NATIONAL ENGINEERING HANDBOOK

SECTION 4

HYDROLOGY

CHAPTER 21. DESIGN HYDROGRAPHS

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CHAPTER 21. DESIGN HYDROGRAPHS

Introduction

This chapter contains a systematic approach to the development of design hydrographs for use in proportioning earth dams and their spillways according to SCS criteria. Included are data or sources of data for design rainfall amount, duration, and distribution; methods of modifying design runoff to include effects of channel losses, quick return flow, or upstream releases; and methods for rapid construction of hydrographs.

The methodology presented in this chapter is suitable for the design of many types of water control structures, including channel works, but the emphasis is on hydrology for design of earth dams that provide temporary storage for flood prevention in addition to permanent storage for other uses. Its chief purpose is to contribute to safe design. Although the methods are based on data of actual storms and floods, they are not intended for reproducing hydrographs of actual floods; more suitable methods for actual floods are found in earlier chapters.

The remainder of this chapter is divided into two major parts. The first is concerned with hydrologic design for principal spillways, the second for emergency spillways. The examples in each part go only as far as the completion of hydrographs. Methods of routing hydrographs through spillways are given in chapter 17. Uses of hydrographs are illustrated in other SCS publications.

Principal Spillways

The SCS criteria require principal spillway capacity and the associated floodwater retarding storage to be such that project objectives are met and that the frequency of emergency spillway operation is within specified limits. The criteria are met by use of a Principal Spillway Hydrograph (PSH) or its mass curve (PSMC), which are developed as shown in this part of the chapter. Details of SCS hydrologic criteria are given first, then details of the PSH and PSMC development are given in examples.

Any one of four methods of runoff determination is suitable for the design of principal spillway capacity and retarding storage. They are (1) the runoff curve number procedure using rainfall data and the watershed's characteristics, (2) the use of runoff volume maps covering specific areas of the United States, (3) the regionalization and transposition of volume-duration-probability analyses made by the SCS Central Technical Unit, and (4) the use of local streamflow data with provision of sufficient documentation on the method and results. The latter two methods are not discussed in this chapter because they vary in procedure from case to case, due to conditions of local data, and standard procedures have not yet been established.

Runoff Curve Number Procedure

The runoff curve number procedure uses certain climatic data and the characteristics of a watershed to convert rainfall data to runoff volume. This procedure should be used for those areas of the country not covered by runoff volume and rate maps. (Exhibit 21.1 through 21.5.)

SOURCES OF RAINFALL DATA. Rainfall data for the determination of direct runoff may be obtained from maps in U.S. Weather Bureau technical papers:

For durations to 1 day.--

TP-40. 48 contiguous States.
TP-42. Puerto Rico and Virgin Islands.
TP-43. Hawaii.
TP-47. Alaska.

For durations from 2 to 10 days.--

TP-49. 48 contiguous States
TP-51. Hawaii.
TP-52. Alaska.
TP-53. Puerto Rico and Virgin Islands.

AREAL ADJUSTMENT OF RAINFALL AMOUNT. If the drainage area above a structure is not over 10 square miles, no adjustment in rainfall amount is made. If it is over 10 square miles, the area-point ratios of table 21.1 may be used to reduce the rainfall amount. The table applies to all geographical locations serviced by SCS. The ratios are based on the 1- and 10-day depth-area curves of figure 10, U.S. Weather Bureau TP-49, but are modified to give a ratio of 1 at 10 square miles.

RUNOFF CURVE NUMBERS. The runoff curve number (CN) for the drainage area above a structure is determined and runoff is estimated as described in chapters 7 through 10. The CN is for antecedent moisture condition II and it applies to the 1-day storm used in development of the PSH or PSMC. If the 100-year frequency 10-day duration point

Table 21.1.--Ratios for areal adjustment of rainfall amount

Area	Area/point ratio for 1 day	Area/point ratio for 10 days	Area	Area/point ratio for 1 day	Area/point ratio for 10 days
sq. mi.			sq. mi.		
10 or less	1.000	1.000	80	937	0.968
15	.978	.991	100	[illegible]	.966
20	.969	.986	[illegible]	[illegible]	.964
25	.964	.983	[illegible]	.925	.962
30	.960	.981	[illegible]	.922	.961
35	.957	[illegible]	180	.920	.960
40	[illegible]	[illegible]	200	.918	.959
50	[illegible]	[illegible]	250	.914	.957
60	[illegible]	.972	300	.911	.956
70	[illegible]	.970	400	.910	.955

Use Revised Table in TR-60

rainfall for the structure site is 6 or more inches, the CN for the 10-day storm is taken from table 21.2. If it is less than 6 inches, the CN for the 10-day storm is the same as that for the 1-day storm. The 10-day CN is used only with the total 10-day rainfall.

CLIMATIC INDEX. The climatic index used in this part of the chapter is:

$$Ci = \frac{100\ Pa}{(Ta)^2} \qquad (21.1)$$

where Ci = climatic index
Pa = average annual precipitation in inches
Ta = average annual temperature in degrees Fahrenheit

Precipitation and temperature data for U.S. Weather Bureau stations can be obtained from the following Weather Bureau publications:

Climatological Data. Issued annually and monthly for each State or a combination of States and for Puerto Rico and Virgin Islands. The annual issues contain annual and monthly data and averages or departures; monthly issues contain similar information for individual months.

Climatic Summary of the United States - Supplement for 1931-1952. Issued once for each State or a combination of States.

Climates of the States. Issued once for each State and for Puerto Rico and Virgin Islands.

Monthly Normals of Temperature, Precipitation, and Heating Degree Days. Issued once for each State or a combination of States. Also contains annual averages.

Table 21.2.--Ten-day runoff curve numbers*

Runoff curve numbers for:					
1 day	10 days	1 day	10 days	1 day	10 days
100	100	80	65	60	41
99	98	79	64	59	40
98	96	78	62	58	39
97	94	77	61	57	38
96	92	76	60	56	37
95	90	75	58	[illegible]	36
94	88	74	57	[illegible]	35
93	86	73	[illegible]	[illegible]	34
92	84	72	[illegible]	52	33
91	82	[illegible]	[illegible]	51	32
90	[illegible]	[illegible]	52	50	32
89	[illegible]	69	51	49	31
88	[illegible]	68	50	48	30
87	70	67	48	47	29
86	74	66	47	46	28
85	72	65	46	45	27
84	71	64	45	44	27
83	69	63	44	43	26
82	68	62	43	42	25
81	66	61	42	41	24

Use Revised Table in TR-60

* This table is used only if the 100-year frequency 10-day point rainfall is 6 or more inches. If it is less, the 10-day CN is the same as that for 1 day.

<u>Climatic Maps for the National Atlas</u>. Maps with a scale of one in ten million. A map for average annual precipitation is available but there is no map for average annual temperature.

SCS personnel may obtain these publications through their Regional Technical Service Center.

<u>CHANNEL LOSSES</u>. If the drainage area above a structure has a climatic index less than 1, then the direct runoff from rainfall may be decreased to account for channel losses of influent streams. Channel losses can be determined from local data but the losses must not be more than determined by use of table 21.3. When adequate local data are not available, table 21.3 is to be used. Example 21.1 gives the procedure for making the channel loss reduction of direct runoff.

Channel losses in areas where the climatic index is 1 or more will require special study; results must be approved by the Director, Engineering Division, before being used in final design hydrology.

<u>QUICK RETURN FLOW</u>. Quick return flow (QRF) is the rate of discharge that persists for some period beyond that for which the 10-day PSH is derived. It includes base flow and other flows that become a part of the flood hydrograph such as (1) rainfall that has infiltrated and reappeared soon afterwards as surface flow; (2) drainage from marshes and potholes; and (3) delayed drainage from snow banks. If the drainage area above a structure has a climatic index greater than 1, then QRF must be added to the hydrograph or mass curve of direct runoff from rainfall. QRF can be determined from local data but it must not be less than the steady rate determined by use of table 21.4. When adequate local data are not available, table 21.4 is to be used. Example 21.2 gives the procedure for adding QRF to the hydrograph or mass curve of direct runoff derived from rainfall.

<u>UPSTREAM RELEASES</u>. Releases from upstream structures must be added to the hydrograph or mass curve of runoff. This addition must be made regardless of other additions or subtractions of flow. Upstream release rates are determined from routings of applicable hydrographs or mass curves through the upstream structures and the reaches downstream from them.

<u>COMBINATIONS OF CHANNEL LOSS, QUICK RETURN FLOW AND UPSTREAM RELEASE</u>. In the introduction it was stated that the chief purpose of the methodology in this chapter is to contribute to safe design and that these methods are not intended for reproducing actual floods. Equation 21.1 and tables 21.1 through 21.4 must be considered in that light.

For large watersheds the topography may be such that two climatic indexes are needed, for example where a semiarid plain is surrounded by mountains. In such cases the design storm is determined for the watershed as a whole, the direct runoff is estimated separately for the two

TABLE 21.3--CHANNEL-LOSS FACTORS FOR REDUCTION OF DIRECT RUNOFF

DRAINAGE AREA	CLIMATIC INDEX CI						
	1.0	0.9	C.8	0.7	0.6	0.5	0.4 OR LESS
SQ. MI.							
1. OR LESS	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.	1.00	.98	.97	.95	.93	.90	.87
3.	1.00	.98	.95	.92	.89	.85	.80
4.	1.00	.97	.94	.90	.86	.81	.76
5.	1.00	.96	.92	.88	.84	.78	.73
6.	1.00	.96	.92	.87	.82	.76	.70
7.	1.00	.96	.91	.86	.81	.75	.68
8.	1.00	.95	.90	.85	.79	.73	.66
9.	1.00	.95	.90	.84	.78	.72	.65
10.	1.00	.95	.89	.84	.77	.71	.63
20.	1.00	.93	.86	.79	.72	.64	.55
30.	1.00	.93	.85	.77	.69	.60	.51
40.	1.00	.92	.84	.75	.66	.57	.48
50.	1.00	.91	.83	.74	.65	.55	.46
60.	1.00	.91	.82	.73	.63	.54	.44
70.	1.00	.91	.81	.72	.62	.53	.43
80.	1.00	.90	.81	.71	.62	.52	.42
90.	1.00	.90	.80	.71	.61	.51	.41
100.	1.00	.90	.80	.70	.60	.50	.40
150.	1.00	.89	.78	.68	.57	.47	.37
200.	1.00	.89	.77	.66	.56	.45	.35
250.	1.00	.88	.77	.65	.54	.44	.33
300.	1.00	.88	.76	.64	.53	.42	.32
350.	1.00	.87	.75	.64	.52	.41	.31
400.	1.00	.87	.75	.63	.51	.41	.30

★U.S. GOVERNMENT PRINTING OFFICE: 1981— 340-931:301

Table 21.4. Minimum quick return flow for PSH derived from rainfall.

Use Revised Table in TR-60

Ci	QRF		Ci	QRF	
	in./day	csm		in./day	csm
1.00	0	0	1.50	0.234	6.29
1.02	.011	.30	1.52	.239	6.43
1.04	.022	.60	1.54	.244	6.56
1.06	.033	.90	1.56	.249	6.70
1.08	.045	1.20	1.58	.254	6.83
1.10	.056	1.50	1.60*	.259	6.96
1.12	.067	1.80	1.65	.270	7.26
1.14	.078	2.10	1.70	[illegible]	7.53
1.16	.089	2.40	1.75	[illegible]	7.80
1.18	.100	2.70	[illegible]	[illegible]	8.04
1.20	.112	3.00	[illegible]	.308	8.28
1.22	.123	[illegible]	[illegible]	.318	8.55
1.24	[illegible]	[illegible]	1.95	.326	8.76
1.26	[illegible]	[illegible]	2.00	.335	9.00
1.28	[illegible]	[illegible]	2.05	.343	9.22
1.30	.163	4.38	2.10*	.351	9.44
1.32	.171	4.60	2.20	.367	9.87
1.34	.180	4.84	2.30	.382	10.27
1.36	.188	5.06	2.40	.396	10.65
1.38	.195	5.24	2.50	.410	11.02
1.40	.202	5.43	2.60	.423	11.37
1.42	.209	5.62	2.70	.436	11.72
1.44	.216	5.81	2.80	.449	12.07
1.46	.222	5.97	2.90	.461	12.40
1.48	.228	6.13	3.00**	.473	12.72

* Change in tabulation interval.

** For Ci greater than 3, use:

$$QRF = 9\ (Ci - 1)^{0.5} \text{ for QRF in csm}$$

or

$$QRF = 0.335\ (Ci - 1)^{0.5} \text{ for QRF in}$$

inches per day.

parts by use of appropriate CN and then combined, the channel loss reduction is based on the area of the semiarid plain and its climatic index, the hydrograph or mass curve of direct runoff is constructed, and QRF from the mountain area is added.

If there are upstream structures, their releases are always added regardless of the downstream climatic index or other considerations.

Runoff Volume Maps Procedure

The runoff volume and rate maps, exhibits 21.1 through 21.5, are provided for areas of the United States where measured runoff volumes vary significantly from those obtained from the curve number procedure for converting rainfall to runoff. The mapped areas are of two general types: (1) the areas where runoff from either snowmelt, dormant season rainfall, or a combination of the two produce greater runoff volumes than growing season rainfall and (2) the deep snowpack areas of high mountain elevations.

AREAS OF MAPPED RUNOFF VOLUME. The 100-year 10-day runoff volume maps, exhibits 21.1 and 21.4, represent regionalized values derived from gaged streamflow data and supplemented with climatological data and local observations. These values should be used for estimating floodwater detention storage within the map area where local streamflow data are not adequate.

Areal reduction should not be made on the 10-day runoff volumes shown in the maps. Since these amounts were derived from stream gage data, base flow and channel loss will be automatically included in the map values and in Table 21.10.

Quick return flow in this procedure is used as the rate of discharge expected to persist beyond the flood period described under the 10-day PSH. The rates of discharge, exhibit 21.3, were derived by averaging the accumulated depths of runoff between the 15th and 30th day on volume-duration-probability (VDP) accumulation graphs. They were obtained from the same VDP station data from which the 100-year 10-day runoff volumes in exhibit 21.1 were obtained.

When using the Runoff Volume Maps Procedure, the quick return flow rate, exhibit 21.3, is made an extension to the PSH before routing it through the reservoir, figure 21.1a.

DEEP SNOWPACK AREAS. Flood volume estimates from the deep snowpack areas may be calculated from local streamflow data or by regionalization and transposition of streamflow data.

A standard procedure for making a regional analysis of volumes of runoff for varying durations and frequencies has not been developed at this time. Past experience has indicated that acceptable estimates can be made using multiple regression techniques. If watersheds can be selected that are reasonably homogeneous with regard to items

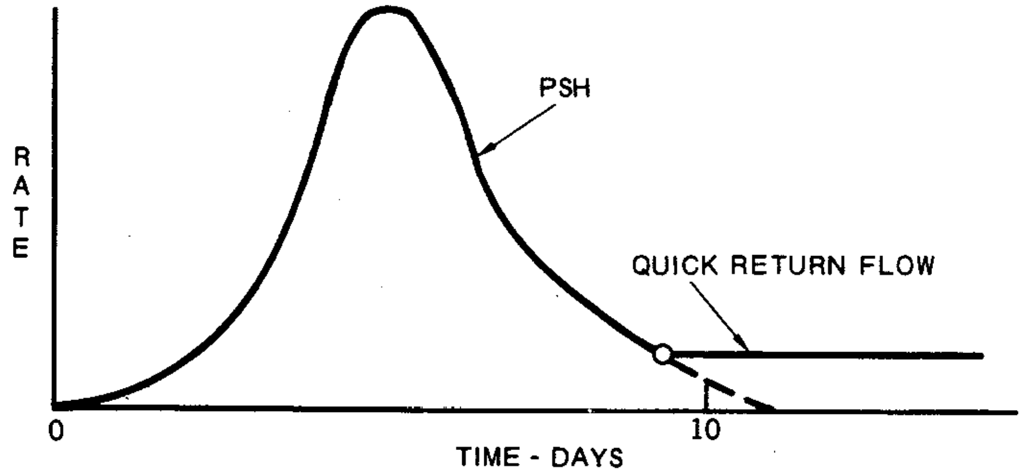


Figure 21.1a Quick Return Flow Combined with Principal Spillway Hydrograph for the Runoff Volume Maps Procedure.

such as seasonal precipitation, range of elevation, aspect, cover, geology, soils, etc., estimating equations can be developed with a minimum number of independent variables. Until techniques are developed to properly analyze the effects of a number of variables, the selection of homogeneous gaged watersheds with as much similarity to the ungaged watersheds as possible is recommended for estimating volume-duration-probability data. Statistics from volume-duration-probability studies of gaged watersheds can also be used to assist in developing estimating equations.

Construction of Principal Spillway Hydrographs and Mass Curves

The principal spillway capacity and retarding storage amount are proportioned using the Principal Spillway Hydrograph (PSH) or its mass curve (PSMC) developed from tabulations given in table 21.10. Examples in this section show how to select the appropriate set of tabulations and to construct the PSH or PSMC. One or more routings of the PSH or PSMC give the required storage and principal spillway capacity; the routings are discussed in chapter 17.

DEVELOPMENT OF TABLE 21.10. The principles of hydrograph development are discussed in chapter 16 but because the standard series of PSH and PSMC is not described there, the method of preparation will be briefly given here.

The PSH and PSMC in table 21.10 are developed from a continuous 10-day period of on-site direct runoff, all of a given frequency. Choice of the 10-day period is based on SCS experience with the use of both stream-flow records and an earlier system of standardized hydrographs. If the runoff in the 10-day period is arranged in order of decreasing rate of flow and then accumulated to form a mass curve, it has the appearance of curve A in figure 21.1. Such a curve is a straight line on log paper and it has the equation:

$$Q_D = Q_{10} \; (D/10)^a \qquad (21.2)$$

where Q_D = total runoff at time D in days
Q_{10} = total runoff at the end of 10 days
D = time in days
a = log (Q_{10}/Q_1), in which Q_1 is the total runoff at the end of 1 day

Thus, knowing only the 1- and 10-day runoff amounts, a continuous mass curve can be developed for the entire 10-day period.

Examination of such mass curves of runoff from streamflow stations in many locations of the United States showed that the exponent a varied from 0.1 to 0.5. Extremes of 0.0458 and 0.699 were chosen for the standard curves; these extremes correspond to Q_1/Q_{10} ratios of 0.9 and 0.2 respectively. The ratio Q_1/Q_{10} is used hereafter in this chapter as a parameter in preference to a or Q_{10}/Q_1 because Q_{10} is more satisfactory as a divisor in preparing PSH and PSMC with dimensionless rates and amounts of flow. Q_1/Q_{10} ratios of 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 were selected to give representative degrees of curvature for the runoff curves.

The 10-day on-site runoff for each Q_1/Q_{10} ratio was rearranged as shown in table 21.5 to provide a moderately critical distribution of the 10-day runoff. This gave a distribution midway between extremes that are theoretically possible. On figure 21.1, curves A and B show the extremes and curve C shows the rearranged distribution for a Q_1/Q_{10} ratio of 0.4.

The effects of watershed lag were included by taking increments of runoff for each of the eight typical mass curves, making incremental hydrographs, and summing these to give total hydrographs for watersheds with times of concentration of 1.5, 3, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, and 72 hours. This gave 112 hydrographs, each of which was reduced to unit rates of runoff and afterwards accumulated and reduced to unit mass curves. Curve D in figure 21.1 is the mass curve developed from curve C for a watershed with a time of concentration of 24 hours. Runoff for curve D went on for more than a day past the termination point E but because the rate was so small, the mass curve was terminated as shown. Other PSH and PSMC in table 21.10 are similarly terminated. The time interval is varied to reduce the size of the table and at the same time give enough points for reproducing the PSH and PSMC accurately. Straight-line connection of points is accurate enough for graphical work and linear interpolation for tabular work.

USE OF TABLE 21.10. The parameters for selecting a set of tabulations from table 21.10 are the Q_1/Q_{10} ratio and the time of concentration T_c in hours. The ratio and T_c of a watershed will seldom be values for

Table 21.5.--Arrangement of increments before construction of PSH and PSMC

Time	Increment
days	
0.0 to 0.5	19th largest 1/2 day
0.5 to 1.0	17th " " "
1.0 to 1.5	15th " " "
1.5 to 2.0	13th " " "
2.0 to 2.5	11th " " "
2.5 to 3.0	9th " " "
3.0 to 3.5	7th " " "
3.5 to 4.0	5th " " "
4.0 to 4.5	3rd " " "
4.5 to 4.6	9th largest 1/10 day
4.6 to 4.7	7th " " "
4.7 to 4.8	5th " " "
4.8 to 4.9	3rd " " "
4.9 to 5.0	Largest 1/10 day
5.0 to 5.1	2nd largest 1/10 day
5.1 to 5.2	4th " " "
5.2 to 5.3	6th " " "
5.3 to 5.4	8th " " "
5.4 to 5.5	10th " " "
5.5 to 6.0	4th largest 1/2 day
6.0 to 6.5	6th " " "
6.5 to 7.0	8th " " "
7.0 to 7.5	10th " " "
7.5 to 8.0	12th " " "
8.0 to 8.5	14th " " "
8.5 to 9.0	16th " " "
9.0 to 9.5	18th " " "
9.5 to 10.0	20th " " "

which the table is prepared, therefore choose that set having a Q_1/Q_{10} ratio and T_c nearest those of the watershed. It is easier to make the choice on table 21.9, which gives available PSH and PSMC and their serial numbers, and then to look up the serial number in table 21.10 for the tabulations.

Examples

The procedure by which a PSH or PSMC is developed will be illustrated by four examples. In example 21.1, channel losses are taken from direct runoff before development of a PSH and PSMC; in example 21.2, QRF is added to a PSH and PSMC; in example 21.3, runoff volume and rate maps (exhibit 21.1 through 21.5) are used to obtain runoff; and in example 21.4, upstream releases are added to a PSH.

Example 21.1.--Develop the 50-year frequency PSH and PSMC for a watershed located at latitude _________, longitude_________. The watershed has a drainage area of 15.0 square miles, time of concentration of 7.1 hours, average annual precipitation of 22.8 inches, average annual temperature of 61.5°F, and a runoff curve number (CN) of 80. There are no upstream structures.

1. Compile the 1- and 10-day point rainfall amounts from U.S. Weather Bureau maps. For this location TP-40 and TP-49 are used. The 50-year frequency 1- and 10-day amounts are 6.8 and 11.0 inches respectively.

2. Determine the areal rainfall. Get the adjustment factors from table 21.1. For the drainage area of 15.0 square miles they are 0.978 and 0.991 for the 1- and 10-day rains respectively. The areal rainfall is 0.978(6.8) = 6.65 inches for the 1-day rain and 0.991(11.0) = 10.9 inches for the 10-day rain.

3. Determine the CN for the 10-day rain. First check whether the 100-year frequency 10-day point rainfall amount is 6 or more inches. The appropriate map in TP-49 shows it is, therefore enter table 21.2 with the 1-day CN of 80 and find the 10-day CN is 65.

4. Estimate the direct runoff for 1 and 10 days. Enter figure 10.1 with the rainfall amounts from step 2 and the appropriate CN from step 3 and find $Q_1 = 4.37$ and $Q_{10} = 6.34$ inches.

5. Compute the climatic index. Using the given data and equation 21.1, the index Ci is $100(22.8)/61.5^2 = 0.603$. Because the Ci is less than 1 the channel loss may be used to reduce direct runoff.

6. Estimate the net runoff. The net runoff is the direct runoff minus the channel loss but when table 21.3 is used the net runoff is obtained by a multiplication not a subtraction. Enter

table 21.3 with the drainage area 15.0 square miles and the Ci of 0.603 and by interpolation find a reduction factor of 0.75. Multiply Q_1 and Q_{10} of step 4 by the factor to get net runoffs of 3.28 and 4.76 inches respectively. The net runoffs will be Q_1 and Q_{10} in the rest of this example.

7. Compute the Q_1/Q_{10} ratio. From step 6, $Q_1/Q_{10} = 3.28/4.76 = 0.689$.

8. Find the PSH and PSMC tabulations in table 21.10. Enter table 21.9 with the ratio 0.689 and T_c of 7.1 hours and find that the PSH with values nearest those is No. 22. Locate the appropriate tabulations in table 21.10 by looking up PSH No. 22. Columns 1, 2, and 4 of table 21.6 show the time, rate, and mass tabulations taken from table 21.10.

9. Compute PSH discharges in cfs. First find the product of drainage area and Q_{10}. This is $15.0(4.76) = 71.40$ mile^2-inches. Multiply the entries in column 2, table 21.6 by 71.40, to get the discharges in cfs in column 3.

