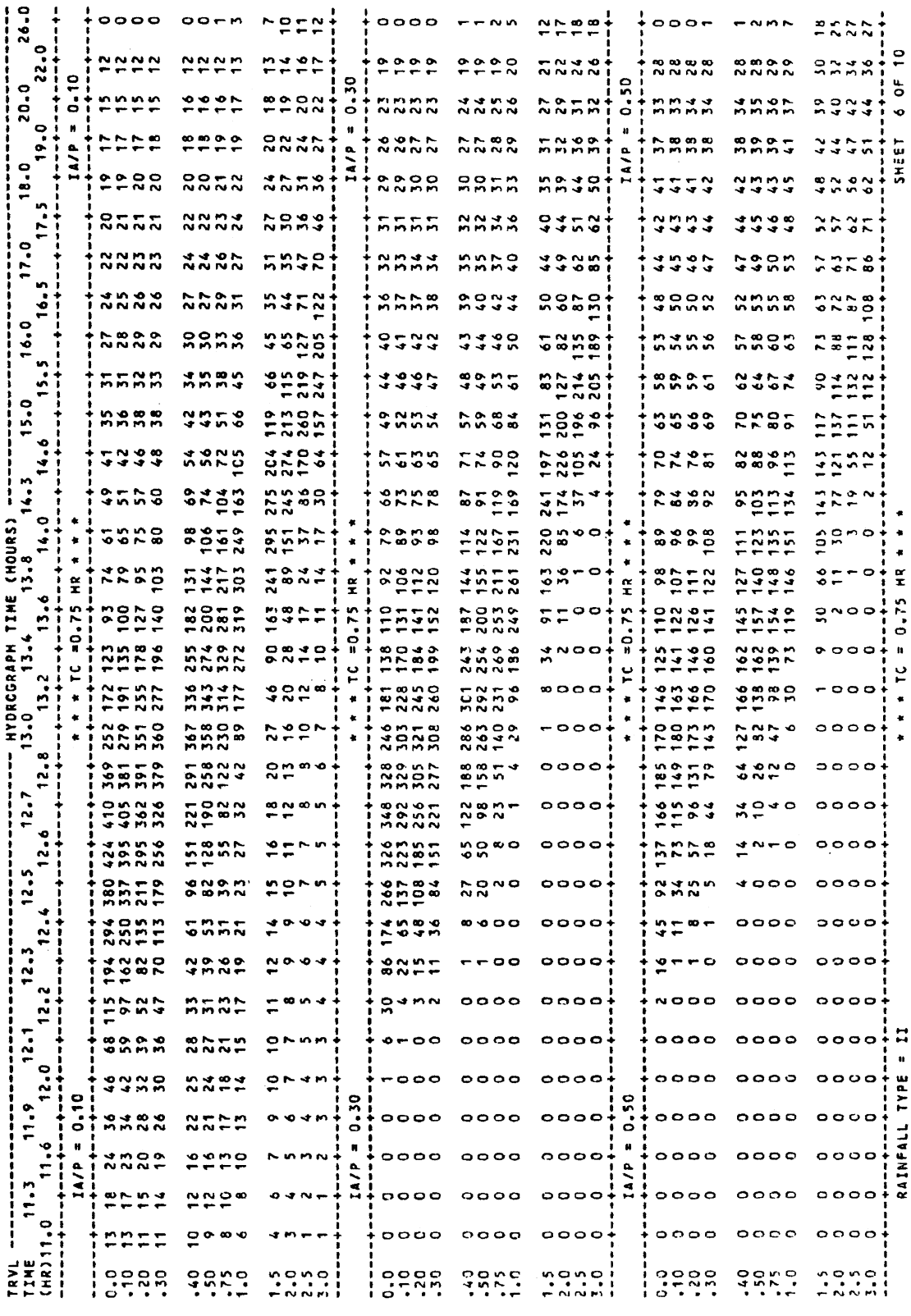


Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

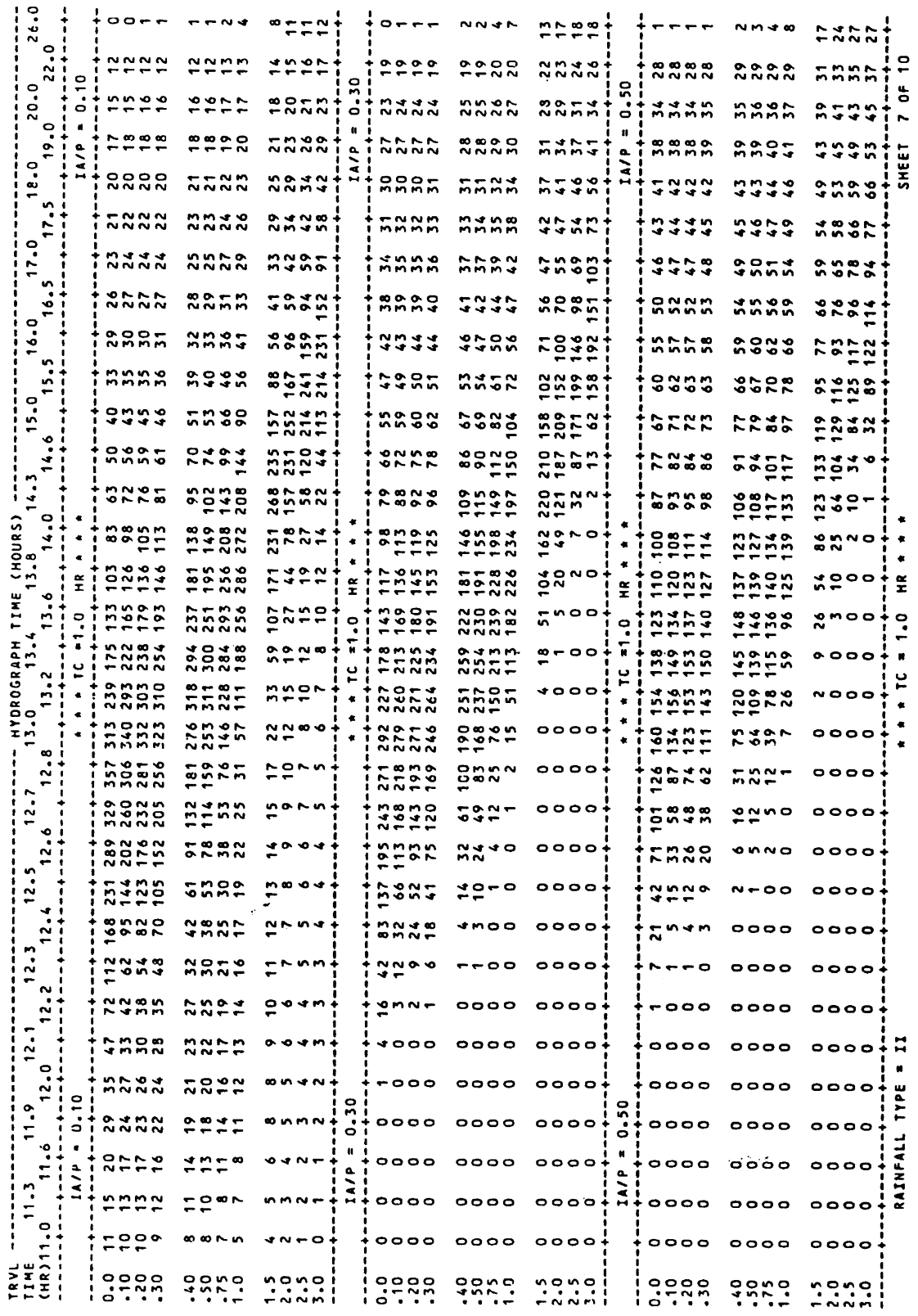