10. Compute PSMC amounts in inches. Multiply the entries in column 4, table 21.6, by Q_{10} (4.76) to get accumulated runoff in inches as shown in column 5. If amounts in acre-feet or another unit are desired, convert Q_{10} to the desired unit before making the series of multiplications.

The example is completed with step 10. The next step is that of routing the PSH or PSMC through the structure; see chapter 17 for routing methods.

In the second example the steps concerning channel loss are omitted and steps concerning QRF are included.

Example 21.2--Develop the 25-year frequency PSH and PSMC for a watershed at latitude ________, longitude ________. The watershed has a drainage area of 8.0 square miles, time of concentration of 2.0 hours, average annual precipitation of 30.5 inches, average annual temperature of 53.1°F, and a runoff curve number of 75. QRF during flood periods is estimated to be 5 cfs. There are no upstream structures in the watershed.

1. Compile the 1- and 10-day point rainfall amounts from U.S. Weather Bureau maps. For this location TP-40 and TP-49 are used. The 25-year frequency 1- and 10-day amounts are 5.6 and 12.5 inches respectively.

2. Determine the areal rainfall. Because the drainage area is not over 10 square miles the areal rainfall is the same as the point rainfall. The amounts in step 1 will be used.

Table 21.6.--PSH and PSMC for example 21.1

Time	$\frac{cfs}{A\ Q_{10}}$	PSH	$\frac{Acc.\ Q}{Q_{10}}$	PSMC
days	csm/inch	cfs		inches
0	0	0	0	0
.2	.231	16	.0007	.00
.5	.418	30	.0045	.02
1.0	.535	38	.0135	.06
2.0	.610	44	.0340	.16
3.0	.837	60	.0609	.29
3.6	1.123	80	.0827	.39
4.0	1.398	100	.1019	.48
4.3	1.932	138	.1196	.57
4.6	2.865	204	.1464	.70
4.8	3.973	284	.1709	.81
4.9	5.461	390	.1883	.90
5.0	27.118	1936	.2482	1.18
5.1	55.278	3947	.3998	1.90
5.2	41.011	2928	.5770	2.75
5.3	23.735	1695	.6961	3.31
5.4	13.975	998	.7655	3.64
5.5	8.668	619	.8072	3.84
5.6	5.638	402	.8335	3.97
5.8	2.818	201	.8634	4.11
6.0	1.859	133	.8798	4.19
6.5	1.360	97	.9078	4.32
7.0	1.002	72	.9290	4.42
7.5	.804	57	.9453	4.50
8.0	.687	59	.9588	4.56
9.0	.533	38	.9812	4.67
9.9	.416	30	.9966	4.74
10.1	.194	14	.9990	4.76
10.3	.044	3	.9998	4.76
10.8	0	0	1.0000	4.76

3. Determine the CN for the 10-day rain. The 10-day amount in step 1 is over 6 inches therefore the 100-year 10-day amount is too, and table 21.2 may be used. Enter the table with the CN of 75 for 1 day and find the CN is 58 at 10 days.

4. Estimate the direct runoff for 1 and 10 days. Enter figure 10.1 with the rainfall amounts from step 2 and the appropriate CN from step 3 and find $Q_1 = 2.94$ and $Q_{10} = 6.68$ inches. Because there are no channel losses, the direct runoff is the net runoff.

5. Compute the Q_1/Q_{10} ratio. From step 4, $Q_1/Q_{10} = 2.94/6.68 = 0.440$.

6. Find the PSH and PSMC tabulations in table 21.10. Enter table 21.9 with the ratio of 0.440 and T_c of 2.0 hours and find that the PSH and PSMC with values nearest those is No. 3. Locate the appropriate tabulations in table 21.10 by looking up PSH No. 3.

7. Compute PSH discharges in cfs. First find the product of drainage area and Q_{10}. This is $8.0(6.68) = 53.44$ mile^2-inches. Multiply the entries in table 21.10 for PSH No. 3 by 53.44 to get discharges in cfs. These are shown in column 2, table 21.7, under the heading of "Preliminary PSH" because the final PSH must contain QRF.

8. Compute PSMC amounts in inches. Multiply the entries in table 21.10 for PSMC No. 3 by Q_{10} (6.68 inches) to get accumulated runoff in inches. The results are shown in column 5, table 21.7, under the heading "Preliminary PSMC" because the final PSMC must contain accumulated QRF. If the PSMC is to be in acre-feet or another unit, convert Q_{10} to the desired unit before making the series of multiplications.

9. Determine the minimum permissible quick return flow. First compute the climatic index: using the average annual precipitation and temperature and equation 21.1, the index Ci is $100(30.5)/53.1^2 = 1.08$. Enter table 21.4 with the Ci of 1.08 and find that the minimum QRF is 0.045 inches per day or 1.20 csm, which converts to $8.0(1.20) = 9.6$ cfs. The locally estimated QRF is 5 cfs. Therefore the minimum permissible QRF is 9.6 cfs because it is larger than the locally estimated flow. Round 9.6 to 10 cfs and tabulate in column 3, table 21.7.

10. Add QRF to the preliminary PSH. The QRF shown in column 3, table 21.7, is added to the preliminary PSH, column 2, to give the PSH discharges in column 4.

11. Add QRF to the preliminary PSMC. The accumulated QRF in inches, column 6, table 21.7, is added to the preliminary PSMC column 5, to give the PSMC amounts in column 7.

Table 21.7.--PSH and PSMC for example 21.2

Time	Prelim-inary PSH	QRF*	PSH	Prelim-inary PSMC	Acc. QRF**	PSMC
days	cfs	cfs	cfs	inches	inches	inches
0	0	10	10	0	0	0
.1	48	10	58	.01	.00	.01
.5	60	10	70	.11	.02	.13
1.0	69	10	79	.26	.04	.30
2.0	78	10	88	.60	.09	.69
3.0	100	10	110	1.00	.14	1.14
3.5	118	10	128	1.26	.16	1.42
4.0	146	10	156	1.58	.18	1.76
4.2	181	10	191	1.72	.19	1.91
4.4	230	10	240	1.91	.20	2.11
4.6	259	10	269	2.13	.21	2.34
4.7	298	10	308	2.25	.21	2.46
4.8	370	10	380	2.40	.22	2.62
4.9	512	10	522	2.60	.22	2.82
5.0	1992	10	2002	3.16	.22	3.38
5.1	1039	10	1049	3.84	.23	4.07
5.2	567	10	577	4.20	.23	4.43
5.3	383	10	393	4.42	.24	4.66
5.4	302	10	312	4.57	.24	4.81
5.5	257	10	267	4.69	.25	4.94
5.6	207	10	217	4.80	.25	5.05
5.8	174	10	184	4.97	.26	5.23
6.0	154	10	164	5.11	.27	5.38
6.5	128	10	138	5.41	.29	5.70
7.0	108	10	118	5.66	.32	5.98
8.0	84	10	94	6.07	.36	6.43
9.0	72	10	82	6.41	.40	6.81
10.0	57	10	67	6.66	.45	7.11
10.1	2	10	12	6.68	.45	7.13
10.3	0	10	10	6.68	.46	7.14
11.0	0	10	10	6.68	.50	7.18
12.0	0	10	10	6.68	.54	7.22
etc.	etc.	etc.	etc.	etc.	etc.	etc.

* 9.6 cfs rounded to 10 cfs.

** At a rate of 0.045 inches per day.

In the third example the use of the runoff volume maps is illustrated.

Example 21.3--Develop the 100-year frequency PSH for a watershed located at 43° latitude and 77° longitude. The watershed has a drainage area of 12 square miles, time of concentration of 3.5 hours.

1. Estimate 100-year 10-day runoff volumes from exhibit 21.1. The interpolated value is 8.8.

2. Select the Q_1/Q_{10} ratio from exhibit 21.2. For this area the value is 0.4.

3. Calculate 1-day volume of runoff. $Q_1/Q_{10} = 0.4$, $Q_1 = (0.4)(8.8) = 3.52$ inches.

4. Find the PSH tabulations in Table 21.10. Enter table 21.9 with the Q_1/Q_{10} ratio of 0.4 and Tc of 3.5 hours and find that the PSH with values nearest is No. 11. Locate appropriate tabulations in table 21.10 by looking up PSH No. 11.

5. Compute PSH discharges in cfs. Find the product of drainage area and Q_{10}. This is (12) (8.8) = 105.6 mile^2-inches. Entries for PSH No. 11 are multiplied by this value to obtain discharge in cfs. These are shown in column 2, table 21.8.

6. Determine the quick-return flow rate. From exhibit 21.3 the interpolated value is 5.3 csm.

7. Extension of quick-return flow rates beyond the PSH. The quick-return flow rate is (12) (5.3) = 63.6 cfs, round to 64 cfs. This constant rate of discharge is an extension to the PSH as shown in figure 21.1a, and column 4, table 21.8. No value less than 64 cfs should be used in the recession side of the PSH.

The procedure for adding releases from upstream structures is shown in the following descriptive example. If a lower structure has channel losses in its contributing area the deduction for channel loss is made in the preliminary PSH for that area. Deductions may also be required for PSH of the upper structures but once these PSH are routed through the structures no further deductions are made in the release rates.

Example 21.4--Adding releases from upstream structures when developing the PSH for a lower structure in a series is done as follows:

1. Develop the preliminary PSH for the lower structure. Use the method of example 21.1 or 21.2 or 21.3 whichever is applicable.

Table 21.8.--PSH for Example 21.3.

Time	Preliminary PSH	QRF	PSH
days	cfs	cfs	cfs
0	0		0
.1	61		61
.5	116		116
1.0	134		134
2.0	151		151
3.0	195		195
3.5	230		230
4.0	285		285
4.3	371		371
4.6	495		495
4.8	667		667
4.9	894		894
5.0	2885		2885
5.1	2455		2455
5.2	1478		1478
5.3	954		954
5.4	696		696
5.5	552		552
5.6	446		446
5.7	383		383
5.8	352		352
6.0	307		307
6.5	251		251
7.0	211		211
7.5	181		181
8.0	163		163
9.0	140		140
10.0	111		111
10.1	16	64	64
10.7	0	64	64
11.0	0	64	64
12.0	0	64	64
etc.	etc.	etc.	etc.

2. Flood-route the upstream structure releases or outflows to the lower structure. Chapter 17 discusses flood-routing procedures.

3. Add the routed flows to the preliminary PSH to get the PSH for the lower structure.

Note that if an upstream structure is itself a lower structure in a series then the procedure of example 21.4 must be followed for it first.

Table 21.9.--Serial numbers of PSH and PSMC

T_c	Q_1/Q_{10}							
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
hours	Serial numbers							
1.5*	1	2	3	4	5	6	7	8
3	9	10	11	12	13	14	15	16
6	17	18	19	20	21	22	23	24
12	25	26	27	28	29	30	31	32
18	33	34	35	36	37	38	39	40
24	41	42	43	44	45	46	47	48
30	49	50	51	52	53	54	55	56
36	57	58	59	60	61	62	63	64
42	65	66	67	68	69	70	71	72
48	73	74	75	76	77	78	79	80
54	81	82	83	84	85	86	87	88
60	89	90	91	92	93	94	95	96
66	97	98	99	100	101	102	103	104
72**	105	106	107	108	109	110	111	112

* Use this row for all T_c less than 1.5 hours.

** Use this row for all T_c over 72 hours.

Table 21.10.--Time, rate and mass tabulations for Principal Spillway Hydrographs (PSH) and Mass Curves (PSMC)

T_c = 1.5 hours

Serial No. :	1		2		3		4	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.1	1.584	.0028	1.188	.0021	.890	.0016	.704	.0013
.5	2.014	.0308	1.510	.0230	1.119	.0170	.895	.0136
1.0	2.126	.0687	1.594	.0515	1.286	.0397	.951	.0305
2.0	2.237	.1480	1.846	.1156	1.454	.0894	1.203	.0705
3.0	2.517	.2358	2.209	.1904	1.873	.1505	1.510	.1208
3.5	2.741	.2845	2.489	.2342	2.208	.1890	1.846	.1530
4.0	3.210	.3385	2.992	.2866	2.741	.2365	2.405	.1946
4.2	3.470	.3624	3.618	.3094	3.394	.2583	3.222	.2144
4.4	3.760	.3885	4.237	.3374	4.313	.2854	3.928	.2396
4.6	4.060	.4172	4.732	.3701	4.851	.3186	4.655	.2706
4.7	4.342	.4323	5.257	.3881	5.570	.3373	5.485	.2888
4.8	4.868	.4489	6.209	.4087	6.916	.3597	6.966	.3111
4.9	5.708	.4679	8.068	.4343	9.587	.3893	10.303	.3421
5.0	10.027	.4962	21.540	.4876	37.270	.4734	57.224	.4632
5.1	7.689	.5281	13.395	.5504	19.442	.5752	25.499	.6115
5.2	5.825	.5524	8.470	.5897	10.603	.6291	12.108	.6790
5.3	4.916	.5718	6.320	.6162	7.162	.6610	7.460	.7141
5.4	4.444	.5886	5.270	.6371	5.642	.6840	5.520	.7373
5.5	4.065	.6040	4.652	.6549	4.812	.7027	4.584	.7555
5.6	3.546	.6176	3.976	.6704	3.875	.7183	3.605	.7701
5.8	3.300	.6430	3.230	.6971	3.261	.7435	2.847	.7927
6.0	3.193	.6659	3.124	.7196	2.882	.7653	2.553	.8121
6.5	2.797	.7183	2.713	.7696	2.405	.8100	2.070	.8505
7.0	2.629	.7661	2.321	.8126	2.020	.8476	1.678	.8816
8.0	2.293	.8526	1.846	.8848	1.566	.9082	1.230	.9305
9.0	2.126	.9306	1.594	.9458	1.342	.9590	.951	.9683
10.0	1.902	.9948	1.510	.9959	1.063	.9971	.839	.9977
10.1	.070	.9998	.056	.9999	.039	.9999	.031	.9999
10.3	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 1.5 hours

Serial No. :	5		6		7		8	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.1	.528	.0009	.352	.0006	.198	.0004	.088	.0002
.5	.671	.0102	.470	.0068	.280	.0040	.140	.0019
1.0	.754	.0232	.559	.0164	.330	.0095	.168	.0047
2.0	.922	.0534	.642	.0373	.442	.0240	.218	.0113
3.0	1.225	.0929	.867	.0654	.587	.0428	.302	.0203
3.5	1.482	.1186	1.113	.0844	.671	.0546	.390	.0268
4.0	2.014	.1533	1.454	.1095	1.062	.0723	.531	.0359
4.2	2.808	.1702	2.034	.1222	1.650	.0826	.838	.0412
4.4	3.374	.1918	2.855	.1400	1.678	.0946	.974	.0479
4.6	4.154	.2191	3.405	.1621	2.442	.1096	1.270	.0555
4.7	4.960	.2354	4.162	.1757	3.055	.1194	1.660	.0607
4.8	6.567	.2561	5.627	.1932	4.179	.1324	2.317	.0678
4.9	10.131	.2860	9.071	.2195	6.888	.1522	3.956	.0790
5.0	81.384	.4500	109.748	.4323	142.265	.4191	179.016	.4063
5.1	31.367	.6520	36.714	.6945	41.728	.7483	45.898	.8086
5.2	12.872	.7312	13.042	.7836	12.441	.8452	11.085	.9105
5.3	7.150	.7671	6.332	.8183	5.140	.8767	3.430	.9364
5.4	5.069	.7890	4.242	.8372	3.117	.8915	1.704	.9456
5.5	4.112	.8054	3.366	.8508	2.426	.9014	1.298	.9510
5.6	2.998	.8182	2.554	.8614	1.696	.9088	.909	.9550
5.8	2.554	.8379	1.976	.8770	1.406	.9195	.805	.9605
6.0	2.028	.8543	1.622	.8897	1.088	.9286	.569	.9652
6.5	1.678	.8853	1.371	.9152	.929	.9459	.426	.9734
7.0	1.342	.9103	1.007	.9344	.671	.9586	.314	.9796
8.0	.924	.9481	.699	.9626	.420	.9765	.224	.9887
9.0	.727	.9769	.532	.9840	.308	.9897	.168	.9953
10.0	.587	.9984	.420	.9989	.258	.9993	.118	.9997
10.1	.022	1.0000	.016	1.0000	.009	1.0000	.004	1.0000
10.3	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 3 hours

Serial No.:	9		10		11		12	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.1	1.034	.0019	.775	.0014	.574	.0010	.460	.0008
.5	1.984	.0277	1.488	.0207	1.102	.0153	.882	.0122
1.0	2.097	.0654	1.572	.0490	1.269	.0377	.938	.0290
2.0	2.207	.1445	1.821	.1128	1.434	.0872	1.186	.0686
3.0	2.483	.2319	2.178	.1870	1.844	.1476	1.490	.1185
3.5	2.703	.2803	2.455	.2304	2.175	.1856	1.820	.1501
4.0	3.226	.3336	2.951	.2819	2.702	.2322	2.372	.1909
4.3	3.515	.3697	3.687	.3172	3.516	.2657	3.283	.2214
4.6	3.982	.4110	4.599	.3630	4.687	.3114	4.455	.2638
4.8	4.607	.4419	5.770	.4001	6.321	.3505	6.315	.3020
4.9	5.310	.4600	7.265	.4238	8.462	.3774	8.934	.3296
5.0	8.383	.4850	16.609	.4674	27.323	.4424	40.542	.4196
5.1	8.061	.5150	15.002	.5250	23.244	.5344	32.577	.5526
5.2	6.429	.5414	10.246	.5710	13.995	.6022	17.510	.6436
5.3	5.305	.5628	7.384	.6031	9.038	.6441	10.235	.6940
5.4	4.654	.5810	5.842	.6272	6.587	.6725	6.862	.7251
5.5	4.194	.5972	4.926	.6468	5.225	.6940	5.100	.7468
5.6	3.708	.6116	4.214	.6635	4.227	.7112	3.989	.7634
5.7	3.583	.6249	3.874	.6782	3.631	.7255	3.293	.7766
5.8	3.367	.6376	3.406	.6915	3.331	.7382	2.940	.7880
6.0	3.143	.6610	3.095	.7148	2.905	.7607	2.581	.8079
6.5	2.762	.7140	2.677	.7654	2.374	.8063	2.042	.8473
7.0	2.593	.7620	2.291	.8090	2.000	.8444	1.656	.8790
7.5	2.428	.8071	2.069	.8477	1.712	.8770	1.407	.9057
8.0	2.262	.8490	1.821	.8819	1.545	.9058	1.214	.9286
9.0	2.097	.9273	1.573	.9433	1.324	.9569	.938	.9669
10.0	1.877	.9919	1.490	.9936	1.050	.9955	.829	.9964
10.1	.280	.9991	.222	.9993	.156	.9995	.123	.9996
10.7	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 3 hours

Serial No. :	13		14		15		16	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.1	.345	.0006	.230	.0004	.129	.0002	.057	.0001
.5	.661	.0092	.455	.0061	.274	.0036	.137	.0017
1.0	.741	.0221	.550	.0156	.318	.0090	.165	.0045
2.0	.906	.0520	.630	.0363	.428	.0234	.208	.0110
3.0	1.200	.0910	.855	.0641	.579	.0420	.290	.0198
3.5	1.462	.1164	1.090	.0827	.662	.0536	.382	.0262
4.0	1.986	.1502	1.434	.1073	1.044	.0707	.524	.0351
4.3	2.802	.1762	2.305	.1270	1.626	.0860	.892	.0431
4.6	3.961	.2131	3.220	.1573	2.277	.1062	1.160	.0538
4.8	5.881	.2477	5.004	.1861	3.699	.1271	2.035	.0650
4.9	8.682	.2741	7.686	.2091	5.803	.1444	3.303	.0746
5.0	56.240	.3920	74.415	.3581	94.971	.3272	118.066	.2947
5.1	42.862	.5720	53.883	.5910	65.740	.6187	78.137	.6504
5.2	20.664	.6874	23.462	.7314	25.834	.7848	27.664	.8423
5.3	10.890	.7447	11.095	.7941	10.896	.8514	10.182	.9109
5.4	6.744	.7767	6.234	.8256	5.412	.8810	4.240	.9370
5.5	4.686	.7975	3.953	.8441	2.980	.8962	1.764	.9479
5.6	3.438	.8122	2.890	.8565	1.996	.9053	1.073	.9531
5.7	2.871	.8237	2.282	.8659	1.580	.9118	.793	.9564
5.8	2.618	.8337	2.033	.8737	1.436	.9172	.781	.9593
6.0	2.113	.8509	1.659	.8870	1.149	.9267	.587	.9642
6.5	1.656	.8827	1.356	.9130	.924	.9445	.427	.9728
7.0	1.325	.9082	.995	.9328	.662	.9576	.317	.9791
7.5	1.080	.9291	.802	.9484	.525	.9678	.250	.9841
8.0	.915	.9467	.690	.9615	.414	.9759	.221	.9883
9.0	.719	.9758	.528	.9832	.304	.9892	.166	.9951
10.0	.582	.9975	.415	.9982	.262	.9989	.123	.9995
10.1	.086	.9997	.062	.9998	.038	.9999	.018	.9999
10.7	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 6 hours

Serial No. :	17		18		19		20	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.2	1.038	.0031	.779	.0023	.577	.0017	.461	.0014
.5	1.862	.0205	1.397	.0154	1.035	.0114	.828	.0091
1.0	2.063	.0575	1.547	.0431	1.244	.0329	.923	.0255
2.0	2.174	.1361	1.792	.1059	1.410	.0818	1.164	.0641
3.0	2.444	.2225	2.136	.1787	1.800	.1407	1.462	.1128
3.6	2.714	.2800	2.489	.2302	2.215	.1854	1.876	.1500
4.0	3.006	.3220	2.886	.2709	2.636	.2222	2.314	.1820
4.3	3.284	.3571	3.349	.3044	3.178	.2536	2.944	.2102
4.6	3.801	.3964	4.282	.3466	4.310	.2950	4.029	.2485
4.8	4.196	.4258	5.046	.3807	5.340	.3300	5.225	.2820
4.9	4.653	.4421	5.951	.4010	6.616	.3521	6.721	.3040
5.0	5.991	.4618	9.630	.4298	13.534	.3892	17.748	.3491
5.1	7.547	.4868	14.087	.4736	22.175	.4551	31.771	.4404
5.2	7.180	.5141	12.665	.5230	18.923	.5309	25.805	.5464
5.3	6.166	.5388	9.785	.5645	13.444	.5906	17.306	.6254
5.4	5.330	.5601	7.628	.5967	9.677	.6332	11.430	.6778
5.5	4.723	.5786	6.186	.6222	7.310	.6645	8.067	.7138
5.6	4.212	.5952	5.169	.6432	5.727	.6886	5.954	.7396
5.8	3.587	.6237	3.923	.6764	3.881	.7233	3.641	.7741
6.0	3.188	.6486	3.214	.7023	3.109	.7487	2.784	.7972
6.5	2.757	.7034	2.662	.7552	2.372	.7971	2.040	.8394
7.0	2.566	.7522	2.282	.8002	2.000	.8367	1.652	.8727
7.5	2.403	.7978	2.052	.8398	1.706	.8704	1.400	.9003
8.0	2.240	.8404	1.808	.8750	1.532	.8999	1.207	.9239
9.0	2.071	.9193	1.559	.9373	1.312	.9519	.933	.9633
9.9	1.862	.9847	1.475	.9879	1.052	.9914	.828	.9932
10.1	.872	.9955	.692	.9965	.490	.9975	.386	.9980
10.3	.198	.9991	.158	.9992	.111	.9995	.040	.9998
10.8	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 6 hours

Serial No. :	21		22		23		24	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.2	.346	.0010	.231	.0007	.130	.0004	.058	.0002
.5	.621	.0068	.418	.0045	.254	.0026	.124	.0012
1.0	.719	.0193	.535	.0135	.302	.0079	.160	.0039
2.0	.881	.0486	.610	.0340	.412	.0218	.194	.0102
3.0	1.167	.0865	.837	.0609	.566	.0398	.274	.0188
3.6	1.518	.1163	1.123	.0827	.708	.0536	.395	.0262
4.0	1.934	.1428	1.398	.1019	1.004	.0668	.510	.0331
4.3	2.527	.1666	1.932	.1196	1.489	.0804	.784	.0401
4.6	3.539	.1997	2.865	.1464	1.961	.0987	.999	.0500
4.8	4.747	.2295	3.973	.1709	2.887	.1161	1.555	.0591
4.9	6.335	.2499	5.461	.1883	4.056	.1289	2.255	.0661
5.0	22.276	.3026	27.118	.2482	32.166	.1955	37.622	.1394
5.1	42.826	.4225	55.278	.3998	69.093	.3817	84.295	.3634
5.2	33.204	.5625	41.011	.5770	49.241	.5993	57.738	.6245
5.3	20.462	.6613	23.735	.6961	26.833	.7392	29.654	.7851
5.4	12.851	.7226	13.975	.7655	14.846	.8159	15.379	.8679
5.5	8.521	.7619	8.668	.8072	8.572	.8589	8.194	.9112
5.6	5.896	.7885	5.638	.8335	5.120	.8841	4.424	.9344
5.8	3.326	.8212	2.818	.8634	2.199	.9096	1.490	.9546
6.0	2.389	.8417	1.859	.8798	1.326	.9216	.680	.9616
6.5	1.655	.8764	1.360	.9078	.931	.9409	.438	.9711
7.0	1.322	.9031	1.002	.9290	.666	.9551	.327	.9779
7.5	1.085	.9249	.804	.9453	.525	.9658	.253	.9832
8.0	.918	.9431	.687	.9588	.415	.9743	.221	.9875
9.0	.718	.9730	.533	.9812	.305	.9880	.165	.9944
9.9	.586	.9952	.416	.9966	.271	.9978	.129	.9990
10.1	.272	.9986	.194	.9990	.122	.9988	.057	.9997
10.3	.062	.9997	.044	.9998	.028	.9999	.013	.9999
10.8	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 12 hours

Serial No. :	25		26		27		28	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.678	.0026	.509	.0019	.377	.0014	.302	.0011
.6	1.577	.0158	1.183	.0118	.879	.0088	.701	.0070
1.0	1.967	.0426	1.475	.0319	1.165	.0242	.878	.0189
2.0	2.156	.1198	1.764	.0926	1.379	.0714	1.124	.0557
3.0	2.408	.2043	2.075	.1631	1.726	.1278	1.414	.1022
4.0	2.842	.3006	2.748	.2502	2.486	.2035	2.164	.1658
4.3	3.105	.3336	2.992	.2818	2.979	.2325	2.507	.1913
4.6	3.485	.3701	3.711	.3187	3.630	.2677	3.345	.2234
4.8	3.804	.3971	4.310	.3483	4.377	.2971	4.148	.2508
4.9	4.043	.4116	4.768	.3651	4.995	.3144	4.855	.2674
5.0	4.540	.4275	5.944	.3849	6.976	.3365	7.736	.2907
5.1	5.388	.4459	8.174	.4110	11.052	.3698	14.079	.3309
5.2	6.200	.4673	10.329	.4452	15.007	.4179	20.236	.3942
5.3	6.451	.4908	10.879	.4844	15.865	.4749	21.358	.4710
5.4	6.163	.5141	9.984	.5230	14.080	.5302	18.384	.5443
5.5	5.659	.5360	8.609	.5574	11.562	.5776	14.463	.6049
5.6	5.157	.5561	7.374	.5870	9.437	.6164	11.327	.6525
5.8	4.298	.5910	5.483	.6342	6.345	.6741	7.000	.7192
6.0	3.706	.6205	4.796	.6533	4.558	.7138	4.649	.7615
6.2	3.331	.6465	3.500	.6985	3.519	.7434	3.366	.7907
6.5	2.940	.6812	2.893	.7335	2.684	.7772	2.389	.8220
6.8	2.717	.7126	2.569	.7638	2.286	.8046	1.948	.8457
7.4	2.477	.7702	2.161	.8159	1.848	.8502	1.519	.8837
8.0	2.283	.8232	1.875	.8608	1.582	.8880	1.262	.9144
9.0	2.086	.9036	1.601	.9253	1.341	.9418	.977	.9559
10.0	1.826	.9772	1.439	.9820	1.053	.9870	.822	.9898
10.3	.844	.9926	.667	.9942	.480	.9958	.377	.9967
10.6	.239	.9981	.189	.9985	.136	.9989	.107	.9991
11.4	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 12 hours

Serial No. :	29		30		31		32	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.226	.0008	.151	.0006	.086	.0003	.038	.0001
.6	.526	.0052	.356	.0035	.212	.0020	.102	.0010
1.0	.672	.0142	.490	.0098	.281	.0058	.145	.0028
2.0	.847	.0423	.585	.0296	.403	.0188	.186	.0089
3.0	1.120	.0781	.801	.0549	.539	.0358	.259	.0169
4.0	1.794	.1294	1.303	.0922	.902	.0601	.470	.0296
4.3	2.121	.1507	1.574	.1078	1.197	.0714	.622	.0354
4.6	2.882	.1780	2.315	.1290	1.594	.0868	.848	.0436
4.8	3.671	.2020	2.999	.1484	2.114	.1002	1.112	.0507
4.9	4.396	.2169	3.664	.1607	2.644	.1090	1.421	.0554
5.0	8.270	.2402	8.608	.1833	8.709	.1299	8.691	.0740
5.1	17.276	.2873	20.646	.2372	24.136	.1904	27.865	.1412
5.2	25.994	.3671	32.253	.3347	38.973	.3066	46.207	.2776
5.3	27.302	.4653	33.657	.4561	40.402	.4527	47.511	.4500
5.4	22.834	.5577	27.414	.5686	32.115	.5862	36.878	.6053
5.5	17.279	.6317	20.012	.6560	22.676	.6871	25.213	.7196
5.6	13.048	.6876	14.617	.7198	16.047	.7584	17.313	.7978
5.8	7.474	.7620	7.808	.8007	7.959	.8447	7.993	.8884
6.0	4.661	.8058	4.506	.8450	4.272	.8884	3.938	.9308
6.2	3.122	.8341	2.813	.8714	2.431	.9125	1.968	.9518
6.5	2.029	.8618	1.724	.8957	1.290	.9323	.795	.9664
6.8	1.582	.8814	1.271	.9119	.858	.9436	.413	.9723
7.4	1.203	.9119	.907	.9355	.598	.9594	.294	.9800
8.0	.972	.9358	.724	.9534	.450	.9709	.234	.9857
9.0	.752	.9674	.560	.9770	.330	.9855	.174	.9932
10.0	.591	.9928	.415	.9949	.269	.9967	.125	.9985
10.3	.268	.9977	.189	.9984	.121	.9990	.056	.9995
10.6	.076	.9994	.054	.9996	.034	.9997	.016	.9999
11.4	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 18 hours

Serial No. :	33		34		35		36	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.277	.0010	.208	.0007	.154	.0005	.123	.0004
.6	1.095	.0086	.821	.0064	.609	.0047	.487	.0038
1.0	1.736	.0302	1.302	.0226	1.008	.0170	.774	.0134
2.0	2.124	.1039	1.716	.0798	1.334	.0614	1.070	.0478
3.0	2.359	.1867	2.004	.1482	1.641	.1156	1.350	.0922
4.0	2.736	.2802	2.576	.2311	2.298	.1866	1.973	.1514
4.5	3.134	.3343	3.092	.2828	2.905	.2337	2.615	.1927
4.9	3.693	.3845	4.116	.3354	4.156	.2848	3.928	.2397
5.0	3.970	.3987	4.720	.3518	5.096	.3019	5.209	.2566
5.1	4.410	.4142	5.777	.3712	6.896	.3241	7.862	.2807
5.2	4.978	.4316	7.206	.3952	9.422	.3542	11.690	.3168
5.3	5.502	.4510	8.529	.4243	11.765	.3933	15.235	.3665
5.4	5.792	.4719	9.213	.4571	12.920	.4389	16.904	.4258
5.5	5.789	.4934	9.122	.4910	12.668	.4862	16.399	.4872
5.6	5.571	.5144	8.512	.5237	11.530	.5309	14.598	.5444
5.7	5.242	.5345	7.676	.5536	10.043	.5707	12.343	.5941
5.8	4.892	.5532	6.849	.5805	8.640	.6052	10.299	.6359
5.9	4.566	.5708	6.122	.6045	7.463	.6350	8.651	.6709
6.0	4.266	.5871	5.472	.6259	6.451	.6607	7.259	.7003
6.2	3.773	.6168	4.430	.6624	4.898	.7023	5.185	.7458
6.4	3.413	.6434	3.726	.6924	3.888	.7346	3.907	.7791
6.7	3.022	.6790	3.078	.7299	2.972	.7721	2.779	.8155
7.0	2.777	.7112	2.671	.7617	2.456	.8020	2.176	.8427
7.4	2.570	.7507	2.306	.7983	2.016	.8348	1.681	.8708
8.0	2.352	.8054	1.978	.8458	1.672	.8753	1.352	.9041
9.0	2.117	.8876	1.662	.9127	1.388	.9313	1.040	.9480
10.0	1.907	.9627	1.491	.9707	1.134	.9784	.874	.9832
10.3	1.375	.9816	1.082	.9855	.797	.9894	.620	.9917
10.7	.464	.9944	.366	.9956	.268	.9968	.209	.9975
11.0	.190	.9979	.149	.9983	.109	.9988	.085	.9990
12.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 18 hours

Serial No. :	37		38		39		40	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.092	.0003	.062	.0002	.035	.0001	.016	.0000
.6	.365	.0028	.245	.0019	.144	.0011	.068	.0005
1.0	.588	.0101	.418	.0069	.244	.0040	.122	.0019
2.0	.809	.0363	.561	.0254	.387	.0159	.177	.0076
3.0	1.059	.0703	.754	.0494	.506	.0320	.241	.0151
4.0	1.616	.1176	1.179	.0836	.789	.0544	.417	.0266
4.5	2.214	.1520	1.684	.1090	1.228	.0724	.647	.0360
4.9	3.472	.1925	2.830	.1410	2.004	.0951	1.065	.0480
5.0	5.102	.2084	4.811	.1551	4.331	.1068	3.740	.0568
5.1	8.709	.2338	9.462	.1814	10.106	.1334	10.725	.0835
5.2	14.028	.2757	16.442	.2292	18.910	.1868	21.507	.1428
5.3	18.934	.3365	22.854	.3016	26.967	.2713	31.324	.2400
5.4	21.138	.4104	25.608	.3909	30.294	.3767	35.205	.3625
5.5	20.281	.4868	24.302	.4828	28.455	.4849	32.720	.4875
5.6	17.690	.5568	20.808	.5659	23.951	.5814	27.092	.5976
5.7	14.565	.6162	16.726	.6351	18.819	.6602	20.835	.6858
5.8	11.834	.6649	13.268	.6904	14.589	.7217	15.811	.7533
5.9	9.716	.7046	10.671	.7345	11.506	.7698	12.251	.8049
6.0	7.960	.7372	8.536	.7699	9.005	.8075	9.384	.8447
6.2	5.384	.7860	5.469	.8210	5.475	.8602	5.391	.8984
6.4	3.847	.8197	3.751	.8545	3.565	.8930	3.308	.9299
6.7	2.526	.8542	2.311	.8872	1.978	.9227	1.586	.9558
7.0	1.873	.8781	1.609	.9084	1.260	.9401	.881	.9689
7.4	1.350	.9016	1.039	.9275	.694	.9540	.341	.9774
8.0	1.051	.9278	.788	.9474	.503	.9671	.254	.9838
9.0	.795	.9613	.592	.9725	.361	.9828	.184	.9918
10.0	.640	.9879	.446	.9915	.288	.9946	.131	.9975
10.3	.447	.9941	.314	.9958	.202	.9973	.094	.9988
10.7	.150	.9982	.106	.9987	.068	.9992	.031	.9996
11.0	.061	.9993	.043	.9995	.028	.9997	.013	.9998
12.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 24 hours

Serial No. :	41		42		43		44	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.132	.0005	.099	.0003	.073	.0002	.058	.0002
.8	1.108	.0113	.831	.0085	.622	.0063	.493	.0050
1.3	1.745	.0452	1.317	.0289	1.029	.0220	.785	.0171
2.0	2.058	.0886	1.641	.0677	1.273	.0521	1.007	.0404
3.0	2.311	.1694	1.940	.1338	1.567	.1041	1.290	.0827
4.0	2.650	.2605	2.432	.2133	2.138	.1711	1.813	.1383
4.6	3.071	.3235	3.016	.2728	2.816	.2248	2.518	.1850
4.9	3.433	.3595	3.652	.3095	3.585	.2599	3.323	.2169
5.0	3.628	.3726	4.052	.3238	4.167	.2742	4.074	.2305
5.1	3.906	.3865	4.674	.3399	5.165	.2914	5.474	.2481
5.2	4.268	.4016	5.529	.3588	6.600	.3131	7.565	.2722
5.3	4.676	.4182	6.517	.3810	8.296	.3406	10.076	.3047
5.4	5.048	.4362	7.417	.4068	9.843	.3741	12.364	.3461
5.5	5.299	.4554	8.000	.4353	10.820	.4122	13.771	.3943
5.6	5.390	.4751	8.180	.4652	11.081	.4526	14.095	.4457
5.7	5.328	.4950	7.984	.4950	10.690	.4928	13.448	.4964
5.8	5.158	.5144	7.544	.5238	9.904	.5308	12.247	.5438
5.9	4.924	.5331	6.981	.5506	8.936	.5656	10.817	.5864
6.0	4.668	.5508	6.387	.5753	7.950	.5967	9.397	.6236
6.2	4.189	.5836	5.336	.6185	6.302	.6491	7.119	.6841
6.4	3.788	.6130	4.505	.6548	5.060	.6909	5.471	.7303
6.6	3.457	.6398	3.864	.6857	4.114	.7246	4.240	.7660
6.9	3.090	.6761	3.227	.7248	3.216	.7648	3.120	.8062
7.2	2.839	.7089	2.785	.7580	2.633	.7970	2.412	.8365
7.6	2.614	.7492	2.396	.7961	2.148	.8320	1.864	.8677
8.0	2.440	.7866	2.115	.8294	1.816	.8612	1.504	.8924
9.0	2.159	.8711	1.728	.8993	1.444	.9202	1.106	.9394
10.0	1.962	.9476	1.528	.9590	1.197	.9691	.913	.9762
10.3	1.660	.9681	1.301	.9750	.984	.9814	.759	.9856
10.8	.670	.9894	.527	.9917	.392	.9938	.304	.9952
11.2	.270	.9960	.212	.9968	.158	.9977	.122	.9982
11.6	.105	.9986	.083	.9989	.061	.9992	.048	.9994
12.5	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 24 hours

Serial No. :	45		46		47		48	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.3	.044	.0002	.029	.0001	.017	.0000	.008	.0000
.8	.370	.0038	.252	.0025	.149	.0015	.071	.0007
1.3	.600	.0130	.430	.0090	.254	.0053	.127	.0026
2.0	.764	.0307	.533	.0216	.362	.0133	.166	.0064
3.0	1.003	.0630	.712	.0442	.477	.0286	.225	.0134
4.0	1.469	.1070	1.072	.0759	.704	.0494	.372	.0240
4.6	2.124	.1457	1.611	.1044	1.155	.0692	.607	.0343
4.9	2.888	.1729	2.306	.1256	1.631	.0843	.864	.0423
5.0	3.800	.1852	3.376	.1361	2.831	.0925	2.199	.0479
5.1	5.632	.2026	5.666	.1527	5.592	.1080	5.458	.0620
5.2	8.450	.2286	9.274	.1802	10.041	.1367	10.806	.0919
5.3	11.874	.2660	13.697	.2225	15.541	.1838	17.458	.1439
5.4	14.982	.3155	17.697	.2803	20.502	.2501	23.431	.2191
5.5	16.845	.3741	20.035	.3498	23.337	.3308	26.765	.3114
5.6	17.205	.4368	20.407	.4243	23.698	.4173	27.079	.4104
5.7	16.242	.4985	19.076	.4970	21.944	.5013	24.844	.5059
5.8	14.568	.5552	16.876	.5632	19.166	.5770	21.438	.5910
5.9	12.633	.6053	14.392	.6207	16.092	.6418	17.740	.6631
6.0	10.755	.6484	12.026	.6694	13.214	.6958	14.330	.7221
6.2	7.851	.7164	8.483	.7441	9.035	.7766	9.512	.8085
6.4	5.804	.7664	6.068	.7973	6.255	.8324	6.370	.8664
6.6	4.290	.8034	4.318	.8353	4.249	.8708	4.110	.9046
6.9	2.972	.8429	2.852	.8742	2.627	.9080	2.352	.9394
7.2	2.168	.8710	1.950	.9003	1.657	.9311	1.334	.9592
7.6	1.581	.8981	1.320	.9238	1.024	.9503	.722	.9736
8.0	1.199	.9185	.925	.9402	.628	.9623	.349	.9813
9.0	.844	.9548	.630	.9676	.392	.9797	.197	.9902
10.0	.678	.9826	.475	.9878	.303	.9922	.140	.9964
10.3	.554	.9895	.390	.9926	.249	.9953	.116	.9978
10.8	.220	.9966	.155	.9976	.099	.9984	.046	.9993
11.2	.088	.9986	.062	.9991	.040	.9994	.018	.9997
11.6	.034	.9995	.024	.9997	.015	.9998	.007	.9999
12.5	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c= 30 hours

Serial No. :	49		50		51		52	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.4	.150	.0007	.113	.0005	.083	.0004	.067	.0003
.9	.955	.0103	.716	.0077	.538	.0057	.425	.0046
1.5	1.686	.0407	1.281	.0306	.998	.0233	.764	.0181
2.0	1.955	.0747	1.541	.0568	1.195	.0437	.937	.0339
3.0	2.252	.1527	1.872	.1201	1.497	.0932	1.229	.0738
4.0	2.574	.2416	2.316	.1965	2.006	.1567	1.686	.1263
4.6	2.929	.3022	2.814	.2528	2.580	.2068	2.274	.1693
4.9	3.228	.3363	3.306	.2865	3.169	.2383	2.889	.1975
5.1	3.579	.3614	4.022	.3133	4.223	.2651	4.269	.2232
5.2	3.830	.3751	4.582	.3292	5.117	.2823	5.520	.2412
5.3	4.124	.3898	5.258	.3474	6.228	.3032	7.111	.2645
5.4	4.438	.4057	5.994	.3682	7.464	.3285	8.910	.2940
5.5	4.724	.4226	6.662	.3916	8.584	.3581	10.535	.3299
5.6	4.935	.4405	7.144	.4171	9.378	.3913	11.666	.3708
5.7	5.052	.4590	7.397	.4440	9.779	.4266	12.218	.4148
5.8	5.063	.4777	7.391	.4713	9.730	.4626	12.098	.4597
5.9	4.985	.4963	7.182	.4982	9.348	.4978	11.502	.5032
6.0	4.845	.5145	6.841	.5241	8.761	.5312	10.630	.5440
6.2	4.471	.5490	5.976	.5716	7.337	.5907	8.585	.6149
6.4	4.090	.5807	5.149	.6126	6.050	.6400	6.816	.6715
6.6	3.758	.6097	4.479	.6481	5.048	.6808	5.492	.7167
6.9	3.346	.6490	3.706	.6933	3.919	.7301	4.032	.7689
7.2	3.042	.6844	3.159	.7312	3.157	.7689	3.076	.8078
7.6	2.760	.7272	2.658	.7640	2.497	.8103	2.284	.8469
8.0	2.555	.7665	2.313	.8106	2.068	.8438	1.799	.8768
8.6	2.322	.8206	1.957	.8576	1.677	.8849	1.366	.9114
9.2	2.170	.8703	1.738	.8984	1.457	.9194	1.116	.9386
10.0	2.009	.9322	1.566	.9470	1.253	.9594	.951	.9688
10.5	1.530	.9661	1.200	.9734	.915	.9800	.705	.9845
11.0	.702	.9864	.551	.9893	.416	.9920	.321	.9938
11.5	.279	.9949	.219	.9960	.165	.9970	.127	.9977
12.0	.107	.9982	.084	.9986	.063	.9990	.048	.9992
13.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 30 hours

Serial No. :	53		54		55		56	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.4	.050	.0002	.033	.0001	.019	.0001	.009	.0000
.9	.320	.0034	.219	.0023	.129	.0013	.062	.0006
1.5	.584	.0137	.416	.0096	.251	.0056	.123	.0027
2.0	.713	.0257	.500	.0180	.332	.0110	.153	.0053
3.0	.949	.0562	.671	.0394	.450	.0253	.211	.0120
4.0	1.355	.0975	.986	.0690	.644	.0449	.336	.0216
4.6	1.898	.1327	1.418	.0948	1.004	.0625	.526	.0308
4.9	2.478	.1566	1.938	.1130	1.373	.0754	.725	.0376
5.1	4.179	.1800	3.972	.1334	3.699	.0923	3.365	.0504
5.2	5.812	.1984	6.010	.1518	6.148	.1104	6.250	.0681
5.3	7.926	.2237	8.685	.1788	9.411	.1390	10.134	.0982
5.4	10.343	.2574	11.774	.2165	13.212	.1806	14.692	.1439
5.5	12.519	.2995	14.539	.2649	16.603	.2355	18.735	.2054
5.6	14.006	.3483	16.397	.3218	18.845	.3007	21.365	.2791
5.7	14.707	.4012	17.246	.3838	19.840	.3718	22.496	.3597
5.8	14.489	.4550	16.905	.4466	19.348	.4439	21.822	.4412
5.9	13.647	.5068	15.784	.5068	17.918	.5125	20.050	.5182
6.0	12.461	.5549	14.256	.5621	16.020	.5749	17.758	.5877
6.2	9.759	.6368	10.855	.6546	11.884	.6777	12.853	.7003
6.4	7.505	.7001	8.116	.7241	8.654	.7527	9.125	.7806
6.6	5.866	.7491	6.195	.7765	6.444	.8080	6.630	.8382
6.9	4.085	.8036	4.141	.8329	4.101	.8654	4.005	.8959
7.2	2.958	.8419	2.860	.8708	2.677	.9019	2.455	.9305
7.6	2.060	.8784	1.856	.9050	1.603	.9328	1.331	.9576
8.0	1.532	.9045	1.292	.9278	1.022	.9517	.757	.9725
8.6	1.082	.9331	.846	.9511	.580	.9691	.349	.9846
9.2	.856	.9541	.639	.9670	.397	.9793	.201	.9900
10.0	.713	.9771	.506	.9838	.319	.9897	.151	.9952
10.5	.517	.9887	.365	.9920	.233	.9949	.109	.9976
11.0	.234	.9955	.165	.9968	.105	.9980	.049	.9991
11.5	.093	.9983	.065	.9988	.042	.9992	.019	.9996
12.0	.035	.9994	.025	.9996	.016	.9997	.007	.9999
13.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 36 hours

Serial No. :	57		58		59		60	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.5	.163	.0009	.122	.0007	.091	.0005	.072	.0004
1.2	1.130	.0170	.848	.0127	.648	.0095	.504	.0075
2.0	1.817	.0623	1.418	.0473	1.101	.0363	.857	.0281
3.0	2.177	.1368	1.794	.1072	1.424	.0830	1.165	.0656
4.0	2.498	.2231	2.211	.1805	1.889	.1433	1.576	.1152
4.8	2.964	.3032	2.884	.2544	2.666	.2088	2.366	.1714
5.0	3.176	.3259	3.250	.2770	3.133	.2301	2.892	.1906
5.1	3.331	.3380	3.565	.2896	3.598	.2425	3.506	.2024
5.2	3.521	.3506	3.965	.3036	4.212	.2569	4.339	.2169
5.3	3.742	.3641	4.451	.3192	4.982	.2739	5.411	.2349
5.4	3.987	.3784	5.002	.3366	5.874	.2940	6.673	.2572
5.5	4.238	.3937	5.574	.3562	6.814	.3174	8.017	.2843
5.6	4.467	.4098	6.095	.3778	7.670	.3442	9.240	.3162
5.7	4.644	.4267	6.492	.4011	8.311	.3737	10.141	.3519
5.8	4.760	.4441	6.741	.4256	8.704	.4051	10.682	.3904
5.9	4.806	.4618	6.826	.4507	8.824	.4375	10.825	.4301
6.0	4.784	.4796	6.757	.4758	8.686	.4698	10.598	.4696
6.1	4.708	.4972	6.567	.5005	8.354	.5013	10.099	.5078
6.2	4.593	.5144	6.293	.5243	7.898	.5314	9.435	.5439
6.4	4.296	.5474	5.623	.5684	6.815	.5858	7.902	.6080
6.6	3.984	.5781	4.960	.6076	5.787	.6323	6.494	.6610
6.8	3.704	.6066	4.403	.6422	4.956	.6719	5.399	.7048
7.1	3.348	.6457	3.736	.6872	3.989	.7212	4.151	.7573
7.5	2.989	.6925	3.078	.7373	3.072	.7729	2.997	.8095
8.0	2.680	.7449	2.536	.7890	2.366	.8227	2.159	.8565
8.6	2.414	.8014	2.108	.8402	1.861	.8690	1.583	.8973
9.2	2.230	.8529	1.837	.8838	1.568	.9068	1.248	.9285
10.0	2.052	.9163	1.610	.9344	1.308	.9490	.994	.9609
10.5	1.710	.9519	1.343	.9623	1.045	.9712	.803	.9778
11.0	.978	.9769	.768	.9819	.587	.9862	.453	.9894
11.6	.391	.9912	.307	.9932	.234	.9948	.180	.9960
12.5	.092	.9982	.072	.9986	.055	.9990	.042	9992
14.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 36 hours