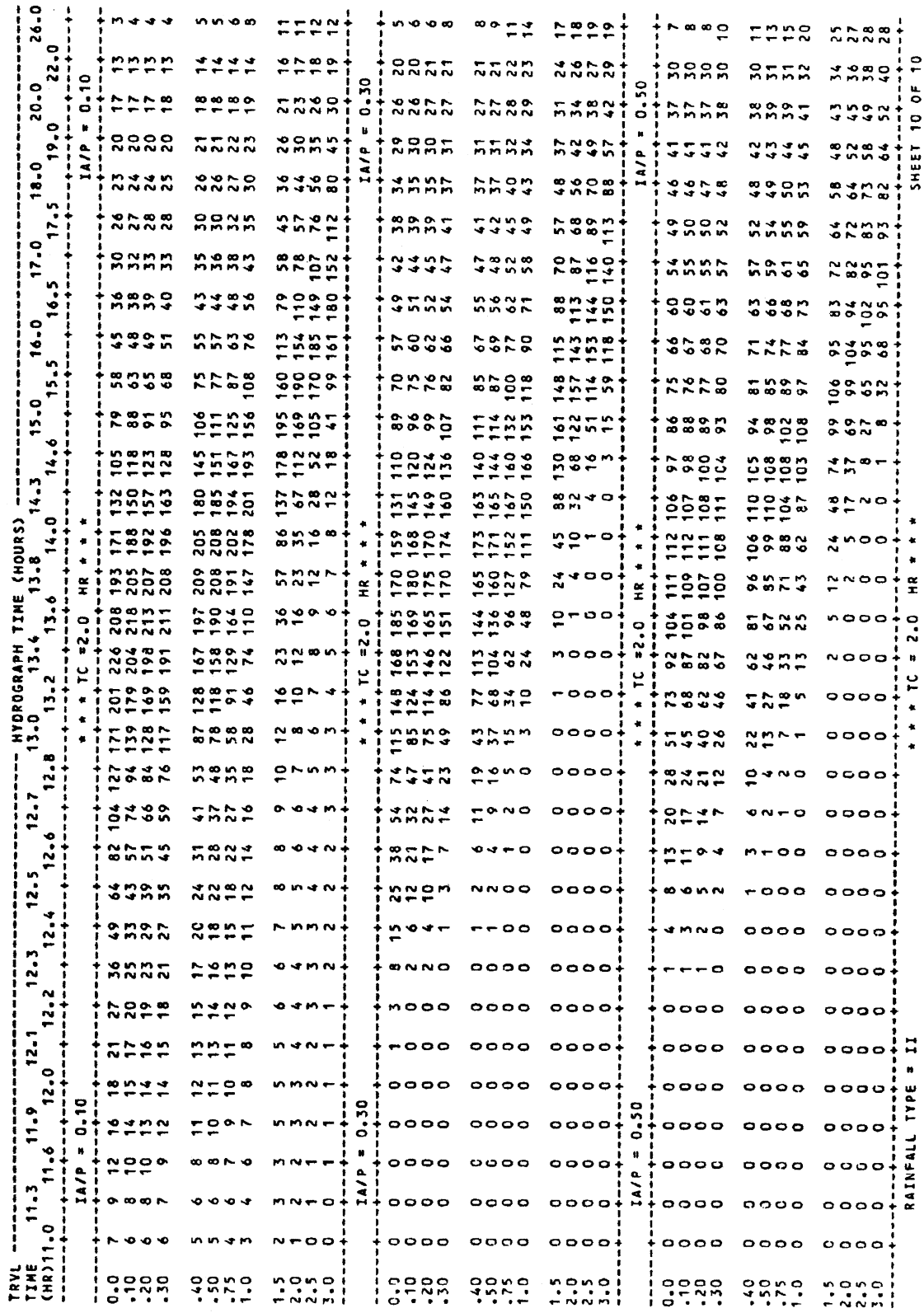


Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

TRVL	HYDROGRAPH TIME (HOURS)																									
TIME (HR)	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
	IA/P = 0.10										* * * TC =1.25 HR * * *																			
0.0	10	13	18	25	29	38	54	81	118	163	213	256	284	311	266	212	163	129	104	78	61	47	37	31	27	24	22	20	18	16	12	1
.10	10	13	17	23	27	34	47	69	102	143	189	234	267	297	274	226	175	138	111	82	64	48	38	31	27	24	22	20	18	16	12	1
.20	9	11	15	20	22	26	31	42	60	88	124	168	212	280	292	261	212	166	131	95	72	53	40	33	28	25	23	21	18	16	12	1
.30	8	11	14	19	21	24	29	38	53	76	108	148	190	263	288	268	224	177	140	101	76	55	41	34	29	25	23	21	18	16	12	2
.40	8	10	13	18	20	23	27	34	46	66	94	130	170	245	282	273	235	188	149	107	80	58	42	34	29	26	23	21	19	16	12	2
.50	7	9	12	16	17	19	22	25	31	41	58	82	114	190	256	279	262	222	178	127	93	65	46	36	31	27	24	22	19	17	13	2
.75	6	8	10	14	15	17	19	21	25	31	41	56	78	139	207	254	265	245	208	152	110	75	51	39	32	28	25	22	19	17	13	3
1.0	5	6	8	10	11	13	14	15	17	19	22	26	33	60	109	173	230	261	255	208	153	100	64	46	36	30	26	24	20	18	13	5
1.5	3	4	5	7	7	8	9	9	10	11	12	13	15	19	27	45	79	130	186	247	239	180	108	68	48	37	31	27	22	19	14	10
2.0	2	3	4	5	6	6	7	7	8	8	9	10	11	13	16	22	35	59	98	171	236	236	156	95	62	44	35	30	23	20	15	11
2.5	1	2	2	3	4	4	4	5	5	5	6	6	7	8	10	12	14	19	28	58	114	197	226	163	102	65	46	36	26	21	16	11
3.0	0	1	1	2	2	2	3	3	3	4	4	4	5	6	7	9	10	13	19	35	88	184	218	169	109	70	49	31	24	18	13	12
	IA/P = 0.30										* * * TC =1.25 HR * * *																			
0.0	0	0	0	0	0	0	2	9	25	50	86	130	174	208	253	235	201	164	136	115	92	76	61	51	44	39	35	32	30	27	24	19	1
.10	0	0	0	0	0	0	1	6	19	40	71	110	153	217	247	227	191	157	131	103	84	66	53	46	41	36	33	31	28	24	19	2
.20	0	0	0	0	0	0	1	4	14	31	58	93	133	202	239	231	199	165	138	108	87	68	55	47	41	37	33	31	28	25	19	2
.30	0	0	0	0	0	0	0	1	3	10	24	46	77	152	210	236	222	190	158	122	97	74	58	49	43	38	34	32	28	25	20	3
.40	0	0	0	0	0	0	0	0	2	8	19	37	64	134	196	232	225	198	166	127	101	77	59	50	43	38	35	32	28	25	20	3
.50	0	0	0	0	0	0	0	0	0	2	6	14	30	82	151	206	228	217	189	146	113	85	64	52	45	40	36	33	29	26	20	5
.75	0	0	0	0	0	0	0	0	0	1	2	7	15	49	105	164	205	218	205	166	129	95	69	55	47	41	37	33	29	26	20	6
1.0	0	0	0	0	0	0	0	0	0	0	1	2	9	32	77	134	185	214	203	166	120	83	63	52	45	39	35	30	27	21	10
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	33	72	121	184	203	171	117	82	62	51	44	39	32	29	22	15
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	21	67	132	194	174	123	86	64	52	45	35	31	24	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	46	121	187	166	119	84	63	52	39	32	25	18
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	44	129	180	160	116	83	63	44	35	27	18
	IA/P = 0.50										* * * TC =1.25 HR * * *																			
0.0	0	0	0	0	0	0	0	1	5	13	26	44	68	91	125	142	142	128	117	107	94	83	72	63	57	52	47	44	42	38	34	28	2
.10	0	0	0	0	0	0	0	0	0	3	10	20	36	57	100	129	140	136	125	114	100	88	76	65	59	54	49	45	43	39	35	29	3
.20	0	0	0	0	0	0	0	0	0	2	7	16	30	48	90	122	139	139	127	117	102	90	77	66	60	54	49	45	43	39	35	29	3
.30	0	0	0	0	0	0	0	0	0	2	5	12	24	59	98	126	137	134	125	109	96	82	69	61	56	51	46	44	40	36	29	4
.40	0	0	0	0	0	0	0	0	0	1	4	10	19	51	89	119	134	136	127	112	98	83	70	62	56	51	47	44	40	36	29	5
.50	0	0	0	0	0	0	0	0	0	1	3	7	15	43	79	112	131	135	129	114	100	85	71	63	57	52	47	44	40	36	29	6
.75	0	0	0	0	0	0	0	0	0	1	3	7	15	39	71	102	123	130	125	112	94	78	67	60	54	49	46	41	37	29	9
1.0	0	0	0	0	0	0	0	0	0	0	1	4	9	17	40	71	101	121	129	121	103	84	71	62	56	51	47	42	38	30	13
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	26	51	92	119	125	105	86	72	63	57	52	44	40	32	23
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	11	35	72	112	122	103	85	71	63	56	47	42	34	26
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	24	66	111	119	101	83	71	62	51	44	36	27
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	23	71	110	116	99	82	70	55	46	37	27
	RAINFALL TYPE = II										* * * TC = 1.25 HR * * *																			