Serial No. :	61		62		63		64	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.5	.054	.0003	.036	.0002	.021	.0001	.010	.0000
1.2	.382	.0056	.266	.0039	.156	.0023	.077	.0011
2.0	.653	.0214	.460	.0150	.298	.0091	.140	.0044
3.0	.895	.0498	.631	.0349	.422	.0224	.198	.0106
4.0	1.258	.0887	.911	.0627	.596	.0407	.306	.0195
4.8	1.986	.1347	1.504	.0965	1.059	.0638	.555	.0315
5.0	2.536	.1510	2.062	.1092	1.574	.0730	1.014	.0367
5.1	3.301	.1618	2.986	.1185	2.645	.0808	2.244	.0427
5.2	4.360	.1759	4.282	.1319	4.170	.0933	4.011	.0542
5.3	5.752	.1946	6.014	.1509	6.245	.1125	6.449	.0735
5.4	7.411	.2189	8.096	.1769	8.766	.1401	9.430	.1027
5.5	9.193	.2495	10.347	.2109	11.507	.1775	12.688	.1434
5.6	10.811	.2864	12.385	.2528	13.984	.2244	15.620	.1956
5.7	11.982	.3284	13.839	.3011	15.724	.2792	17.650	.2568
5.8	12.675	.3739	14.683	.3537	16.719	.3389	18.791	.3239
5.9	12.833	.4209	14.846	.4081	16.878	.4008	18.923	.3934
6.0	12.498	.4676	14.387	.4620	16.277	.4619	18.170	.4617
6.1	11.814	.5125	13.499	.5134	15.167	.5198	16.818	.5261
6.2	10.927	.5544	12.374	.5611	13.786	.5732	15.168	.5850
6.4	8.922	.6277	9.876	.6432	10.772	.6638	11.616	.6838
6.6	7.130	.6868	7.709	.7079	8.215	.7335	8.662	.7581
6.8	5.776	.7342	6.123	.7586	6.390	.7870	6.602	.8140
7.1	4.260	.7893	4.373	.8161	4.400	.8459	4.379	.8738
7.5	2.893	.8412	2.805	.8680	2.648	.8966	2.461	.9228
8.0	1.947	.8852	1.756	.9092	1.528	.9343	1.295	.9564
8.6	1.323	.9206	1.105	.9400	.855	.9596	.632	.9767
9.2	.991	.9460	.779	.9607	.540	.9749	.340	.9873
10.0	.752	.9711	.542	.9794	.340	.9870	.164	.9938
10.5	.594	.9837	.422	.9884	.268	.9927	.126	.9966
11.0	.332	.9922	.236	.9945	.150	.9965	.070	.9984
11.6	.132	.9971	.094	.9979	.059	.9987	.028	.9994
12.5	.031	.9994	.022	.9996	.014	.9997	.006	.9999
14.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 42 hours

Serial No. :	65		66		67		68	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.174	.0011	.131	.0008	.097	.0006	.078	.0005
1.2	.892	.0123	.670	.0092	.509	.0069	.398	.0054
2.0	1.666	.0516	1.290	.0391	1.001	.0300	.777	.0232
3.0	2.097	.1220	1.714	.0952	1.354	.0737	1.101	.0580
4.0	2.428	.2056	2.120	.1655	1.789	.1309	1.484	.1050
4.8	2.846	.2829	2.711	.2358	2.466	.1922	2.162	.1572
5.0	3.026	.3046	3.007	.2568	2.834	.2117	2.570	.1744
5.2	3.301	.3280	3.550	.2809	3.630	.2353	3.610	.1969
5.4	3.669	.3537	4.330	.3099	4.841	.2664	5.268	.2294
5.5	3.875	.3677	4.784	.3268	5.564	.2856	6.278	.2507
5.6	4.082	.3824	5.245	.3453	6.306	.3075	7.325	.2757
5.7	4.272	.3979	5.667	.3654	6.989	.3320	8.287	.3045
5.8	4.425	.4139	6.004	.3870	7.524	.3588	9.031	.3364
5.9	4.536	.4305	6.241	.4096	7.898	.3872	9.546	.3707
6.0	4.597	.4474	6.366	.4329	8.086	.4167	9.795	.4063
6.1	4.606	.4644	6.370	.4564	8.075	.4465	9.756	.4423
6.2	4.569	.4814	6.272	.4798	7.899	.4759	9.484	.4778
6.3	4.497	.4982	6.098	.5026	7.608	.5045	9.058	.5119
6.4	4.399	.5146	5.872	.5247	7.239	.5319	8.531	.5444
6.6	4.155	.5463	5.338	.5662	6.391	.5822	7.346	.6029
6.8	3.895	.5761	4.795	.6036	5.554	.6262	6.206	.6528
7.0	3.653	.6040	4.317	.6372	4.840	.6645	5.262	.6949
7.3	3.343	.6428	3.734	.6818	4.001	.7133	4.182	.7469
7.6	3.088	.6784	3.266	.7205	3.348	.7538	3.359	.7884
8.0	2.820	.7220	2.784	.7650	2.700	.7981	2.568	.8317
8.5	2.565	.7718	2.355	.8122	2.165	.8427	1.943	.8729
9.2	2.310	.8346	1.961	.8676	1.713	.8922	1.420	.9156
10.0	2.110	.9000	1.683	.9212	1.397	.9379	1.084	.9522
10.5	1.840	.9370	1.451	.9504	1.151	.9616	.884	.9704
11.2	.967	.9737	.762	.9794	.588	.9842	.454	.9878
12.0	.334	.9915	.263	.9933	.202	.9949	.156	.9961
12.8	.110	.9975	.086	.9980	.066	.9985	.051	.9988
14.5	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 42 hours

Serial No. :	69		70		71		72	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.058	.0004	.039	.0002	.023	.0001	.010	.0001
1.2	.301	.0041	.209	.0028	.122	.0016	.060	.0008
2.0	.592	.0176	.418	.0123	.266	.0074	.126	.0036
3.0	.844	.0441	.593	.0309	.396	.0197	.186	.0093
4.0	1.178	.0807	.850	.0569	.558	.0370	.282	.0177
4.8	1.798	.1230	1.347	.0879	.939	.0579	.490	.0285
5.0	2.216	.1376	1.759	.0990	1.313	.0658	.810	.0328
5.2	3.499	.1582	3.293	.1172	3.079	.0814	2.818	.0455
5.4	5.621	.1914	5.903	.1505	6.173	.1148	6.419	.0788
5.5	6.936	.2146	7.540	.1752	8.138	.1412	8.728	.1066
5.6	8.308	.2426	9.258	.2062	10.212	.1749	11.174	.1432
5.7	9.567	.2755	10.832	.2431	12.111	.2159	13.409	.1884
5.8	10.527	.3125	12.016	.2852	13.520	.2631	15.045	.2406
5.9	11.188	.3525	12.824	.3309	14.476	.3146	16.148	.2980
6.0	11.495	.3943	13.187	.3787	14.890	.3686	16.606	.3582
6.1	11.418	.4364	13.063	.4270	14.708	.4230	16.354	.4188
6.2	11.040	.4778	12.566	.4742	14.078	.4759	15.577	.4774
6.3	10.467	.5174	11.836	.5191	13.180	.5260	14.500	.5327
6.4	9.774	.5547	10.968	.5610	12.127	.5726	13.251	.5837
6.6	8.239	.6211	9.079	.6349	9.864	.6535	10.602	.6715
6.8	6.794	.6763	7.338	.6951	7.814	.7183	8.237	.7404
7.0	5.622	.7218	5.958	.7438	6.217	.7696	6.425	.7940
7.3	4.315	.7764	4.449	.8010	4.506	.8284	4.519	.8540
7.6	3.340	.8185	3.331	.8437	3.257	.8710	3.151	.8960
8.0	2.424	.8604	2.296	.8844	2.123	.9097	1.937	.9324
8.5	1.726	.8982	1.540	.9192	1.320	.9409	1.114	.9599
9.2	1.174	.9348	.973	.9507	.742	.9665	.545	.9802
10.0	.844	.9642	.637	.9742	.428	.9835	.250	.9919
10.5	.662	.9782	.475	.9844	.301	.9901	.144	.9953
11.2	.335	.9910	.239	.9936	.152	.9960	.072	.9981
12.0	.115	.9971	.082	.9980	.052	.9987	.024	.9994
12.8	.037	.9992	.026	.9994	.017	.9996	.008	.9998
14.5	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 48 hours

Serial No. :	73		74		75		76	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.120	.0008	.090	.0006	.067	.0004	.054	.0003
1.3	.811	.0118	.610	.0088	.464	.0066	.362	.0052
2.0	1.500	.0425	1.155	.0321	.895	.0246	.694	.0191
3.0	2.001	.1083	1.624	.0842	1.278	.0651	1.033	.0512
4.0	2.350	.1888	2.027	.1514	1.692	.1193	1.398	.0955
4.8	2.733	.2635	2.557	.2182	2.291	.1770	1.988	.1442
5.0	2.888	.2843	2.803	.2380	2.595	.1949	2.320	.1599
5.2	3.116	.3065	3.230	.2602	3.203	.2162	3.099	.1797
5.4	3.413	.3306	3.831	.2862	4.107	.2430	4.305	.2068
5.5	3.585	.3436	4.194	.3010	4.670	.2592	5.077	.2241
5.6	3.763	.3572	4.576	.3172	5.272	.2775	5.909	.2443
5.7	3.939	.3714	4.958	.3348	5.877	.2981	6.752	.2677
5.8	4.100	.3863	5.310	.3538	6.437	.3208	7.532	.2940
5.9	4.235	.4017	5.600	.3740	6.892	.3454	8.160	.3229
6.0	4.335	.4176	5.812	.3951	7.221	.3714	8.606	.3538
6.1	4.400	.4338	5.943	.4168	7.419	.3985	8.868	.3860
6.2	4.428	.4501	5.992	.4388	7.486	.4260	8.946	.4189
6.3	4.420	.4665	5.962	.4610	7.427	.4535	8.848	.4517
6.4	4.379	.4828	5.863	.4828	7.257	.4806	8.596	.4839
6.6	4.228	.5146	5.521	.5249	6.702	.5322	7.805	.5444
6.8	4.025	.5452	5.084	.5642	6.017	.5791	6.860	.5986
7.0	3.804	.5742	4.630	.6000	5.322	.6209	5.917	.6456
7.3	3.499	.6147	4.037	.6480	4.446	.6748	4.766	.7044
7.6	3.240	.6521	3.556	.6900	3.765	.7202	3.899	.7521
8.0	2.956	.6979	3.037	.7386	3.053	.7702	3.014	.8028
8.5	2.677	.7499	2.552	.7900	2.425	.8203	2.259	.8508
9.2	2.393	.8153	2.097	.8497	1.881	.8753	1.621	.9002
10.0	2.171	.8827	1.775	.9065	1.512	.9250	1.213	.9413
10.5	1.944	.9212	1.558	.9376	1.273	.9508	1.003	.9618
11.2	1.189	.9625	.942	.9704	.737	.9770	.570	.9823
12.0	.478	.9858	.377	.9889	.293	.9914	.226	.9934
13.0	.142	.9962	.112	.9970	.086	.9977	.066	.9982
15.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 48 hours

Serial No. :	77		78		79		80	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.040	.0002	.027	.0002	.016	.0001	.007	.0000
1.3	.274	.0039	.190	.0027	.112	.0016	.055	.0008
2.0	.528	.0145	.373	.0101	.234	.0061	.112	.0029
3.0	.790	.0389	.555	.0272	.370	.1727	.173	.0082
4.0	1.104	.0732	.793	.0516	.522	.0334	.261	.0160
4.8	1.639	.1125	1.218	.0802	.840	.0526	.437	.0258
5.0	1.977	.1256	1.545	.0901	1.138	.0596	.689	.0296
5.2	2.918	.1434	2.651	.1052	2.395	.0722	2.098	.0394
5.4	4.429	.1702	4.476	.1311	4.524	.0972	4.538	.0632
5.5	5.419	.1882	5.696	.1498	5.972	.1166	6.226	.0830
5.6	6.493	.2102	7.024	.1732	7.558	.1414	8.080	.1093
5.7	7.586	.2362	8.382	.2016	9.183	.1722	9.984	.1426
5.8	8.600	.2660	9.640	.2348	10.691	.2088	11.750	.1825
5.9	9.405	.2991	10.630	.2721	11.865	.2503	13.110	.2282
6.0	9.970	.3348	11.315	.3125	12.668	.2954	14.028	.2781
6.1	10.296	.3722	11.702	.3549	13.112	.3429	14.526	.3306
6.2	10.381	.4102	11.791	.3981	13.198	.3913	14.603	.3842
6.3	10.238	.4482	11.598	.4412	12.948	.4394	14.287	.4373
6.4	9.898	.4853	11.163	.4831	12.407	.4860	13.633	.4887
6.6	8.858	.5545	9.866	.5606	10.836	.5717	11.770	.5823
6.8	7.644	.6154	8.386	.6279	9.075	.6450	9.720	.6613
7.0	6.452	.6671	6.954	.6841	7.390	.7053	7.779	.7253
7.3	5.034	.7302	5.290	.7512	5.473	.7757	5.612	.7984
7.6	3.995	.7799	4.095	.8029	4.128	.8284	4.125	.8519
8.0	2.954	.8308	2.908	.8540	2.810	.8789	2.693	.9014
8.5	2.092	.8764	1.951	.8977	1.772	.9200	1.599	.9396
9.2	1.397	.9206	1.213	.9376	.998	.9546	.812	.9695
10.0	.985	.9550	.791	.9663	.587	.9770	.416	.9866
10.5	.784	.9713	.599	.9791	.422	.9863	.265	.9928
11.2	.425	.9869	.305	.9906	.194	.9941	.093	.9972
12.0	.168	.9951	.120	.9965	.076	.9978	.036	.9990
13.0	.049	.9987	.035	.9991	.022	.9994	.010	.9997
15.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 54 hours

Serial No. :	81		82		83		84	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.087	.0005	.065	.0004	.048	.0003	.039	.0002
1.3	.640	.0089	.481	.0067	.366	.0050	.286	.0039
2.0	1.331	.0349	1.020	.0263	.790	.0201	.612	.0156
3.0	1.897	.0957	1.529	.0742	1.199	.0573	.965	.0450
4.0	2.269	.1730	1.937	.1381	1.601	.1085	1.319	.0867
4.8	2.631	.2451	2.422	.2018	2.141	.1629	1.841	.1323
5.0	2.768	.2650	2.633	.2204	2.398	.1795	2.118	.1468
5.2	2.961	.2862	2.977	.2411	2.876	.1989	2.717	.1644
5.4	3.210	.3090	3.462	.2648	3.589	.2226	3.652	.1877
5.6	3.504	.3338	4.063	.2926	4.502	.2524	4.883	.2191
5.8	3.811	.3609	4.713	.3250	5.516	.2894	6.275	.2602
6.0	4.070	.3901	5.261	.3620	6.370	.3334	7.446	.3110
6.1	4.164	.4054	5.454	.3181	6.666	.3574	7.844	.3392
6.2	4.231	.4209	5.591	.4022	6.873	.3824	8.121	.3686
6.3	4.271	.4366	5.667	.4230	6.986	.4080	8.269	.3989
6.4	4.278	.4524	5.672	.4439	6.982	.4337	8.246	.4293
6.5	4.260	.4682	5.621	.4648	6.891	.4593	8.108	.4594
6.6	4.219	.4839	5.524	.4854	6.732	.4845	7.876	.4889
6.8	4.085	.5147	5.230	.5252	6.262	.5325	7.216	.5446
7.0	3.912	.5443	4.866	.5625	5.697	.5766	6.443	.5950
7.3	3.630	.5862	4.298	.6132	4.840	.6348	5.294	.6597
7.6	3.373	.6250	3.808	.6581	4.130	.6843	4.372	.7129
8.0	3.085	.6727	3.278	.7104	3.392	.7396	3.445	.7703
8.5	2.790	.7270	2.754	.7659	2.695	.7955	2.591	.8256
9.0	2.560	.7764	2.371	.8131	2.218	.8405	2.025	.8678
9.5	2.381	.8220	2.086	.8541	1.880	.8782	1.627	.9013
10.0	2.237	.8647	1.874	.8906	1.632	.9105	1.349	.9286
10.6	1.969	.9119	1.603	.9294	1.335	.9435	1.075	.9554
11.2	1.389	.9496	1.119	.9600	.902	.9684	.718	.9754
12.0	.635	.9787	.504	.9832	.397	.9869	.308	.9899
13.0	.218	.9932	.172	.9946	.134	.9958	.104	.9968
14.0	.071	.9980	.056	.9985	.043	.9988	.033	.9991
16.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 54 hours

Serial No. :	85		86		87		88	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.029	.0002	.019	.0001	.011	.0001	.005	.0000
1.3	.216	.0030	.150	.0020	.088	.0012	.043	.0006
2.0	.466	.0118	.328	.0082	.204	.0049	.098	.0024
3.0	.736	.0342	.517	.0239	.343	.0151	.160	.0072
4.0	1.036	.0664	.742	.0468	.490	.0302	.242	.0144
4.8	1.506	.1029	1.112	.0732	.760	.0479	.394	.0234
5.0	1.786	.1149	1.378	.0822	1.003	.0542	.597	.0268
5.2	2.494	.1304	2.194	.0951	1.916	.0646	1.604	.0345
5.4	3.650	.1528	3.575	.1160	3.512	.0842	3.419	.0525
5.6	5.204	.1853	5.464	.1491	5.730	.1180	5.975	.0868
5.8	6.992	.2302	7.667	.1974	8.350	.1698	9.207	.1419
6.0	8.492	.2876	9.507	.2611	10.530	.2398	11.554	.2182
6.1	8.993	.3198	10.113	.2972	11.237	.2798	12.360	.2622
6.2	9.340	.3535	10.531	.3352	11.722	.3220	12.912	.3087
6.3	9.523	.3883	10.748	.3744	11.972	.3656	13.191	.3567
6.4	9.476	.4233	10.674	.4138	11.860	.4094	13.035	.4049
6.5	9.286	.4578	10.427	.4526	11.551	.4525	12.656	.4521
6.6	8.978	.4914	10.041	.4903	11.079	.4941	12.092	.4976
6.8	8.120	.5545	8.982	.5604	9.805	.5711	10.593	.5812
7.0	7.135	.6107	7.792	.6222	8.398	.6381	8.962	.6531
7.3	5.694	.6813	6.072	.6984	6.386	.7192	6.657	.7386
7.6	4.572	.7377	4.765	.7578	4.894	.7809	4.985	.8022
8.0	3.472	.7967	3.505	.8183	3.484	.8421	3.439	.8637
8.5	2.478	.8511	2.385	.8721	2.250	.8944	2.113	.9142
9.0	1.847	.8904	1.701	.9091	1.521	.9284	1.358	.9453
9.5	1.417	.9203	1.245	.9360	1.044	.9518	.871	.9656
10.0	1.129	.9436	.944	.9560	.744	.9680	.575	.9787
10.6	.866	.9656	.689	.9739	.517	.9818	.366	.9888
11.2	.561	.9814	.432	.9863	.310	.9909	.201	.9951
12.0	.230	.9925	.166	.9946	.105	.9966	.050	.9984
13.0	.077	.9976	.055	.9983	.035	.9989	.017	.9995
14.0	.025	.9993	.018	.9995	.011	.9997	.005	.9999
16.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 60 hours

Serial No. :	89		90		91		92	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.065	.0004	.048	.0003	.036	.0002	.029	.0002
1.3	.506	.0068	.380	.0051	.288	.0038	.226	.0030
2.0	1.164	.0286	.890	.0216	.687	.0164	.533	.0128
3.0	1.785	.0844	1.430	.0652	1.119	.0503	.896	.0394
4.0	2.184	.1580	1.848	.1258	1.515	.0986	1.244	.0786
4.8	2.534	.2276	2.298	.1864	2.008	.1498	1.713	.1214
5.0	2.658	.2468	2.483	.2041	2.229	.1654	1.949	.1348
5.2	2.824	.2670	2.769	.2234	2.617	.1832	2.423	.1508
5.4	3.038	.2887	3.168	.2453	3.189	.2045	3.160	.1712
5.6	3.290	.3121	3.665	.2705	3.929	.2307	4.142	.1980
5.8	3.562	.3374	4.221	.2996	4.777	.2628	5.287	.2327
6.0	3.819	.3648	4.757	.3329	5.606	.3012	6.420	.2760
6.2	4.012	.3938	5.150	.3695	6.204	.3449	7.221	.3264
6.3	4.080	.4088	5.286	.3888	6.411	.3681	7.499	.3535
6.4	4.122	.4239	5.366	.4085	6.526	.3920	7.645	.3815
6.5	4.142	.4392	5.399	.4284	6.570	.4162	7.694	.4097
6.6	4.140	.4546	5.388	.4483	6.544	.4404	7.650	.4380
6.8	4.077	.4850	5.237	.4877	6.293	.4878	7.284	.4932
7.0	3.959	.5148	4.981	.5254	5.890	.5328	6.723	.5449
7.2	3.809	.5435	4.671	.5611	5.415	.5745	6.078	.5921
7.4	3.645	.5711	4.339	.5944	4.912	.6126	5.402	.6344
7.7	3.408	.6102	3.881	.6400	4.242	.6632	4.525	.6892
8.0	3.199	.6469	3.493	.6808	3.698	.7071	3.838	.7353
8.5	2.901	.7032	2.958	.7402	2.976	.7684	2.946	.7974
9.0	2.656	.7546	2.535	.7908	2.430	.8180	2.283	.8453
9.5	2.463	.8019	2.224	.8346	2.055	.8591	1.839	.8830
10.0	2.306	.8460	1.985	.8734	1.769	.8943	1.510	.9138
10.6	2.059	.8948	1.708	.9145	1.456	.9301	1.199	.9437
11.2	1.561	.9354	1.277	.9479	1.055	.9581	.859	.9666
12.0	.806	.9699	.653	.9760	.529	.9810	.424	.9852
13.0	.308	.9891	.245	.9914	.193	.9933	.150	.9948
14.0	.114	.9963	.090	.9971	.070	.9978	.054	.9983
16.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 60 hours

Serial No. :	93		94		95		96	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.022	.0001	.014	.0001	.008	.0000	.004	.0000
1.3	.170	.0023	.118	.0016	.069	.0009	.034	.0004
2.0	.405	.0097	.285	.0067	.176	.0040	.084	.0019
3.0	.683	.0299	.480	.0210	.317	.0132	.148	.0063
4.0	.973	.0602	.695	.0423	.459	.0273	.224	.0130
4.8	1.392	.0942	1.022	.0669	.694	.0437	.357	.0212
5.0	1.627	.1052	1.244	.0751	.895	.0494	.525	.0243
5.2	2.178	.1190	1.865	.0863	1.580	.0582	1.268	.0306
5.4	3.074	.1382	2.921	.1038	2.786	.0741	2.626	.0447
5.6	4.299	.1652	4.394	.1305	4.503	.1007	4.590	.0709
5.8	5.750	.2022	6.161	.1692	6.582	.1413	6.989	.1133
6.0	7.197	.2499	7.936	.2212	8.687	.1976	9.432	.1738
6.2	8.204	.3069	9.151	.2844	10.102	.2670	11.047	.2494
6.3	8.555	.3377	9.578	.3188	10.602	.3050	11.622	.2911
6.4	8.729	.3696	9.779	.3545	10.824	.3445	11.860	.3342
6.5	8.782	.4018	9.835	.3906	10.878	.3844	11.908	.3780
6.6	8.718	.4340	9.750	.4266	10.768	.4242	11.770	.4215
6.8	8.230	.4966	9.138	.4963	10.016	.5008	10.868	.5049
7.0	7.507	.5546	8.255	.5604	8.961	.5707	9.633	.5804
7.2	6.690	.6069	7.272	.6176	7.804	.6324	8.298	.6463
7.4	5.840	.6531	6.254	.6673	6.610	.6854	6.924	.7022
7.7	4.765	.7116	4.994	.7293	5.162	.7502	5.294	.7694
8.0	3.946	.7595	4.055	.7791	4.109	.8012	4.136	.8212
8.5	2.903	.8220	2.874	.8422	2.803	.8640	2.723	.8834
9.0	2.142	.8681	2.027	.8868	1.876	.9065	1.735	.9237
9.5	1.657	.9028	1.510	.9190	1.332	.9356	1.178	.9501
10.0	1.306	.9299	1.136	.9432	.945	.9564	.784	.9680
10.6	.994	.9552	.821	.9647	.647	.9738	.495	.9819
11.2	.693	.9739	.558	.9798	.428	.9855	.312	.9906
12.0	.334	.9887	.261	.9917	.191	.9945	.128	.9970
13.0	.112	.9962	.081	.9972	.051	.9982	.025	.9992
14.0	.040	.9987	.029	.9991	.018	.9994	.009	.9997
16.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 66 hours

Serial No. :	97		98		99		100	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.050	.0003	.037	.0002	.028	.0002	.022	.0001
1.3	.401	.0053	.302	.0040	.229	.0030	.179	.0023
2.0	1.008	.0234	.769	.0177	.593	.0135	.460	.0105
3.0	1.670	.0741	1.330	.0572	1.039	.0441	.828	.0345
4.0	2.095	.1441	1.758	.1143	1.431	.0894	1.171	.0712
4.8	2.438	.2110	2.184	.1720	1.887	.1378	1.599	.1113
5.0	2.553	.2294	2.349	.1888	2.082	.1524	1.803	.1238
5.2	2.701	.2488	2.593	.2070	2.406	.1688	2.193	.1384
5.4	2.887	.2695	2.926	.2273	2.872	.1882	2.781	.1567
5.6	3.106	.2917	3.342	.2505	3.478	.2116	3.572	.1800
5.8	3.348	.3156	3.819	.2769	4.191	.2399	4.520	.2098
6.0	3.589	.3412	4.308	.3070	4.934	.2736	5.521	.2468
6.2	3.796	.3686	4.726	.3404	5.570	.3124	6.377	.2909
6.4	3.942	.3972	5.015	.3765	6.003	.3552	6.952	.3401
6.5	3.987	.4119	5.102	.3952	6.129	.3776	7.114	.3661
6.6	4.015	.4267	5.154	.4141	6.205	.4004	7.211	.3925
6.7	4.023	.4416	5.160	.4332	6.204	.4233	7.197	.4190
6.8	4.014	.4565	5.133	.4522	6.157	.4461	7.125	.4454
7.0	3.951	.4860	4.988	.4897	5.921	.4907	6.787	.4968
7.2	3.846	.5148	4.764	.5257	5.571	.5332	6.305	.5451
7.4	3.716	.5428	4.497	.5600	5.165	.5728	5.756	.5896
7.7	3.502	.5829	4.070	.6074	4.528	.6264	4.910	.6485
8.0	3.297	.6206	3.679	.6504	3.964	.6733	4.181	.6987
8.5	3.001	.6788	3.142	.7132	3.230	.7394	3.266	.7669
9.0	2.752	.7320	2.707	.7671	2.661	.7935	2.570	.8204
9.5	2.545	.7809	2.362	.8138	2.228	.8384	2.048	.8627
10.0	2.379	.8264	2.103	.8549	1.917	.8765	1.688	.8970
10.6	2.143	.8769	1.816	.8985	1.585	.9153	1.339	.9304
11.2	1.708	.9200	1.418	.9346	1.196	.9462	.992	.9562
12.0	.978	.9596	.806	.9672	.669	.9734	.552	.9787
13.0	.410	.9839	.332	.9872	.269	.9898	.215	.9921
14.0	.166	.9939	.132	.9952	.104	.9962	.081	.9971
17.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 66 hours

Serial No. :	101		102		103		104	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.016	.0001	.011	.0001	.006	.0000	.003	.0000
1.3	.135	.0018	.094	.0012	.055	.0007	.027	.0003
2.0	.350	.0079	.246	.0055	.150	.0033	.072	.0016
3.0	.631	.0262	.443	.0183	.291	.0115	.136	.0055
4.0	.913	.0544	.650	.0382	.430	.0246	.209	.0117
4.8	1.292	.0862	.945	.0612	.638	.0399	.326	.0193
5.0	1.493	.0964	1.132	.0687	.806	.0451	.466	.0221
5.2	1.939	.1089	1.627	.0786	1.347	.0527	1.047	.0273
5.4	2.642	.1256	2.441	.0935	2.264	.0659	2.065	.0386
5.6	3.615	.1486	3.597	.1156	3.598	.0873	3.577	.0593
5.8	4.801	.1795	5.028	.1473	5.268	.1198	5.492	.0925
6.0	6.067	.2196	6.568	.1900	7.079	.1653	7.581	.1406
6.2	7.146	.2685	7.876	.2434	8.612	.2234	9.340	.2033
6.4	7.864	.3239	8.740	.3048	9.617	.2907	10.484	.2764
6.5	8.061	.3533	8.972	.3374	9.878	.3266	10.772	.3155
6.6	8.181	.3832	9.116	.3707	10.044	.3632	10.959	.3555
6.7	8.151	.4133	9.068	.4042	9.970	.4000	10.854	.3956
6.8	8.052	.4431	8.942	.4373	9.814	.4364	10.664	.4351
7.0	7.608	.5009	8.392	.5012	9.146	.5063	9.871	.5108
7.2	6.991	.5547	7.645	.5604	8.257	.5704	8.836	.5797
7.4	6.301	.6037	6.818	.6136	7.288	.6276	7.722	.6406
7.7	5.246	.6674	5.567	.6818	5.833	.6998	6.063	.7163
8.0	4.361	.7203	4.535	.7375	4.654	.7575	4.744	.7757
8.5	3.282	.7902	3.309	.8090	3.291	.8298	3.259	.8484
9.0	2.480	.8429	2.412	.8612	2.306	.8808	2.204	.8981
9.5	1.893	.8828	1.768	.8993	1.610	.9164	1.472	.9313
10.0	1.506	.9139	1.356	.9278	1.183	.9418	1.037	.9541
10.6	1.143	.9431	.980	.9535	.809	.9636	.662	.9726
11.2	.821	.9648	.680	.9717	.543	.9784	.420	.9844
12.0	.452	.9832	.371	.9869	.293	.9904	.224	.9936
13.0	.168	.9940	.130	.9956	.093	.9971	.059	.9985
14.0	.060	.9978	.044	.9984	.028	.9990	.013	.9995
17.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 72 hours

Serial No. :	105		106		107		108	
Q_1/Q_{10} :	0.2		0.3		0.4		0.5	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.039	.0002	.029	.0002	.022	.0001	.017	.0001
1.3	.321	.0042	.241	.0031	.183	.0023	.143	.0018
2.0	.867	.0193	.660	.0146	.508	.0111	.395	.0086
3.0	1.552	.0650	1.230	.0500	.959	.0385	.762	.0302
4.0	2.001	.1311	1.668	.1037	1.349	.0810	1.101	.0644
4.8	2.345	.1953	2.076	.1586	1.777	.1266	1.497	.1021
5.0	2.452	.2130	2.226	.1745	1.950	.1403	1.676	.1137
5.2	2.587	.2317	2.438	.1917	2.226	.1556	2.001	.1272
5.4	2.753	.2514	2.725	.2107	2.620	.1735	2.492	.1437
5.6	2.946	.2725	3.078	.2322	3.123	.1946	3.136	.1643
5.8	3.161	.2951	3.487	.2564	3.721	.2198	3.919	.1903
6.0	3.383	.3193	3.923	.2838	4.372	.2497	4.785	.2224
6.2	3.591	.3451	4.338	.3143	5.000	.2843	5.629	.2608
6.4	3.755	.3723	4.658	.3476	5.477	.3230	6.257	.3047
6.6	3.863	.4006	4.866	.3829	5.782	.3646	6.655	.3524
6.7	3.895	.4149	4.923	.4010	5.862	.3861	6.755	.3771
6.8	3.911	.4294	4.948	.4192	5.894	.4078	6.790	.4021
6.9	3.912	.4438	4.943	.4375	5.879	.4295	6.762	.4271
7.0	3.899	.4583	4.908	.4557	5.819	.4511	6.672	.4518
7.2	3.838	.4869	4.772	.4915	5.601	.4933	6.364	.5000
7.5	3.689	.5288	4.460	.5428	5.121	.5528	5.712	.5669
8.0	3.378	.5942	3.844	.6195	4.210	.6388	4.508	.6610
8.5	3.088	.6540	3.303	.6853	3.454	.7091	3.550	.7347
9.0	2.840	.7088	2.866	.7422	2.874	.7673	2.836	.7934
9.5	2.628	.7593	2.507	.7918	2.418	.8160	2.284	.8404
10.0	2.450	.8062	2.220	.8353	2.064	.8572	1.863	.8783
10.6	2.222	.8583	1.925	.8813	1.719	.8990	1.491	.9153
11.2	1.836	.9037	1.551	.9200	1.337	.9330	1.131	.9444
12.0	1.142	.9478	.954	.9570	.804	.9644	.673	.9708
13.0	.523	.9774	.435	.9816	.365	.9851	.305	.9880
14.0	.229	.9906	.185	.9925	.150	.9941	.119	.9954
15.0	.098	.9963	.078	.9971	.062	.9977	.048	.9983
17.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

Table 21.10.--(Continued)

T_c = 72 hours

Serial No. :	109		110		111		112	
Q_1/Q_{10} :	0.6		0.7		0.8		0.9	
Time	PSH	PSMC	PSH	PSMC	PSH	PSMC	PSH	PSMC
days	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}	cfs/AQ_{10}	Q/Q_{10}
0	0	0	0	0	0	0	0	0
.6	.013	.0001	.009	.0000	.005	.0000	.002	.0000
1.3	.108	.0014	.075	.0010	.044	.0006	.021	.0003
2.0	.300	.0065	.210	.0045	.128	.0027	.062	.0013
3.0	.581	.0229	.408	.0160	.266	.0100	.125	.0048
4.0	.856	.0492	.608	.0345	.402	.0222	.194	.0105
4.8	1.202	.0789	.876	.0559	.590	.0364	.299	.0176
5.0	1.378	.0884	1.037	.0629	.733	.0412	.419	.0201
5.2	1.744	.0997	1.437	.0717	1.164	.0478	.877	.0245
5.4	2.324	.1146	2.103	.0847	1.910	.0590	1.701	.0338
5.6	3.106	.1345	3.019	.1034	2.956	.0768	2.874	.0505
5.8	4.072	.1609	4.171	.1298	4.288	.1033	4.388	.0771
6.0	5.156	.1948	5.478	.1653	5.814	.1405	6.136	.1157
6.2	6.221	.2368	6.771	.2104	7.334	.1889	7.888	.1673
6.4	7.001	.2856	7.705	.2638	8.413	.2469	9.111	.2299
6.6	7.491	.3391	8.290	.3228	9.085	.3114	9.867	.2999
6.7	7.610	.3669	8.427	.3536	9.237	.3451	10.032	.3365
6.8	7.647	.3950	8.467	.3847	9.275	.3792	10.065	.3734
6.9	7.604	.4231	8.411	.4157	9.200	.4132	9.969	.4102
7.0	7.483	.4508	8.258	.4464	9.010	.4467	9.739	.4465
7.2	7.083	.5046	7.767	.5055	8.420	.5109	9.044	.5157
7.5	6.257	.5784	6.775	.5860	7.251	.5976	7.693	.6082
8.0	4.767	.6797	5.015	.6942	5.213	.7118	5.380	.7278
8.5	3.622	.7563	3.698	.7735	3.728	.7930	3.742	.8104
9.0	2.792	.8151	2.765	.8327	2.699	.8518	2.632	.8686
9.5	2.166	.8606	2.075	.8770	1.950	.8943	1.839	.9095
10.0	1.700	.8958	1.568	.9101	1.411	.9247	1.275	.9376
10.6	1.311	.9290	1.161	.9401	1.001	.9511	.863	.9609
11.2	.962	.9540	.822	.9619	.683	.9695	.559	.9764
12.0	.561	.9762	.470	.9806	.381	.9849	.301	.9887
13.0	.253	.9906	.212	.9927	.172	.9947	.136	.9965
14.0	.092	.9966	.069	.9975	.047	.9984	.027	.9992
15.0	.036	.9987	.026	.9991	.016	.9994	.008	.9997
17.0	0	1.0000	0	1.0000	0	1.0000	0	1.0000

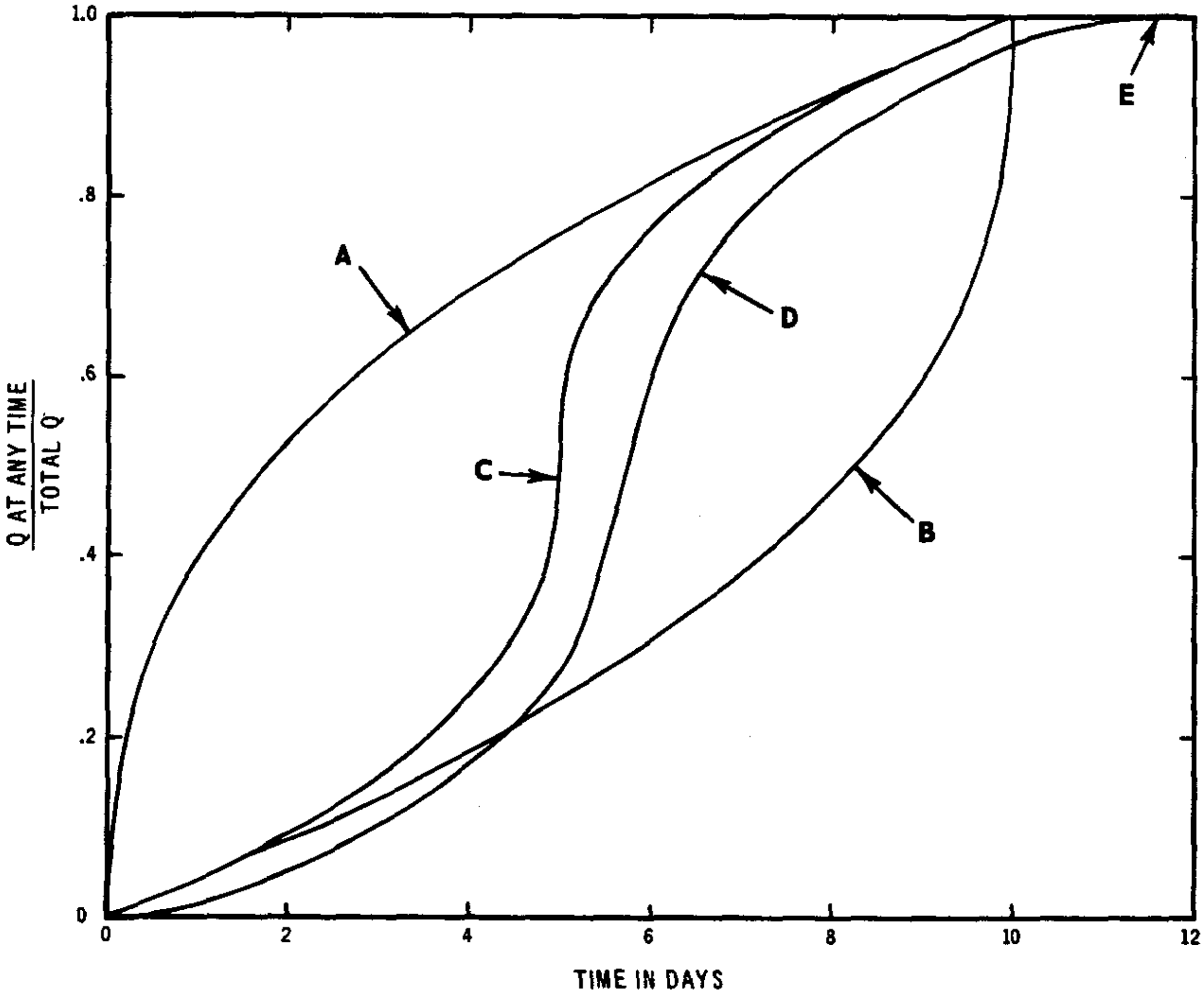
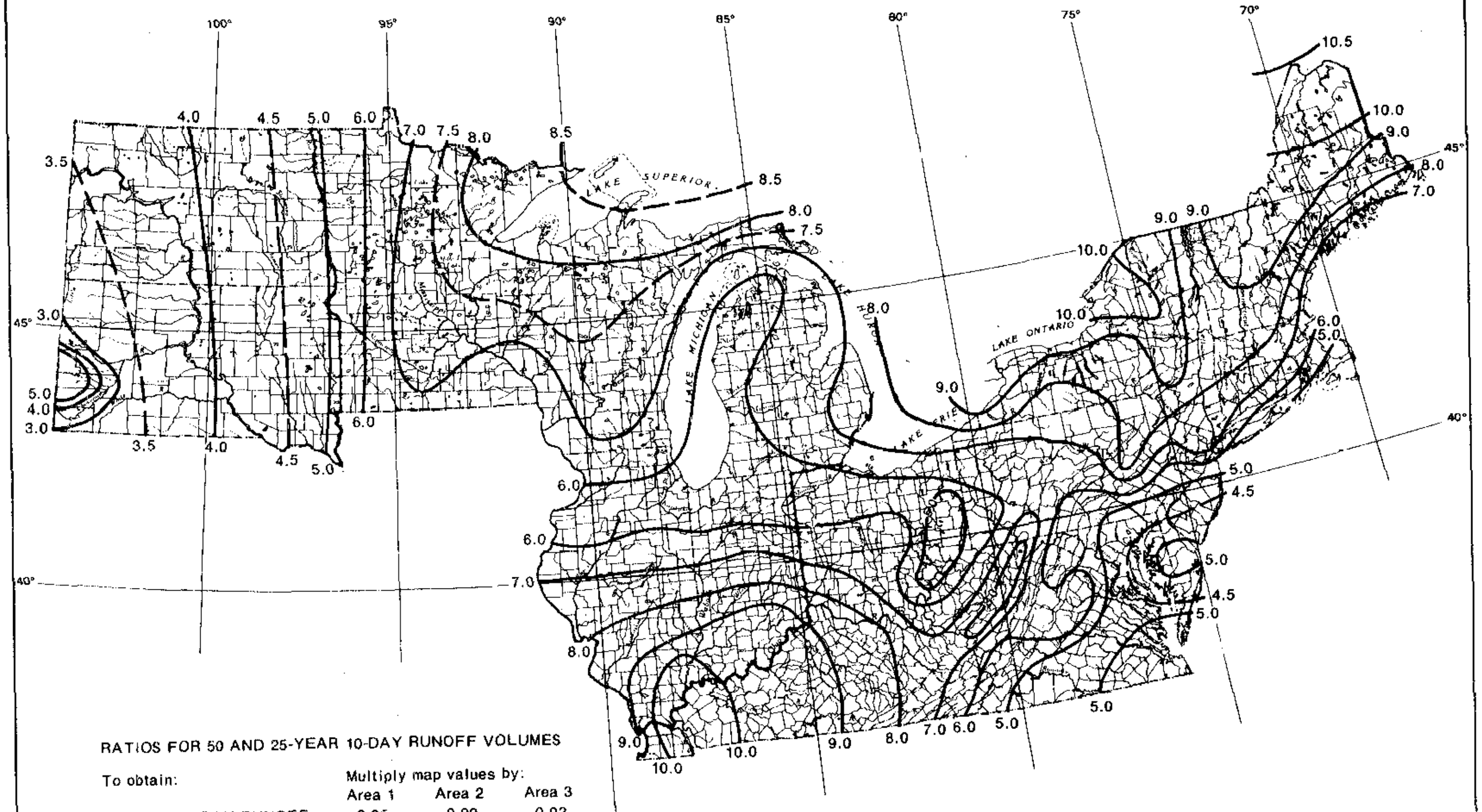


FIGURE 21.1 - Mass curves of runoff in various arrangements.



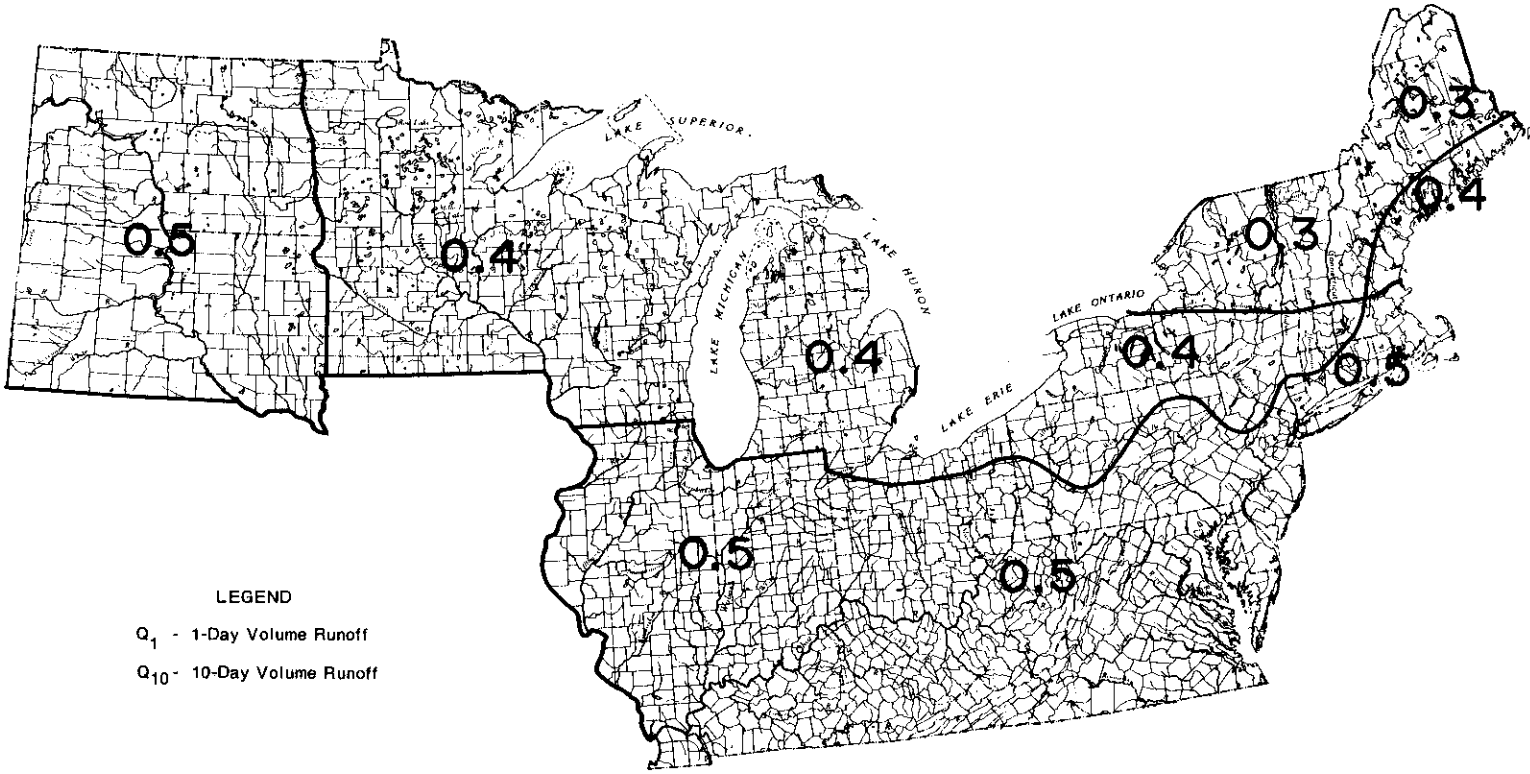
RATIOS FOR 50 AND 25-YEAR 10-DAY RUNOFF VOLUMES

To obtain:	Multiply map values by: Area 1	Area 2	Area 3
50-YEAR 10-DAY RUNOFF	0.85	0.90	0.92
25-YEAR 10-DAY RUNOFF	0.70	0.80	0.85

FIGURE 2-1 (A)

100-YEAR, 10-DAY RUNOFF (INCHES)

PRINCIPAL SPILLWAY HYDROGRAPH



LEGEND

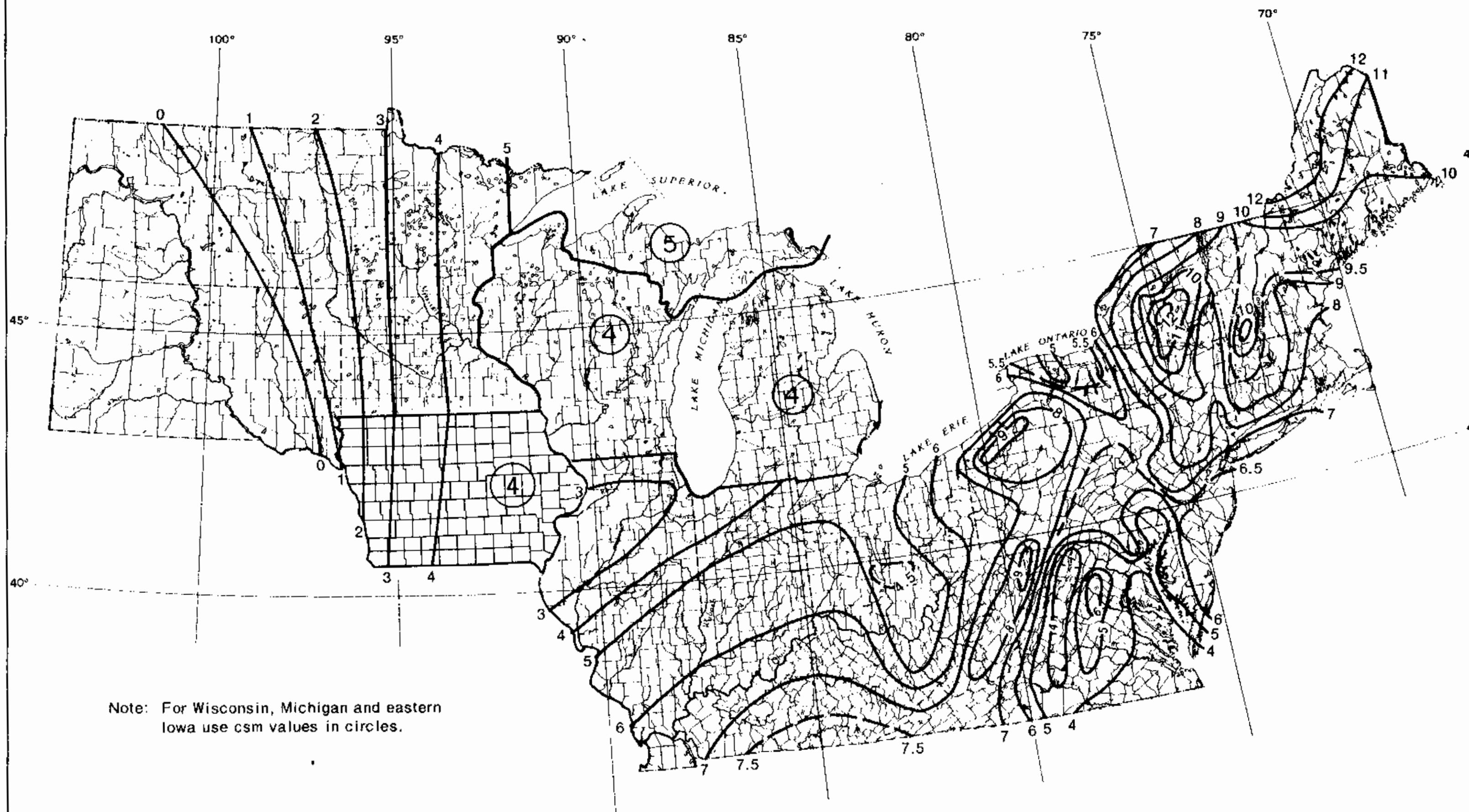
Q_1 - 1-Day Volume Runoff

Q_{10} - 10-Day Volume Runoff

FIGURE 2-1 (B)

RATIOS OF VOLUMES OF RUNOFF (Q_1/Q_{10})

PRINCIPAL SPILLWAY HYDROGRAPH



Note: For Wisconsin, Michigan and eastern Iowa use csm values in circles.