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.



TRVL TIME (HR)	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
11.0																															
IA/P = 0.10													* * * TC =2.0 HR * * *																IA/P = 0.10		
0.0	7	9	12	16	18	21	27	36	49	64	82	104	127	171	201	226	208	193	171	132	105	79	58	45	36	30	26	23	20	17	13	3
.10	6	8	10	14	15	17	20	25	33	43	57	74	94	139	179	204	218	205	188	150	118	88	63	48	38	32	27	24	20	17	13	4
.20	6	8	10	13	14	16	19	23	29	39	51	66	84	128	169	198	213	207	192	157	123	91	65	49	39	33	28	24	20	17	13	4
.30	6	7	9	12	14	15	18	21	27	35	45	59	76	117	159	191	211	208	196	163	128	95	68	51	40	33	28	25	20	18	13	4
.40	5	6	8	11	12	13	15	17	20	24	31	41	53	87	128	167	197	209	205	180	145	106	75	55	43	35	30	26	21	18	14	5
.50	5	6	8	10	11	13	14	16	18	22	28	37	48	78	118	158	190	208	208	185	151	111	77	57	44	36	30	26	21	18	14	5
.75	4	6	7	9	10	11	12	13	15	18	22	27	35	58	91	129	164	191	202	194	167	125	87	63	48	38	32	27	22	18	14	6
1.0	3	4	6	7	8	8	9	10	11	12	14	16	18	28	46	74	110	147	178	201	193	156	108	76	56	43	35	30	23	19	14	8
1.5	2	3	3	5	5	5	6	6	7	8	8	9	10	12	16	23	36	57	86	137	178	195	160	113	79	58	45	36	26	21	16	11
2.0	1	2	2	3	3	4	4	4	5	5	6	6	7	8	10	12	16	23	35	67	112	169	190	154	110	78	57	44	30	23	17	11
2.5	0	1	1	2	2	3	3	3	4	4	4	4	5	6	7	8	9	12	16	28	52	105	170	185	149	107	76	56	35	26	18	12
3.0	0	0	1	1	1	1	2	2	2	2	3	3	3	4	5	6	7	8	12	18	41	99	161	180	152	112	80	45	30	19	14	12
IA/P = 0.30													* * * TC =2.0 HR * * *																IA/P = 0.30		
0.0	0	0	0	0	0	1	3	8	15	25	38	54	74	115	148	168	185	170	159	131	110	89	70	57	49	42	38	34	29	26	20	5
.10	0	0	0	0	0	0	2	6	12	21	32	47	85	124	153	169	180	168	145	120	96	75	60	51	44	39	35	30	26	20	6
.20	0	0	0	0	0	0	2	4	10	17	27	41	75	114	146	165	175	170	149	124	99	76	62	52	45	39	35	30	27	21	6
.30	0	0	0	0	0	0	1	3	7	14	23	49	86	122	151	170	174	160	136	107	82	66	54	47	41	37	31	27	21	8
.40	0	0	0	0	0	0	0	1	2	6	11	19	43	77	113	144	165	173	163	140	111	85	67	55	47	41	37	31	27	21	8
.50	0	0	0	0	0	0	0	1	2	4	9	16	37	68	104	136	160	171	165	144	114	87	69	56	48	42	37	31	27	21	9
.75	0	0	0	0	0	0	0	0	1	2	5	15	34	62	96	127	152	167	160	132	100	77	62	52	45	40	32	28	22	11
1.0	0	0	0	0	0	0	0	0	0	0	3	10	24	48	79	111	150	166	153	118	90	71	58	49	43	34	29	23	14