FIGURE 2-1 (C)

QUICK RETURN FLOW (csm)

PRINCIPAL SPILLWAY HYDROGRAPH

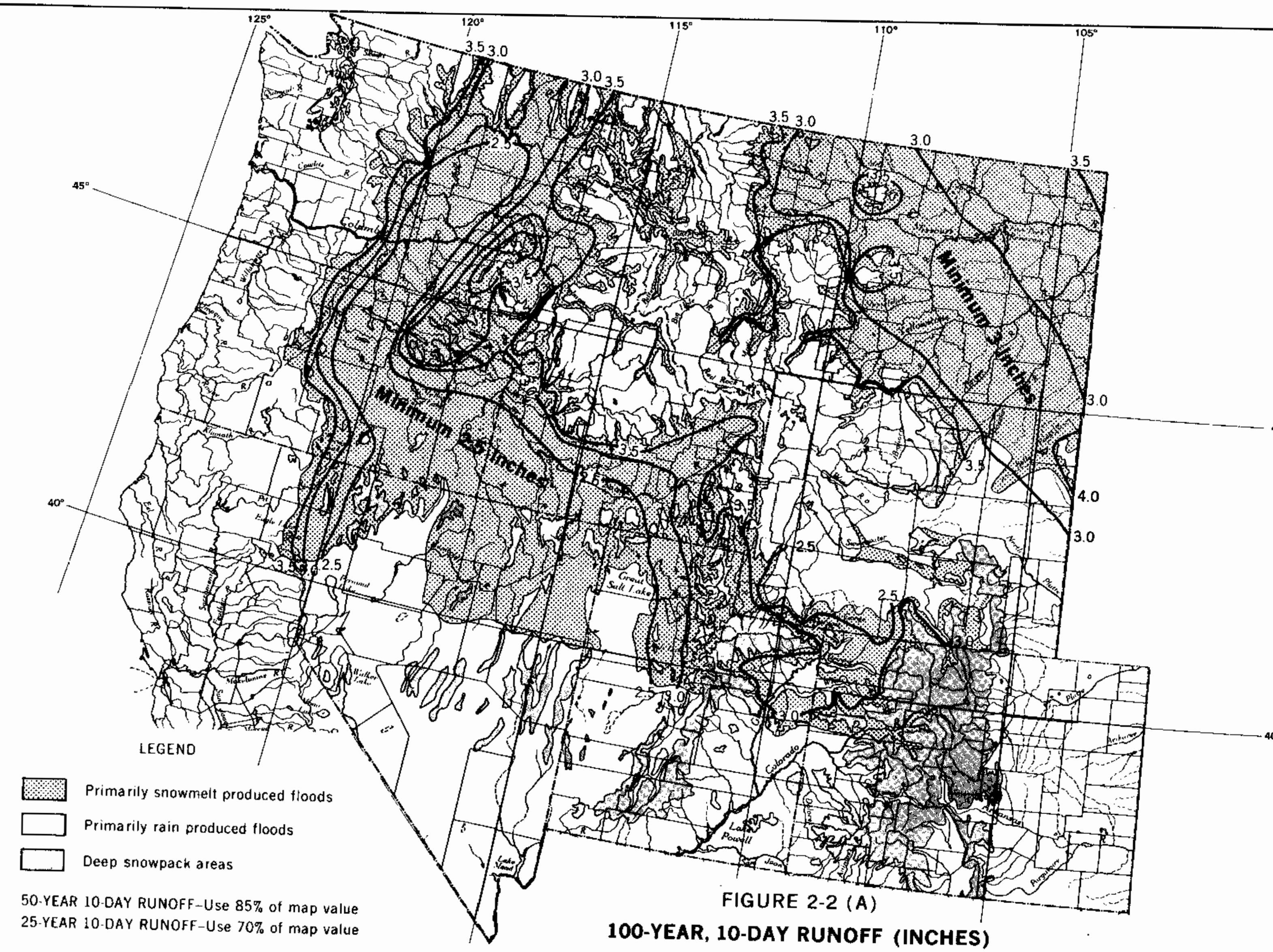


FIGURE 2-2 (A)

100-YEAR, 10-DAY RUNOFF (INCHES)

PRINCIPAL SPILLWAY HYDROGRAPH SNOWMELT PRODUCING FLOOD AREAS

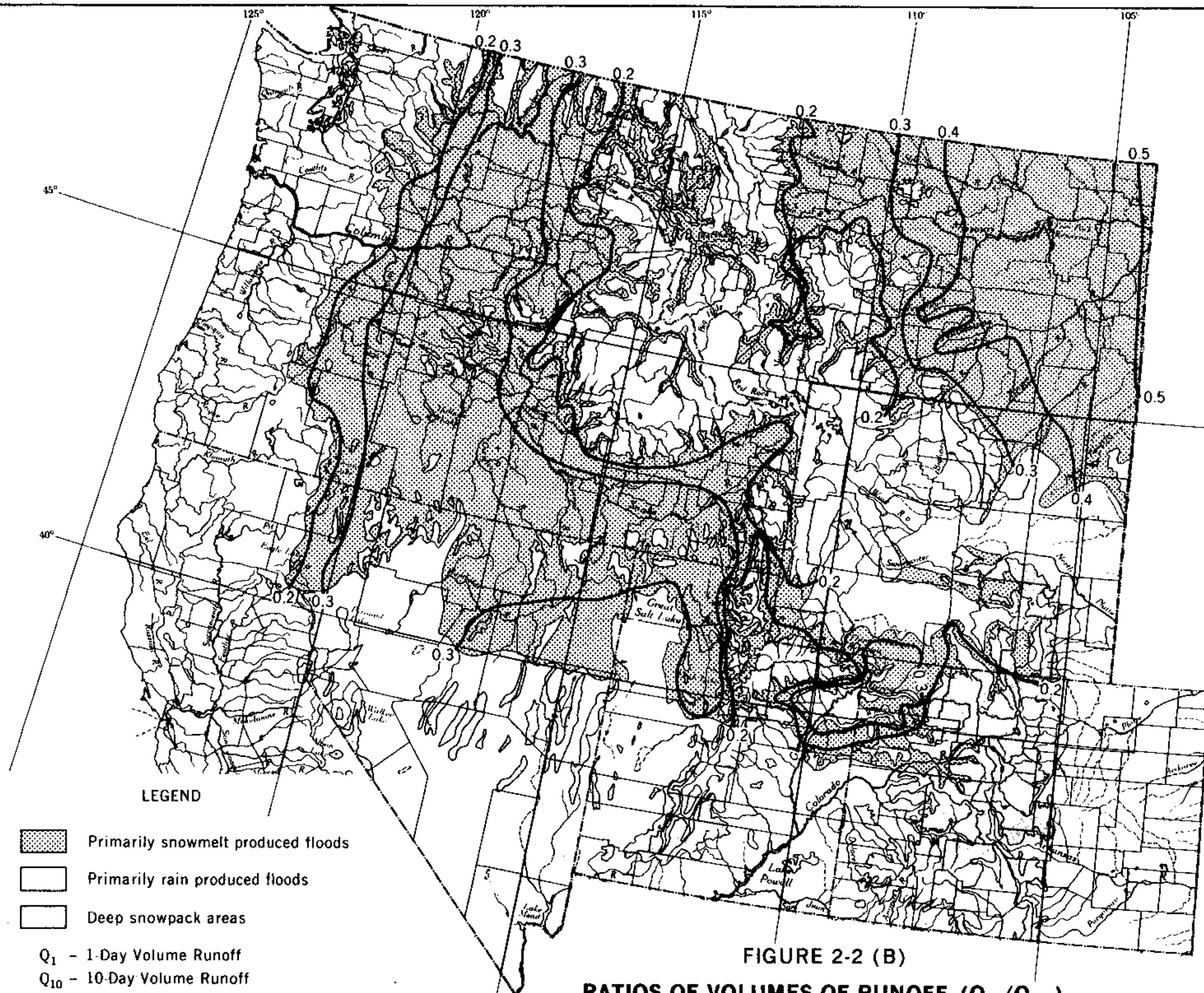


FIGURE 2-2 (B)

RATIOS OF VOLUMES OF RUNOFF (Q_1/Q_{10})

PRINCIPAL SPILLWAY HYDROGRAPH SNOWMELT PRODUCING FLOOD AREAS

JANUARY 1971, REV. APRIL 1976

Emergency Spillways 1/

Flows larger than those completely controllable by the principal spillway and retarding storage are safely conveyed past an earth dam by an emergency spillway. The emergency spillway is designed by use of an Emergency Spillway Hydrograph (ESH) and its minimum freeboard determined by use of a Freeboard Hydrograph (FH). Both kinds of hydrographs are constructed by the same procedure. There is a small difference in that procedure depending on whether a watershed's time of concentration is or is not over six hours.

This part of the chapter presents a manual method of developing ESH and FH. The method requires the use of the dimensionless hydrographs given in table 21.17. Methods of routing the ESH or FH through structures are given in chapter 17.

Alternatives to developing and routing the hydrographs manually are (i) use of the SCS electronic computer program, in which basic data are input and the ESH or FH, the routed hydrograph, and reservoir elevations are output; and (ii) the Upper Darby or UD method, in which no hydrograph is needed but which uses the hydrograph characteristics of ESH or FH in an indirect routing procedure with results in terms of spillway elevation and capacity.

The hydrologic criteria given below apply to the manual method and its alternatives. The examples that follow apply only to the manual method.

Hydrologic Criteria

SOURCE OF DESIGN STORM RAINFALL AMOUNT. The basic 6-hour design storm rainfall amount used in development of ESH and FH is taken from one of the following maps:

1/ Background information on the material in this part of the chapter is given in "Central Technical Unit Method of Hydrograph Development," by M. H. Kleen and R. G. Andrews, Transactions, American Society of Agricultural Engineers, vol. 5, no. 2, p. 180-185, 1962; and in "Hydrology of Spillway Design: Small Structures - Limited Data," by Harold O. Ogrosky, paper no. 3914, Proceedings, American Society of Civil Engineers, Journal of the Hydraulics Division, May 1964.

ES-1020, 5 sheets. 48 contiguous States. Supplementary sheets for California and Washington-Oregon are also given.

ES-1021, 5 sheets. Hawaii.

ES-1022, 5 sheets. Alaska.

ES-1023, 5 sheets. Puerto Rico.

ES-1024, 5 sheets. Virgin Islands.

The rainfall amounts on these maps are minimums allowed by SCS criteria for various classes of structures.

DURATION ADJUSTMENT OF RAINFALL AMOUNT. If the time of concentration of the drainage area above a structure is more than six hours, the duration of the design storm is made equal to that time and the rainfall amount is increased using a factor from figure 21.2, part (c).

AREAL ADJUSTMENT OF RAINFALL AMOUNT. If the drainage area above a structure is 10 square miles or less, the areal rainfall is the same as the rainfall taken from the maps of ES-1020 through 1024. If the area is over 10 square miles but not over 100 square miles, the areal rainfall is obtained by use of a factor from figure 21.2, part (a). If the area is over 100 square miles, the adjustment factor for the area is requested from the Engineering Division, Washington, D. C. When a request is submitted, the following information about the area should also be submitted: (1) location, preferably the latitude and longitude of the watershed outlet; (2) size in square miles; (3) length in miles, following the main valley; (4) time of concentration in hours; (5) runoff curve number; (6) proposed value of the adjustment or adjustment factor. If a factor is also needed for a subwatershed of that watershed, then similar information about the subwatershed should also be submitted.

RUNOFF DETERMINATION. Runoff is determined using the methods of chapter 10. The runoff curve number (CN) for the drainage area above a structure is determined by any of the methods in chapter 10. This CN must be for antecedent moisture condition II or greater and it applies throughout the design storm regardless of the storm duration.

DIMENSIONLESS HYDROGRAPHS. The ESH and FH are made using the dimensionless hydrographs given in table 21.17. If a hydrograph is to be developed in an electronic computer program, then the storm distribution given in figure 21.2.b (ES-1003-b) must be used to get an equivalent ESH or FH.

Construction of Emergency Spillway and Freeboard Hydrographs

Two examples of hydrograph construction are given. The first illustrates the procedure when the watershed time of concentration is not over six hours, the second when it is. There is no difference in procedure for ESH and FH. Equations used in the examples are listed in table 21.11.

Example 21.5.--Construct an ESH for a class (b) structure with a drainage area of 1.86 square miles, time of concentration of 1.25 hours, CN of 82, and location at latitude____, longitude____.

1. Determine the 6-hour design storm rainfall amount, P. For this structure class the ESH rainfall amount is taken from ES-1020, sheet 2 of 5. For the given location the map shows that P = 9.4 inches.

2. Determine the areal rainfall amount. The areal rainfall is the same as in step 1 because the drainage area is not over 10 square miles. Step 2 of example 21.6 shows the process.

3. *Make the duration adjustment of rainfall amount. No adjustment is made because the time of concentration is not over six hours.* Step 3 of example 21.6 shows the process.

4. Determine the runoff amount, Q. Enter figure 10.1 with P = 9.4 inches and CN = 82 and find Q = 7.21 inches.

5. Determine the hydrograph family. Enter figure 21.3 (ES-1011) with CN = 82 and at P = 9.4 read hydrograph family 2.

6. Determine the duration of excess rainfall, T_o. Enter figure 21.4 (ES-1012) with P = 9.4 inches and at CN = 82 read by interpolation that T_o = 5.37 hours.

7. Compute the initial value of T_p. By equation 21.4 this is 0.7(1.25) = 0.88 hours.

8. Compute the T_o/T_p ratio. This is 5.37/0.88 = 6.10.

9. Select a revised T_o/T_p ratio from table 21.16. This table shows the hydrograph families and ratios for which dimensionless hydrographs are given in table 21.17. Enter table 21.16 with the ratio from step 8 and select the tabulated ratio nearest it. For this example the selected ratio, (T_o/T_p)rev., is 6.

10. Compute Rev. T_p. This is a revised T_p used because of the change in ratio. By equation 21.5, Rev. T_p = 5.37/6 = 0.895 hours.

11. Compute q_p. By equation 21.6 this is 484(1.86)/0.895 = 1006 cfs.

12. Compute Q_{qp}. Using the Q from step 4 and the q_p from step 11 gives $Q(q_p)$ = 7.21(1006) = 7253.26 cfs. Round to 7250 cfs.

13. Compute the times for which hydrograph rates will be computed. In equation 21.7 use Rev. T_p from step 10 and the entries in the t/T_p column of the selected hydrograph in table 21.17. The computed times are shown in column 2 of table 21.12.

Table 21.11--Equations used in construction of ESH and FH

Equation	No.
$T_p = 0.7\ T_c$	21.4
$\text{Rev. } T_p = \dfrac{T_o}{(T_o/T_p)_{rev.}}$	21.5
$q_p = \dfrac{484\ A}{\text{Rev. } T_p}$	21.6
$t = (t/T_p)\ (\text{Rev. } T_p)$	21.7
$q = (q_c/q_p)\ Q_{q_p}$	21.8

where

A = drainage area in square miles

q = hydrograph rate in cfs

q_c = hydrograph rate in cfs when $Q = 1$ inch

q_p = hydrograph peak rate in cfs when $Q = 1$ inch

Q = design storm runoff in inches

Rev. T_p = revised time to peak in hours

t = time in hours at which hydrograph rate is computed

T_c = time of concentration in hours

T_o = duration of excess rainfall in hours

$(T_o/T_p)_{rev.}$ = revised ratio from table 21.16

T_p = time to peak in hours for CTU design hydrographs

14. Compute the hydrograph rates. Use equation 21.8 and the q_c/q_p column of the selected hydrograph in table 21.17. The computed rates are shown in column 3 of table 21.12.

The hydrograph is completed with step 14. How the hydrograph is further retabulated or plotted for routing through the spillway depends on the routing method to be used. See chapter 17 for routing details.

The mass curve for the hydrograph can be obtained using the Q_t/Q column of the selected hydrograph in table 21.17. Ratios in that column are multiplied by the Q of step 4 to give accumulated runoff in inches at the time computed in step 13. For accumulated runoff in acre-feet or another unit, convert Q to the desired unit before making the series of multiplications.

In the following example the storm duration is increased because the time of concentration is over six hours. Increasing the duration also requires increasing the rainfall amount but if the drainage area is over 10 square miles the increase is partly offset by the decrease in areal rainfall.

Example 21.6.--Construct a FH for a class (c) structure with a drainage area of 23.0 square miles, time of concentration of 10.8 hours, CN of 77, and location at latitude____, longitude____.

1. Determine the 6-hour design storm rainfall amount, P. For this structure class the FH rainfall amount is taken from ES-1020, sheet 5 of 5. For the given location the map shows that P = 25.5 inches.

2. Determine the areal rainfall amount. Use the appropriate curve on figure 21.2.a (ES-1003-a). For this location the "Humid and subhumid climate" curve applies and the adjustment factor for the drainage area of 23.0 square miles is 0.93. The adjusted rainfall is 0.93(25.5) = 23.72 inches.

3. Make the duration adjustment of rainfall amount. The duration is made equal to the time of concentration, in this case, 10.8 hours. Enter figure 21.2.c (ES-1003-c) with the duration of 10.8 hours and find an adjustment factor of 1.18. The adjusted rainfall is 1.18(23.72) = 27.99 inches. It is rounded to 28.0 inches for the remainder of this example.

4. Determine the runoff amount, Q. Enter figure 10.1 with the rainfall from step 3 (P = 28.0 inches) and at CN = 77 find Q = 24.7 inches.

5. Determine the hydrograph family. Enter figure 21.3 (ES-1011) with CN = 77 and at P = 28.0 inches read hydrograph family 1.

6. Determine the duration of excess rainfall, T_o. Enter table 21.14 with CN = 77 and find that P*, the rainfall prior to the excess rainfall, is 0.60 inches. Enter table 21.15 with the ratio P*/P = 0.60/28.0 = 0.0214 and by interpolation read a time ratio of 0.950. Then T_o = (time ratio) x (storm duration) = 0.950(10.8) = 10.26 hours.

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HYDROGRAPH COMPUTATION

DATE ~~~
COMPUTED BY ~~~
CHECKED BY ~~~

WATERSHED OR PROJECT (EXAMPLE 21.5)

STATE ~~~

STRUCTURE SITE OR SUBAREA ~~~

DR. AREA 1.86 SQ. MI. STRUCTURE CLASS b

T_c 1.25 HR. STORM DURATION 6 HR.

POINT RAINFALL 9.4 IN.

ADJUSTED RAINFALL:

AREAL : FACTOR 1.0 IN. 9.4

DURATION : FACTOR 1.0 IN. 9.4

RUNOFF CURVE NO. 82

Q 7.21 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 0.88 HR.

T_o 5.37 HR.

(T_o / T_p): COMPUTED 6.10 ; USED 6

REVISED T_p 0.895

$q_p = \frac{484A}{\text{REV. } T_p}$ = 1006 CFS.

$(Q)(q_p)$ = 7250 CFS.

t(COLUMN) = (t/T_p) REV. T_p q(COLUMN) = $(q_c/q_p)(Q)(q_p)$

Q(COLUMN) = $(Q_t/Q)Q$

	$t=(t/T_p)\text{Rev. } T_p$	$q=(q_c/q_p)(Q)(q_p)$	$Q_t=(Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2	.30	7	
3	.61	36	
4	.91	109	
5	1.22	268	
6	1.52	710	
7	1.82	1769	
8	2.13	2951	
9	2.43	3364	
10	2.74	3110	
11	3.04	2661	
12	3.35	2240	
13	3.65	1892	
14	3.96	1624	
15	4.26	1399	
16	4.56	1225	
17	4.87	1102	
18	5.17	1008	
19	5.48	935	
20	5.78	819	
21	6.09	616	
22	6.39	399	
23	6.69	254	
24	7.00	145	
25	7.30	87	
26	7.61	58	
27	7.91	36	
28	8.22	29	
29	8.52	22	
30	8.82	14	
31	9.13	7	
32	9.43	0	
33			
34			

Table 21.12 Hydrograph computation

7. Compute the initial value of T_p. By equation 21.4 this is 0.7(10.8) = 7.56 hours.

8. Compute the T_o/T_p ratio. This is 10.26/7.56 = 1.357.

9. Select a revised T_o/T_p ratio from table 21.16. Enter table 21.16 with the ratio from step 8 and select the tabulated ratio nearest it. For this example the selected ratio, (T_o/T_p)rev., is 1.5.

10. Compute Rev. T_p. This is a revised T_p used because of the change in ratio. By equation 21.5, Rev. T_p = 10.26/1.5 = 6.84 hours.

11. Compute q_p. By equation 21.6 this is 484(23.0)/6.84 = 1627.5 cfs. Round to 1628 cfs.

12. Compute Qq_p. Using the Q from step 4 and the q_p from step 11 gives $Q(q_p)$ = 24.7(1628) = 40,211.6 cfs. Round to 40,212 cfs.

13. Compute the times for which hydrograph rates will be computed. Use equation 21.7 with the Rev. T_p from step 10 and the entries in the t/T_p column of the selected hydrograph in table 21.17. The computed rates are shown in column 2 of table 21.13.

14. Compute the hydrograph rates. Use equation 21.8 with Qq_p of step 12 and the q_c/q_p column of the selected hydrograph in table 21.17. The computed rates are shown in column 3 of table 21.13.

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HYDROGRAPH COMPUTATION

DATE ______
COMPUTED BY ______
CHECKED BY ______

WATERSHED OR PROJECT (EXAMPLE 21.6)

STATE ______

STRUCTURE SITE OR SUBAREA ______

DR. AREA 23.0 SQ. MI. STRUCTURE CLASS C

T_c 10.8 HR. STORM DURATION 10.8 HR.

POINT RAINFALL 25.5 IN.

ADJUSTED RAINFALL:

AREAL : FACTOR .93 IN. 23.72

DURATION : FACTOR 1.18 IN. 27.99

RUNOFF CURVE NO. 77

Q 24.7 IN.

HYDROGRAPH FAMILY NO. 1

COMPUTED T_p 7.56 HR.

T_o 10.26 HR.

(T_o / T_p):

COMPUTED 1.357 ; USED 1.5

REVISED T_p 6.84

$q_p = \frac{484A}{\text{REV. } T_p}$ = 1628 CFS.

$(Q)(q_p)$ = 40,212 CFS.

t(COLUMN) = (t / T_p) REV. T_p q(COLUMN) = $(q_c / q_p)(Q)(q_p)$

Q(COLUMN) = $(Q_t / Q)Q$

	$t=(t/T_p)$Rev. T_p	$q=(q_c/q_p)(Q)(q_p)$	$Q_t=(Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2	2.19	482	
3	4.38	4745	
4	6.57	15160	
5	8.76	28591	
6	10.94	32773	
7	13.13	28912	
8	15.32	21152	
9	17.51	14155	
10	19.70	9048	
11	21.89	5750	
12	24.08	3619	
13	26.26	2292	
14	28.45	1488	
15	30.64	965	
16	32.83	603	
17	35.02	322	
18	37.21	161	
19	39.40	80	
20	41.59	40	
21	43.78	0	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			

Table 21.13 Hydrograph computation.

Table 21.14.--Rainfall prior to excess rainfall.

CN	P* (inches)	CN	P* (inches)	CN	P* (inches)	CN	P* (inches)	CN	P* (inches)
100	0	86	0.33	72	0.78	58	1.45	44	2.54
99	.02	85	.35	71	.82	57	1.51	43	2.64
98	.04	84	.38	70	.86	56	1.57	42	2.76
97	.06	83	.41	69	.90	55	1.64	41	2.88
96	.08	82	.44	68	.94	53	1.70	40	3.00
95	.11	81	.47	67	.98	53	1.77	39	3.12
94	.13	80	.50	66	1.03	52	1.85	38	3.26
93	.15	79	.53	65	1.08	51	1.92	37	3.40
92	.17	78	.56	64	1.12	50	2.00	36	3.56
91	.20	77	.60	63	1.17	49	2.08	35	3.72
90	.22	76	.63	62	1.23	48	2.16	34	3.88
89	.25	75	.67	61	1.28	47	2.26	33	4.06
88	.27	74	.70	60	1.33	46	2.34	32	4.24
87	.30	73	.74	59	1.39	45	2.44	31	4.44

Table 21.15.--Rainfall and time ratios for determining T_o when the storm duration is greater than 6 hours.

Rain-fall ratio	Time ratio	Rain-fall ratio	Time ratio	Rain-fall ratio	Time ratio	Rain-fall ratio	Time ratio
0	1.000	0.070	0.852	0.140	0.746	0.210	0.684
.002	.995	.072	.848	.142	.744	.212	.682
.004	.990	.074	.844	.144	.742	.214	.680
.006	.985	.076	.841	.146	.740	.216	.679
.008	.981	.078	.837	.148	.739	.218	.677
.010	.976	.080	.833	.150	.737	.220	.675
.012	.971	.082	.830	.152	.735	.222	.673
.014	.967	.084	.827	.154	.733	.224	.672
.016	.962	.086	.824	.156	.732	.226	.670
.018	.957	.088	.821	.158	.730	.228	.668
.020	.952	.090	.818	.160	.728	.230	.667
.022	.948	.092	.815	.162	.726	.232	.666
.024	.943	.094	.812	.164	.724	.234	.666
.026	.938	.096	.809	.166	.723	.236	.665
.028	.933	.098	.806	.168	.721	.238	.665
.030	.929	.100	.803	.170	.719	.240	.664
.032	.924	.102	.800	.172	.717		
.034	.919	.104	.797	.174	.716	(Change in tabulation increment.)	
.036	.915	.106	.794	.176	.714		
.038	.911	.108	.791	.178	.712		
.040	.908	.110	.788	.180	.710	.250	.662
.042	.904	.112	.785	.182	.709	.300	.651
.044	.900	.114	.782	.184	.707	.350	.640
.046	.896	.116	.779	.186	.705	.400	.628
.048	.893	.118	.776	.188	.703	.450	.617
.050	.889	.120	.773	.190	.702	.500	.606
.052	.885	.122	.770	.192	.700	.550	.595
.054	.882	.124	.767	.194	.698	.600	.583
.056	.878	.126	.764	.196	.696	.650	.542
.058	.874	.128	.761	.198	.695	.700	.500
.060	.870	.130	.758	.200	.693	.750	.447
.062	.867	.132	.755	.202	.691	.800	.386
.064	.863	.134	.751	.204	.689	.850	.310
.066	.859	.136	.749	.206	.687	.900	.220
.068	.856	.138	.747	.208	.686	.950	.116

Table 21.16.--Hydrograph families and T_o/T_p ratios for which dimensionless hydrograph ratios are given in table 21.17

Hydrograph	T_o/T_p											
Family	1	1.5	2	3	4	6	10	16	25	36	50	75
1	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*	*	
5	*	*	*	*	*	*	*	*	*	*	*	

Asterisks signify that dimensionless hydrograph tabulations are given in table 21.17.

Table 21.17 --Time, discharge, and accumulated runoff ratios for dimensionless hydrographs

Hydrograph Family 1

Line No.	$T_o/T_p = 1$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 1.5$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 2$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.28	.029	.003	.32	.012	.001	.29	.007	.001
3	.56	.150	.021	.64	.118	.017	.58	.035	.005
4	.84	.472	.086	.96	.377	.075	.87	.164	.027
5	1.12	.798	.216	1.28	.711	.204	1.16	.432	.090
6	1.40	.901	.392	1.60	.815	.384	1.45	.669	.208
7	1.68	.776	.564	1.92	.719	.565	1.74	.740	.359
8	1.96	.568	.703	2.24	.526	.712	2.03	.680	.511
9	2.24	.389	.801	2.56	.352	.815	2.32	.561	.644
10	2.52	.258	.868	2.88	.225	.884	2.61	.441	.751
11	2.80	.173	.913	3.20	.143	.927	2.90	.319	.833
12	3.08	.115	.942	3.52	.090	.954	3.19	.212	.890
13	3.36	.078	.962	3.84	.057	.972	3.48	.140	.927
14	3.64	.052	.976	4.16	.037	.983	3.77	.094	.952
15	3.92	.036	.985	4.48	.024	.990	4.06	.063	.969
16	4.20	.024	.991	4.80	.015	.995	4.35	.042	.981
17	4.48	.016	.995	5.12	.008	.997	4.64	.028	.988
18	4.76	.009	.997	5.44	.004	.999	4.93	.017	.993
19	5.04	.005	.999	5.76	.002	1.000	5.22	.011	.996
20	5.32	.002	1.000	6.08	.001	1.000	5.51	.007	.998
21	5.60	.001	1.000	6.40	0	1.000	5.80	.004	.999
22	5.88	0	1.000				6.09	.002	1.000
23							6.38	.001	1.000
24							6.67	0	1.000

Table 21.17 (Continued) Hydrograph Family 1

	$T_o/T_p = 3$			$T_o/T_p = 4$			$T_o/T_p = 6$		
Line No.	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.35	.005	.001	.35	.003	.000	.44	.003	.001
3	.70	.027	.005	.70	.015	.003	.98	.018	.003
4	1.05	.101	.021	1.05	.049	.011	1.32	.041	.012
5	1.40	.302	.074	1.40	.122	.033	1.76	.084	.032
6	1.75	.563	.185	1.75	.298	.087	2.20	.176	.074
7	2.10	.650	.342	2.10	.528	.194	2.64	.386	.165
8	2.45	.576	.501	2.45	.585	.337	3.08	.497	.309
9	2.80	.460	.635	2.80	.518	.479	3.52	.430	.459
10	3.15	.374	.743	3.15	.413	.599	3.96	.335	.583
11	3.50	.290	.829	3.50	.334	.695	4.40	.258	.679
12	3.85	.201	.892	3.85	.273	.774	4.84	.202	.754
13	4.20	.127	.935	4.20	.231	.839	5.28	.164	.813
14	4.55	.078	.961	4.55	.185	.892	5.72	.139	.862
15	4.90	.047	.977	4.90	.128	.933	6.16	.124	.905
16	5.25	.028		5.25	.080	.959	6.60	.100	.941
17	5.60	.016	.993	5.60	.047	.976	7.04	.060	.967
18	5.95	.009	.996	5.95	.028	.985	7.48	.033	.982
19	6.30	.005	.998	6.30	.017	.991	7.92	.018	.991
20	6.65	.003	.999	6.65	.010	.995	8.36	.009	.995
21	7.00	.002	.999	7.00	.006	.997	8.80	.005	.997
22	7.35	.001	1.000	7.35	.004	.998	9.24	.003	.999
23	7.70	0	1.000	7.70	.003	.999	9.68	.002	.999
24				8.05	.002	1.000	10.12	.001	1.000
25				8.40	.001	1.000	10.56	0	1.000
26				8.75	0	1.000			

Table 21.17 (Continued) Hydrograph Family 1

	$T_o/T_p = 10$			$T_o/T_p = 16$			$T_o/T_p = 25$		
Line No.	t/T_p	q_c/q_p	Qt/Q	t/T_p	q_c/q_p	Qt/Q	t/T_p	q_c/q_p	Qt/Q
1	0	0	0	0	0	0	0	0	0
2	.56	.002	.000	.66	.001	.000	1.22	.002	.001
3	1.12	.013	.004	1.32	.006	.002	2.44	.009	.006
4	1.68	.027	.012	1.98	.015	.007	3.66	.018	.018
5	2.24	.047	.027	2.64	.027	.017	4.88	.027	.038
6	2.80	.071	.052	3.30	.037	.033	6.10	.036	.067
7	3.36	.115	.090	3.96	.047	.053	7.32	.046	.103
8	3.92	.278	.172	4.62	.062	.080	8.54	.116	.176
9	4.48	.394	.312	5.28	.092	.117	9.76	.232	.333
10	5.04	.322	.461	5.94	.223	.194	10.98	.146	.503
11	5.60	.235	.577	6.60	.309	.323	12.20	.088	.608
12	6.16	.174	.662	7.26	.243	.457	13.42	.062	.675
13	6.72	.136	.726	7.92	.171	.557	14.64	.051	.726
14	7.28	.110	.777	8.58	.124	.629	15.86	.045	.769
15	7.84	.092	.819	9.24	.097	.683	17.08	.039	.807
16	8.40	.079	.855	9.90	.081	.726	18.30	.035	.840
17	8.96	.073	.886	10.56	.070	.763	19.52	.031	.870
18	9.52	.068	.916	11.22	.061	.794	20.74	.027	.896
19	10.08	.065	.943	11.88	.055	.823	21.96	.025	.920
20	10.64	.053	.968	12.54	.050	.848	23.18	.025	.942
21	11.20	.027	.984	13.20	.047	.872	24.40	.025	.965
22	11.76	.012	.993	13.86	.045	.894	25.62	.020	.985
23	12.32	.006	.996	14.52	.044	.916	26.84	.005	.996
24	12.88	.003	.998	15.18	.043	.937	28.06	.002	.999
25	13.44	.002	.999	15.84	.040	.957	29.28	0	1.000
26	14.00	.001	1.000	16.50	.034	.975			
27	14.56	0	1.000	17.16	.020	.988			
28				17.82	.008	.995			
29				18.48	.004	.998			
30				19.14	.002	.999			
31				19.80	.001	1.000			
32				20.46	0	1.000			

Table 21.17 (Continued)

Hydrograph Family 1

Line No.	$T_o/T_p = 36$ t/Tp	qc/qp	Qt/Q	$T_o/T_p = 50$ t/Tp	qc/qp	Qt/Q	$T_o/T_p = 75$ t/Tp	qc/qp	Qt/Q
1	0	0	0	0	0	0	0	0	0
2	1.70	.002	.001	2.00	.0019	.001	3.00	.0017	.002
3	3.40	.008	.008	4.00	.0052	.007	6.00	.0039	.008
4	5.10	.014	.021	6.00	.0085	.017	9.00	.0054	.018
5	6.80	.020	.043	8.00	.0118	.031	12.00	.0084	.033
6	8.50	.026	.072	10.00	.0151	.051	15.00	.0106	.053
7	10.20	.033	.109	12.00	.0192	.076	18.00	.0137	.079
8	11.90	.077	.178	14.00	.0259	.109	21.00	.0197	.115
9	13.60	.177	.338	16.00	.0578	.170	24.00	.0516	.192
10	15.30	.101	.513	18.00	.1330	.310	27.00	.0900	.344
11	17.00	.058	.613	20.00	.0941	.475	30.00	.0593	.504
12	18.70	.044	.678	22.00	.0506	.581	33.00	.0321	.602
13	20.40	.036	.728	24.00	.0357	.644	36.00	.0226	.661
14	22.10	.030	.770	26.00	.0297	.692	39.00	.0188	.705
15	23.80	.027	.805	28.00	.0254	.732	42.00	.0161	.742
16	25.50	.024	.838	30.00	.0219	.766	45.00	.0142	.775
17	27.20	.022	.867	32.00	.0192	.797	48.00	.0125	.804
18	28.90	.020	.893	34.00	.0172	.823	51.00	.0112	.829
19	30.60	.018	.917	36.00	.0159	.847	54.00	.0105	.852
20	32.30	.017	.939	38.00	.0150	.870	57.00	.0100	.874
21	34.00	.017	.960	40.00	.0145	.891	60.00	.0097	.896
22	35.70	.017	.982	42.00	.0140	.912	63.00	.0094	.916
23	37.40	.004	.995	44.00	.0136	.932	66.00	.0090	.936
24	39.10	.002	.999	46.00	.0131	.952	69.00	.0087	.955
25	40.80	0	1.000	48.00	.0125	.971	72.00	.0084	.973
26				50.00	.0123	.989	75.00	.0081	.991
27				52.00	.0016	.999	78.00	.0002	1.000
28				54.00	0	1.000	81.00	0	1.000

Table 21.17 (Continued)

Hydrograph Family 2

Line No.	$T_o/T_p = 1$			$T_o/T_p = 1.5$			$T_o/T_p = 2$		
	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.28	.026	.003	.22	.003	.000	.28	.004	.000
3	.56	.170	.023	.44	.041	.004	.56	.040	.005
4	.84	.480	.091	.66	.161	.020	.84	.170	.027
5	1.12	.802	.224	.88	.362	.063	1.12	.428	.089
6	1.40	.885	.399	1.10	.604	.142	1.40	.645	.200
7	1.68	.770	.571	1.32	.740	.251	1.68	.715	.340
8	1.96	.550	.708	1.54	.790	.375	1.96	.677	.484
9	2.24	.380	.804	1.76	.746	.501	2.24	.574	.614
10	2.52	.257	.870	1.98	.640	.613	2.52	.472	.722
11	2.80	.166	.914	2.20	.536	.709	2.80	.369	.809
12	3.08	.113	.943	2.42	.414	.786	3.08	.247	.873
13	3.36	.078	.963	2.64	.303	.845	3.36	.168	.915
14	3.64	.052	.976	2.86	.219	.887	3.64	.113	.945
15	3.92	.034	.985	3.08	.160	.918	3.92	.075	.964
16	4.20	.023	.991	3.30	.117	.941	4.20	.050	.977
17	4.48	.015	.995	3.52	.088	.947	4.48	.034	.986
18	4.76	.009	.998	3.74	.064	.970	4.76	.021	.991
19	5.04	.004	.999	3.96	.047	.979	5.04	.014	.995
20	5.32	.002	1.000	4.18	.035	.985	5.32	.008	.997
21	5.60	.001	1.000	4.40	.025	.990	5.60	.004	.998
22	5.88	0	1.000	4.62	.018	.994	5.88	.003	.999
23				4.84	.012	.996	6.16	.002	1.000
24				5.06	.007	.998	6.44	.001	1.000
25				5.28	.004	.999	6.72	0	1.000
26				5.50	.003	.999			
27				5.72	.002	1.000			
28				5.94	.001	1.000			
29				6.16	0	1.000			

Table 21.17 (Continued) Hydrograph Family 2

	$T_o/T_p = 3$			$T_o/T_p = 4$			$T_o/T_p = 6$		
Line No.	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.32	.003	.000	.32	.002	.000	.34	.001	.000
3	.64	.017	.003	.64	.009	.002	.68	.005	.001
4	.96	.093	.016	.96	.036	.007	1.02	.015	.003
5	1.28	.311	.064	1.28	.129	.026	1.36	.037	.010
6	1.60	.530	.163	1.60	.332	.081	1.70	.098	.027
7	1.92	.615	.298	1.92	.501	.179	2.04	.244	.070
8	2.24	.575	.439	2.24	.550	.303	2.38	.407	.151
9	2.56	.487	.565	2.56	.500	.426	2.72	.464	.261
10	2.88	.409	.671	2.88	.422	.535	3.06	.429	.373
11	3.20	.344	.760	3.20	.358	.627	3.40	.367	.473
12	3.52	.279	.834	3.52	.302	.705	3.74	.309	.557
13	3.84	.206	.891	3.84	.274	.773	4.08	.261	.629
14	4.16	.135	.931	4.16	.230	.832	4.42	.224	.690
15	4.48	.087	.958	4.48	.195	.882	4.76	.193	.742
16	4.80	.054	.974	4.80	.147	.922	5.10	.169	.787
17	5.12	.032	.984	5.12	.099	.951	5.44	.152	.828
18	5.44	.019	.990	5.44	.061	.970	5.78	.139	.864
19	5.76	.012	.994	5.76	.037	.982	6.12	.129	.898
20	6.08	.008	.997	6.08	.023	.989	6.46	.113	.928
21	6.40	.005	.998	6.40	.013	.993	6.80	.085	.953
22	6.72	.003	.999	6.72	.008	.996	7.14	.055	.971
23	7.04	.002	1.000	7.04	.005	.997	7.48	.035	.982
24	7.36	.001	1.000	7.36	.004	.998	7.82	.020	.989
25	7.68	0	1.000	7.68	.003	.999	8.16	.012	.993
26				8.00	.002	1.000	8.50	.008	.995
27				8.32	.001	1.000	8.84	.005	.997
28				8.64	0	1.000	9.18	.004	.998
29							9.52	.003	.999
30							9.86	.002	.999
31							10.20	.001	1.000
32							10.54	0	1.000

Table 21.17 (Continued) Hydrograph Family 2

Line No.	$T_o/T_p = 10$ t/Tp	qc/qp	Qt/Q	$T_o/T_p = 16$ t/Tp	qc/qp	Qt/Q	$T_o/T_p = 25$ t/Tp	qc/qp	Qt/Q
1	0	0	0	0	0	0	0	0	0
2	.63	.002	.000	.90	.002	.001	1.30	.002	.001
3	1.26	.009	.003	1.80	.007	.004	2.60	.006	.005
4	1.89	.027	.011	2.70	.020	.013	3.90	.014	.014
5	2.52	.063	.032	3.60	.037	.031	5.20	.024	.032
6	3.15	.236	.102	4.50	.148	.093	6.50	.088	.086
7	3.78	.364	.241	5.40	.277	.233	7.80	.210	.228
8	4.41	.307	.397	6.30	.214	.396	9.10	.146	.397
9	5.04	.226	.521	7.20	.149	.516	10.40	.097	.513
10	5.67	.172	.613	8.10	.112	.603	11.70	.072	.593
11	6.30	.136	.685	9.00	.088	.669	13.00	.057	.655
12	6.93	.113	.743	9.90	.073	.722	14.30	.049	.705
13	7.56	.097	.792	10.80	.063	.767	15.60	.044	.750
14	8.19	.085	.834	11.70	.056	.807	16.90	.039	.789
15	8.82	.078	.872	12.60	.052	.842	18.20	.035	.824
16	9.45	.074	.907	13.50	.048	.875	19.50	.033	.857
17	10.08	.069	.940	14.40	.045	.906	20.80	.031	.887
18	10.71	.053	.969	15.30	.044	.936	22.10	.029	.916
19	11.34	.025	.987	16.20	.042	.964	23.40	.028	.943
20	11.97	.009	.995	17.10	.023	.986	24.70	.027	.969
21	12.60	.004	.998	18.00	.006	.995	26.00	.014	.989
22	13.23	.002	.999	18.90	.003	.998	27.30	.004	.997
23	13.86	.001	1.000	19.80	.001	1.000	28.60	.001	1.000
24	14.49	0	1.000	20.70	0	1.000	29.90	0	1.000

Table 21.17 (Continued) Hydrograph Family 2

Line No.	$T_o/T_p = 36$			$T_o/T_p = 50$			$T_o/T_p = 75$		
	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	1.79	.002	.001	2.50	.0018	.002	3.00	.0012	.001
3	3.58	.006	.007	5.00	.0047	.008	6.00	.0027	.006
4	5.37	.012	.019	7.50	.0087	.020	9.00	.0044	.014
5	7.16	.019	.039	10.00	.0145	.041	12.00	.0067	.026
6	8.95	.057	.909	12.50	.0615	.111	15.00	.0108	.045
7	10.74	.157	.232	15.00	.1184	.276	18.00	.0309	.091
8	12.53	.104	.405	17.50	.0621	.442	21.00	.0790	.213
9	14.32	.068	.519	20.00	.0433	.539	24.00	.0624	.369
10	16.11	.047	.596	22.50	.0342	.611	27.00	.0357	.478
11	17.90	.040	.653	25.00	.0274	.667	30.00	.0283	.548
12	19.69	.034	.703	27.50	.0234	.714	33.00	.0234	.606
13	21.48	.030	.745	30.00	.0209	.755	36.00	.0196	.653
14	23.27	.026	.782	32.50	.0187	.791	39.00	.0167	.693
15	25.06	.025	.816	35.00	.0167	.824	42.00	.0150	.728
16	26.85	.023	.848	37.50	.0159	.854	45.00	.0137	.760
17	28.64	.021	.877	40.00	.0153	.882	48.00	.0126	.789
18	30.43	.020	.904	42.50	.0147	.910	51.00	.0115	.816
19	32.22	.019	.930	45.00	.0142	.936	54.00	.0108	.840
20	34.01	.018	.955	47.50	.0136	.962	57.00	.0104	.864
21	35.80	.017	.978	50.00	.0131	.986	60.00	.0101	.886
22	37.59	.007	.994	52.50	.0008	.999	63.00	.0098	.908
23	39.38	.001	.999	55.00	0	1.000	66.00	.0095	.930
24	41.17	0	1.000				69.00	.0092	.950
25							72.00	.0089	.970
26							75.00	.0086	.990
27							78.00	.0003	1.000
28							81.00	0	1.000

Table 21.17 (Continued)

Hydrograph Family 3

Line No.	$T_o/T_p = 1$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 1.5$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 2$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.26	.048	.005	.29	.028	.003	.30	.012	.001
3	.52	.219	.030	.58	.190	.026	.60	.123	.016
4	.78	.521	.101	.87	.450	.094	.90	.343	.068
5	1.04	.762	.224	1.16	.656	.212	1.20	.570	.169
6	1.30	.844	.378	1.45	.734	.360	1.50	.657	.304
7	1.56	.778	.533	1.74	.685	.511	1.80	.630	.447
8	1.82	.621	.668	2.03	.585	.646	2.10	.562	.578
9	2.08	.441	.769	2.32	.445	.756	2.40	.484	.694
10	2.34	.305	.841	2.61	.350	.841	2.70	.379	.789
11	2.60	.214	.891	2.90	.199	.899	3.00	.267	.861
12	2.86	.149	.925	3.19	.132	.934	3.30	.177	.910
13	3.12	.103	.949	3.48	.089	.958	3.60	.116	.942
14	3.38	.070	.966	3.77	.057	.973	3.90	.076	.964
15	3.64	.048	.977	4.06	.038	.983	4.20	.050	.977
16	3.90	.034	.985	4.35	.025	.990	4.50	.033	.987
17	4.16	.024	.991	4.64	.015	.994	4.80	.020	.992
18	4.42	.016	.995	4.93	.008	.997	5.10	.011	.996
19	4.68	.010	.997	5.22	.005	.998	5.40	.006	.998
20	4.94	.006	.999	5.51	.003	.999	5.70	.004	.999
21	5.20	.003	1.000	5.80	.002	1.000	6.00	.002	1.000
22	5.46	.001	1.000	6.09	.001	1.000	6.30	.001	1.000
23	5.72	0	1.000	6.38	0	1.000	6.60	0	1.000