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	24	45	88	130	161	148	115	88	70	57	48	37	31	24	17
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	10	32	68	122	157	143	113	87	68	56	42	34	26	18
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	16	51	114	153	144	116	89	70	49	38	27	19
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	15	59	118	150	140	113	88	57	42	29	19
IA/P = 0.50													* * * TC =2.0 HR * * *																IA/P = 0.50		
0.0	0	0	0	0	0	0	0	1	4	8	13	20	28	51	73	92	104	111	112	106	97	86	75	66	60	54	49	46	41	37	30	7
.10	0	0	0	0	0	0	0	1	3	6	11	17	24	45	68	87	101	109	112	107	98	88	76	67	60	55	50	46	41	37	30	8
.20	0	0	0	0	0	0	0	1	2	5	9	14	21	40	62	82	98	107	111	108	100	89	77	68	61	55	50	47	41	37	30	8
.30	0	0	0	0	0	0	0	0	2	4	7	12	26	46	67	86	100	108	111	104	93	80	70	63	57	52	48	42	38	30	10
.40	0	0	0	0	0	0	0	0	1	3	6	10	22	41	62	81	96	106	110	105	94	81	71	63	57	52	48	42	38	30	11
.50	0	0	0	0	0	0	0	0	1	2	4	7	13	27	46	67	85	99	110	108	98	85	74	66	59	54	49	43	39	31	13
.75	0	0	0	0	0	0	0	0	0	1	2	4	7	18	33	52	71	88	104	108	102	89	77	68	61	55	50	47	44	39	31	15
1.0	0	0	0	0	0	0	0	0	0	0	1	2	5	13	25	43	62	87	103	108	97	84	73	65	59	53	45	41	32	20
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	12	24	48	74	99	106	95	83	72	64	58	48	43	34	25
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	17	37	69	99	104	94	82	72	64	52	45	36	27
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	27	65	95	102	95	83	73	58	49	38	28
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	32	68	95	101	93	82	64	52	40	28

RAINFALL TYPE = II * * * TC = 2.0 HR * * * SHEET 10 OF 10

Exhibit 5-11, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution.

Hydrology Training Series
Module 206C—Peak Discharge Tabular Method, TR55

Certificate of Completion

This is to certify that

_____

has completed Hydrology Training Series
Module 206C—Peak Discharge Tabular Method, TR55
on _____ and should be credited with three hours of training.

Signed _____ _____
Supervisor/Trainer Participant

Completion of Hydrology Training Series
Module 206C—Peak Discharge Tabular Method, TR55
is acknowledged and documented in the above-named employee's record.

Signed _____ Date _____
Training Officer

United States Department of Agriculture, Natural Resources Conservation Service