Table 21.17 (Continued) Hydrograph Family 3

	$T_o/T_p = 3$			$T_o/T_p = 4$			$T_o/T_p = 6$		
Line No.	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.34	.004	.001	.36	.003	.000	.42	.002	.000
3	.68	.088	.012	.72	.044	.007	.84	.021	.004
4	1.02	.289	.059	1.08	.203	.040	1.26	.138	.029
5	1.36	.489	.157	1.44	.400	.120	1.68	.320	.100
6	1.70	.543	.286	1.80	.478	.237	2.10	.390	.210
7	2.04	.507	.418	2.16	.450	.360	2.52	.363	.327
8	2.38	.445	.537	2.52	.397	.473	2.94	.314	.432
9	2.72	.385	.641	2.88	.342	.572	3.36	.270	.522
10	3.06	.340	.732	3.24	.296	.656	3.78	.232	.600
11	3.40	.294	.811	3.60	.257	.730	4.20	.199	.667
12	3.74	.223	.876	3.96	.234	.795	4.62	.174	.725
13	4.08	.149	.922	4.32	.210	.855	5.04	.155	.776
14	4.42	.096	.953	4.68	.169	.905	5.46	.144	.822
15	4.76	.056	.972	5.04	.111	.942	5.88	.137	.866
16	5.10	.033	.983	5.40	.067	.966	6.30	.127	.907
17	5.44	.019	.990	5.76	.037	.980	6.72	.101	.942
18	5.78	.013	.994	6.12	.022	.988	7.14	.063	.968
19	6.12	.008	.996	6.48	.014	.993	7.56	.033	.983
20	6.46	.004	.998	6.84	.008	.995	7.98	.018	.991
21	6.80	.003	.999	7.20	.006	.997	8.40	.010	.995
22	7.14	.002	.999	7.56	.004	.999	8.82	.005	.997
23	7.48	.001	1.000	7.92	.002	.999	9.24	.003	.998
24	7.82	0	1.000	8.28	.001	1.000	9.66	.002	.999
25				8.64	0	1.000	10.08	.001	1.000
26							10.50		1.000
27							10.92	0	1.000

Table 21.17(Continued) Hydrograph Family 3

Line No.	$T_o/T_p = 10$ t/T_p	qc/qp	Qt/Q	$T_o/T_p = 16$ t/T_p	qc/qp	Qt/Q	$T_o/T_p = 25$ t/T_p	qc/qp	Qt/Q
1	0	0	0	0	0	0	0	0	0
2	.54	.001	.000	.90	.002	.001	1.23	.002	.001
3	1.08	.008	.002	1.80	.016	.007	2.46	.009	.006
4	1.62	.069	.017	2.70	.122	.053	3.69	.073	.043
5	2.16	.231	.077	3.60	.230	.170	4.92	.173	.154
6	2.70	.303	.184	4.50	.185	.308	6.15	.132	.291
7	3.24	.269	.298	5.40	.139	.415	7.38	.096	.394
8	3.78	.223	.396	6.30	.113	.499	8.61	.076	.471
9	4.32	.188	.478	7.20	.094	.568	9.84	.064	.534
10	4.86	.159	.548	8.10	.081	.626	11.07	.055	.588
11	5.40	.139	.607	9.00	.072	.677	12.30	.050	.635
12	5.94	.122	.659	9.90	.064	.722	13.53	.046	.678
13	6.48	.108	.705	10.80	.057	.762	14.76	.042	.718
14	7.02	.097	.746	11.70	.053	.799	15.99	.038	.754
15	7.56	.089	.783	12.60	.050	.833	17.22	.035	.787
16	8.10	.081	.817	13.50	.049	.866	18.45	.033	.818
17	8.64	.078	.849	14.40	.048	.898	19.68	.032	.947
18	9.18	.077	.880	15.30	.047	.930	20.91	.031	.875
19	9.72	.077	.911	16.20	.046	.961	22.14	.031	.903
20	10.26	.075	.941	17.10	.024	.984	23.37	.031	.931
21	10.80	.055	.967	18.00	.006	.994	24.60	.031	.959
22	11.34	.030	.984	18.90	.004	.997	25.83	.025	.984
23	11.88	.012	.992	19.80	.002	.999	27.06	.004	.997
24	12.42	.006	.996	20.70	0	1.000	28.29	.001	1.000
25	12.96	.004	.998				29.52	0	1.000
26	13.50	.002	.999						
27	14.04	.001	1.000						
28	14.58	0	1.000						

Table 21.17 (Continued)

Hydrograph Family 3

Line No.	$T_o/T_p = 36$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 50$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 75$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	1.62	.002	.001	2.25	.0008	.001	3.25	.0009	.001
3	3.24	.006	.006	4.50	.0070	.007	6.50	.0057	.009
4	4.86	.047	.037	6.75	.0474	.052	9.75	.0289	.051
5	6.48	.130	.143	9.00	.0972	.173	13.00	.0667	.166
6	8.10	.097	.277	11.25	.0642	.307	16.25	.0445	.299
7	9.72	.069	.376	13.50	.0460	.399	19.50	.0317	.391
8	11.34	.052	.448	15.75	.0375	.469	22.75	.0257	.460
9	12.96	.045	.505	18.00	.0322	.527	26.00	.0219	.517
10	14.58	.041	.551	20.25	.0285	.577	29.25	.0195	.567
11	16.20	.037	.603	22.50	.0258	.622	32.50	.0176	.612
12	17.82	.034	.645	24.75	.0239	.664	35.75	.0160	.652
13	19.44	.031	.683	27.00	.0219	.702	39.00	.0147	.689
14	21.06	.028	.719	29.25	.0201	.737	42.25	.0136	.723
15	22.68	.025	.750	31.50	.0185	.769	45.50	.0127	.755
16	24.30	.024	.779	33.75	.0173	.799	48.75	.0118	.784
17	25.92	.024	.808	36.00	.0165	.829	52.00	.0113	.812
18	27.54	.024	.836	38.25	.0162	.854	55.25	.0109	.839
19	29.16	.024	.865	40.50	.0159	.881	58.50	.0107	.865
20	30.78	.023	.893	42.75	.0156	.907	61.75	.0105	.890
21	32.40	.023	.920	45.00	.0153	.933	65.00	.0103	.915
22	34.02	.023	.947	47.25	.0150	.958	68.25	.0101	.940
23	35.64	.023	.974	49.50	.0147	.983	71.50	.0099	.964
24	37.26	.007	.992	51.75	.0028	.998	74.75	.0097	.988
25	38.88	.003	.998	54.00	0	1.000	78.00	.0003	1.000
26	40.50	0	1.000				81.25	0	1.000

Table 21.17 (Continued)

Hydrograph Family 4

Line No.	$T_o/T_p = 1$			$T_o/T_p = 1.5$			$T_o/T_p = 2$		
	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.28	.051	.005	.28	.038	.004	.32	.031	.004
3	.56	.220	.033	.56	.166	.025	.64	.173	.028
4	.84	.490	.107	.84	.360	.079	.96	.360	.091
5	1.12	.738	.234	1.12	.551	.174	1.28	.494	.191
6	1.40	.830	.397	1.40	.651	.298	1.60	.555	.315
7	1.68	.751	.560	1.68	.686	.436	1.92	.567	.447
8	1.96	.573	.697	1.96	.650	.575	2.24	.555	.580
9	2.24	.392	.797	2.24	.543	.698	2.56	.490	.703
10	2.52	.259	.865	2.52	.392	.795	2.88	.370	.805
11	2.80	.174	.910	2.80	.267	.863	3.20	.242	.877
12	3.08	.118	.940	3.08	.180	.909	3.52	.150	.923
13	3.36	.079	.960	3.36	.120	.940	3.84	.098	.952
14	3.64	.053	.974	3.64	.081	.961	4.16	.063	.971
15	3.92	.036	.983	3.92	.055	.975	4.48	.038	.983
16	4.20	.025	.990	4.20	.036	.984	4.80	.024	.991
17	4.48	.017	.994	4.48	.024	.991	5.12	.013	.995
18	4.76	.011	.997	4.76	.015	.995	5.44	.008	.997
19	5.04	.006	.999	5.04	.009	.997	5.76	.004	.999
20	5.32	.003	.999	5.32	.005	.999	6.08	.002	.999
21	5.60	.001	1.000	5.60	.003	.999	6.40	.001	1.000
22	5.88	0	1.000	5.88	.001	1.000	6.72	0	1.000
23				6.16	0	1.000			

Table 21.17 (Continued) Hydrograph Family 4

Line No.	$T_o/T_p = 3$ t/T_p	q_c/q_p	Qt/Q	$T_o/T_p = 4$ t/T_p	q_c/q_p	Qt/Q	$T_o/T_p = 6$ t/T_p	q_c/q_p	Qt/Q
1	0	0	0	0	0	0	0	0	0
2	.28	.018	.002	.40	.023	. 03	.40	.014	.002
3	.56	.086	.013	.80	.143	.028	.80	.088	.017
4	.84	.200	.042	1.20	.272	.089	1.20	.191	.058
5	1.12	.311	.095	1.60	.326	.177	1.60	.244	.122
6	1.40	.386	.167	2.00	.340	.276	2.00	.250	.195
7	1.68	.415	.250	2.40	.337	.376	2.40	.246	.268
8	1.96	.422	.337	2.80	.323	.473	2.80	.240	.340
9	2.24	.417	.424	3.20	.306	.566	3.20	.233	.410
10	2.52	.402	.509	3.60	.293	.654	3.60	.223	.477
11	2.80	.394	.591	4.00	.286	.740	4.00	.212	.541
12	3.08	.387	.672	4.40	.266	.821	4.40	.202	.602
13	3.36	.363	.750	4.80	.197	.890	4.80	.194	.660
14	3.64	.316	.820	5.20	.122	.937	5.20	.189	.717
15	3.92	.236	.877	5.60	.067	.965	5.60	.187	.772
16	4.20	.164	.919	6.00	.036	.980	6.00	.185	.827
17	4.48	.108	.947	6.40	.021	.988	6.40	.175	.880
18	4.76	.073	.966	6.80	.013	.993	6.80	.131	.925
19	5.04	.047	.978	7.20	.008	.996	7.20	.080	.956
20	5.32	.030	.986	7.60	.005	.998	7.60	.046	.975
21	5.60	.020	.991	8.00	.002	.999	8.00	.027	.985
22	5.88	.013	.995	8.40	.001	1.000	8.40	.016	.992
23	6.16	.008	.997	8.80	0	1.000	8.80	.009	.995
24	6.44	.005	.998				9.20	.005	.997
25	6.72	.003	.999				9.60	.003	.999
26	7.00	.002	1.000				10.00	.002	.999
27	7.28	.001	1.000				10.40	.001	1.000
28	7.56		1.000				10.80	0	1.000
29	7.84	0	1.000						

Table 21.17 (Continued) Hydrograph Family 4

	$T_o/T_p = 10$			$T_o/T_p = 16$			$T_o/T_p = 25$		
Line No.	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.50	.015	.003	.62	.015	.003	1.02	.025	.009
3	1.00	.079	.020	1.24	.064	.022	2.04	.070	.045
4	1.50	.151	.062	1.86	.112	.062	3.06	.092	.106
5	2.00	.177	.122	2.48	.128	.117	4.08	.082	.170
6	2.50	.170	.186	3.10	.119	.173	5.10	.068	.227
7	3.00	.159	.247	3.72	.105	.225	6.12	.062	.276
8	3.50	.152	.304	4.34	.097	.271	7.14	.059	.321
9	4.00	.146	.358	4.96	.094	.315	8.16	.056	.365
10	4.50	.141	.411	5.58	.091	.357	9.18	.055	.407
11	5.00	.136	.462	6.20	.089	.398	10.20	.054	.448
12	5.50	.131	.511	6.82	.087	.438	11.22	.053	.488
13	6.00	.126	.558	7.44	.085	.478	12.24	.052	.528
14	6.50	.121	.604	8.06	.082	.516	13.26	.050	.566
15	7.00	.116	.647	8.68	.079	.553	14.28	.049	.603
16	7.50	.112	.689	9.30	.076	.588	15.30	.047	.639
17	8.00	.112	.730	9.92	.074	.623	16.32	.046	.674
18	8.50	.111	.771	10.54	.072	.656	17.34	.045	.709
19	9.00	.111	.812	11.16	.071	.689	18.36	.044	.742
20	9.50	.110	.852	11.78	.070	.721	19.38	.044	.775
21	10.00	.110	.893	12.40	.069	.753	20.40	.044	.809
22	10.50	.100	.931	13.02	.069	.785	21.42	.044	.842
23	11.00	.065	.962	13.64	.069	.816	22.44	.044	.875
24	11.50	.033	.980	14.26	.069	.848	23.46	.044	.908
25	12.00	.025	.990	14.88	.069	.879	24.48	.044	.941
26	12.50	.007	.996	15.50	.069	.911	25.50	.039	.972
27	13.00	.004	.998	16.12	.068	.942	26.52	.012	.992
28	13.50	.002	.999	16.74	.053	.970	27.54	.004	.998
29	14.00	.001	1.000	17.36	.023	.987	28.56	.001	1.000
30	14.50	0	1.000	17.98	.009	.995	29.58	0	1.000
31				18.60	.004	.998			
32				19.22	.002	.999			
33				19.84	.001	1.000			
34				20.46	0	1.000			

Table 21.17 (Continued)

	Hydrograph Family 4						Hydrograph Family 5		
	T_o/T_p = 36			T_o/T_p = 50			T_o/T_p = 1		
Line No.	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q	t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	1.50	.0306	.017	2.00	.0277	.020	.26	.021	.002
3	3.00	.0575	.066	4.00	.0464	.075	.52	.106	.014
4	4.50	.0672	.135	6.00	.0435	.141	.78	.289	.052
5	6.00	.0492	.199	8.00	.0378	.201	1.04	.530	.131
6	7.50	.0433	.251	10.00	.0335	.254	1.30	.740	.254
7	9.00	.0418	.298	12.00	.0307	.301	1.56	.848	.407
8	10.50	.0408	.344	14.00	.0291	.345	1.82	.767	.563
9	12.00	.0400	.388	16.00	.0282	.388	2.08	.590	.693
10	13.50	.0391	.432	18.00	.0274	.429	2.34	.406	.789
11	15.00	.0382	.475	20.00	.0266	.468	2.60	.279	.855
12	16.50	.0371	.517	22.00	.0258	.507	2.86	.193	.901
13	18.00	.0358	.557	24.00	.0250	.544	3.12	.134	.933
14	19.50	.0341	.596	26.00	.0242	.581	3.38	.092	.954
15	21.00	.0319	.632	28.00	.0234	.616	3.64	.065	.969
16	22.50	.0308	.667	30.00	.0230	.650	3.90	.044	.980
17	24.00	.0306	.701	32.00	.0229	.683	4.16	.030	.987
18	25.50	.0306	.735	34.00	.0227	.718	4.42	.021	.992
19	27.00	.0306	.769	36.00	.0226	.751	4.68	.015	.995
20	28.50	.0306	.803	38.00	.0225	.784	4.94	.009	.998
21	30.00	.0306	.837	40.00	.0224	.817	5.20	.005	.999
22	31.50	.0306	.871	42.00	.0222	.850	5.46	.002	1.000
23	33.00	.0306	.905	44.00	.0221	.883	5.72	0	1.000
24	34.50	.0306	.939	46.00	.0219	.915			
25	36.00	.0306	.973	48.00	.0219	.948			
26	37.50	.0085	.994	50.00	.0217	.980			
27	39.00	.0009	1.000	52.00	.0029	.998			
28	40.50	0	1.000	54.00	0	1.000			

Table 21.17 (Continued) Hydrograph Family 5

Line No.	$T_o/T_p = 1.5$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 2$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 3$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.25	.013	.001	.25	.010	.001	.34	.010	.001
3	.50	.065	.008	.50	.048	.006	.68	.068	.011
4	.75	.173	.030	.75	.127	.022	1.02	.150	.039
5	1.00	.306	.075	1.00	.227	.055	1.36	.229	.086
6	1.25	.434	.143	1.25	.318	.106	1.70	.283	.151
7	1.50	.562	.235	1.50	.389	.171	2.04	.315	.226
8	1.75	.680	.350	1.75	.448	.248	2.38	.339	.308
9	2.00	.737	.481	2.00	.523	.338	2.72	.378	.399
10	2.25	.673	.611	2.25	.609	.443	3.06	.459	.504
11	2.50	.530	.722	2.50	.642	.558	3.40	.509	.626
12	3.75	.381	.806	2.75	.576	.671	3.74	.446	.746
13	3.00	.262	.866	3.00	.450	.766	4.08	.310	.841
14	3.25	.185	.907	3.25	.322	.837	4.42	.190	.904
15	3.50	.129	.936	3.50	.222	.888	4.76	.117	.943
16	3.75	.090	.956	3.75	.156	.923	5.10	.069	.966
17	4.00	.063	.970	4.00	.109	.947	5.44	.040	.980
18	4.25	.045	.980	4.25	.075	.964	5.78	.025	.988
19	4.50	.031	.987	4.50	.053	.976	6.12	.016	.993
20	4.75	.022	.992	4.75	.037	.984	6.46	.009	.997
21	5.00	.014	.995	5.00	.025	.990	6.80	.005	.998
22	5.25	.009	.998	5.25	.017	.994	7.14	.003	.999
23	5.50	.005	.999	5.50	.011	.996	7.48	.001	1.000
24	5.75	.003	1.000	5.75	.007	.998	7.82	0	1.000
25	6.00	.001	1.000	6.00	.004	.999			
26	6.25	0	1.000	6.25	.002	1.000			
27				6.50	.001	1.000			
28				6.75	0	1.000			

Table 21.17 (Continued) Hydrograph Family 5

Line No.	$T_o/T_p = 4$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 6$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 10$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0	0	0	0
2	.36	.010	.001	.52	.015	.003	.67	.013	.003
3	.72	.053	.010	1.04	.070	.019	1.34	.061	.022
4	1.08	.124	.033	1.56	.130	.057	2.01	.091	.059
5	1.44	.181	.074	2.08	.159	.112	2.68	.102	.107
6	1.80	.220	.127	2.60	.172	.176	3.35	.107	.159
7	2.16	.243	.189	3.12	.178	.242	4.02	.110	.213
8	2.52	.256	.255	3.64	.182	.311	4.69	.111	.268
9	2.88	.263	.325	4.16	.183	.381	5.36	.111	.323
10	3.24	.273	.396	4.68	.184	.451	6.03	.112	.378
11	3.60	.308	.473	5.20	.218	.527	6.70	.112	.434
12	3.96	.380	.565	5.72	.285	.623	7.37	.112	.490
13	4.32	.427	.672	6.24	.324	.740	8.04	.116	.546
14	4.68	.377	.779	6.76	.267	.852	8.71	.160	.615
15	5.04	.260	.864	7.28	.133	.929	9.38	.198	.704
16	5.40	.155	.919	7.80	.064	.966	10.05	.212	.805
17	5.76	.094	.953	8.32	.029	.984	10.72	.168	.900
18	6.12	.055	.972	8.84	.016	.993	11.39	.074	.960
19	6.48	.032	.984	9.36	.007	.997	12.06	.027	.985
20	6.84	.019	.991	9.88	.003	.999	12.73	.010	.994
21	7.20	.012	.995	10.40	.001	1.000	13.40	.005	.998
22	7.56	.007	.997	10.92	0	1.000	14.07	.002	1.000
23	7.92	.004	.999				14.74	0	1.000
24	8.28	.002	1.000						
25	8.64	0	1.000						

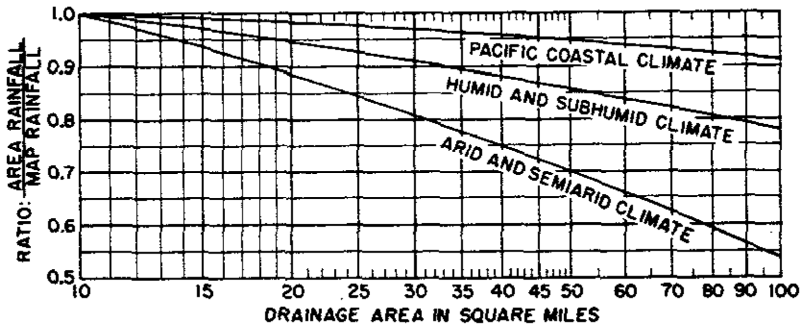
Table 21.17 (Continued) Hydrograph Family 5

Line No.	$T_o/T_p = 16$ t/T_p	q_c/q_p	Qt/Q	$T_o/T_p = 25$ t/T_p	q_c/q_p	Qt/Q
1	0	0	0	0	0	0
2	.80	.008	.002	1.25	.015	.007
3	1.60	.046	.018	2.50	.039	.032
4	2.40	.060	.050	3.75	.043	.070
5	3.20	.065	.087	5.00	.044	.110
6	4.00	.067	.126	6.25	.044	.151
7	4.80	.067	.166	7.50	.044	.191
8	5.60	.068	.206	8.75	.044	.232
9	6.40	.068	.246	10.00	.044	.273
10	7.20	.068	.286	11.25	.044	.314
11	8.00	.068	.327	12.50	.044	.354
12	8.80	.068	.367	13.75	.044	.395
13	9.60	.068	.407	15.00	.044	.436
14	10.40	.068	.448	16.25	.044	.476
15	11.20	.068	.488	17.50	.044	.517
16	12.00	.068	.528	18.75	.045	.558
17	12.80	.086	.574	20.00	.067	.610
18	13.60	.121	.636	21.25	.083	.679
19	14.40	.133	.711	22.50	.087	.758
20	15.20	.136	.791	23.75	.087	.839
21	16.00	.137	.872	25.00	.088	.920
22	16.80	.098	.941	26.25	.035	.976
23	17.60	.033	.980	27.50	.006	.995
24	18.40	.012	.993	28.75	.002	.999
25	19.20	.004	.998	30.00	0	1.000
26	20.00	.001	1.000			
27	20.80	0	1.000			

Table 21.17 (Concluded) Hydrograph Family 5

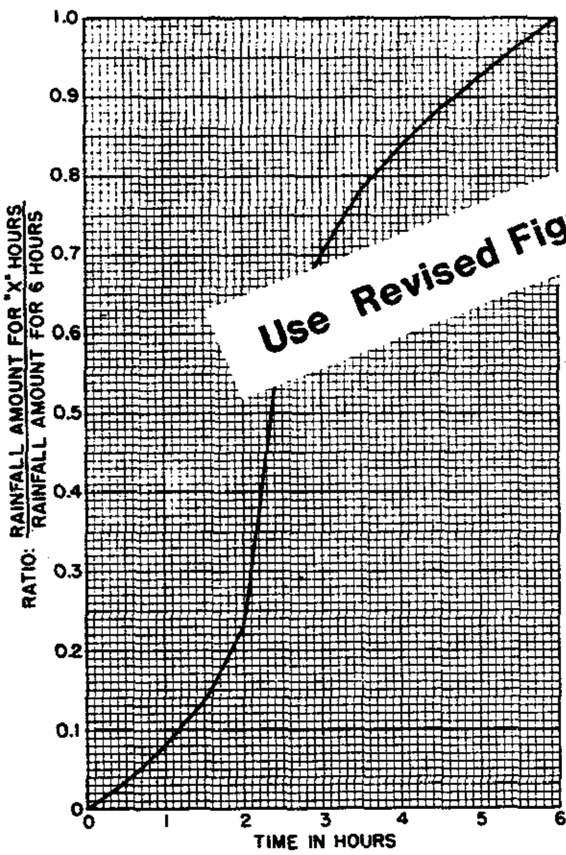
Line No.	$T_o/T_p = 36$ t/T_p	q_c/q_p	Q_t/Q	$T_o/T_p = 50$ t/T_p	q_c/q_p	Q_t/Q
1	0	0	0	0	0	0
2	1.50	.0195	.011	2.00	.0167	.012
3	3.00	.0275	.037	4.00	.0204	.040
4	4.50	.0294	.068	6.00	.0214	.071
5	6.00	.0300	.101	8.00	.0216	.102
6	7.50	.0301	.135	10.00	.0216	.134
7	9.00	.0301	..168	12.00	.0216	.166
8	10.50	.0301	.202	14.00	.0216	.198
9	12.00	.0301	.235	16.00	.0216	.230
10	13.50	.0301	.268	18.00	.0216	.262
11	15.00	.0301	.302	20.00	.0216	.294
12	16.50	.0301	.335	22.00	.0216	.326
13	18.00	.0301	.369	24.00	.0216	.358
14	19.50	.0301	.402	26.00	.0216	.390
15	21.00	.0301	.435	28.00	.0216	.422
16	22.50	.0301	.469	30.00	.0216	.454
17	24.00	.0311	.503	32.00	.0217	.486
18	25.50	.0364	.540	34.00	.0243	.520
19	27.00	.0425	.584	36.00	.0287	.559
20	28.50	.0480	.634	38.00	.0329	.604
21	30.00	.0525	.690	40.00	.0363	.656
22	31.50	.0561	.750	42.00	.0391	.711
23	33.00	.0584	.814	44.00	.0411	.771
24	34.50	.0598	.879	46.00	.0423	.832
25	36.00	.0603	.946	48.00	.0430	.895
26	37.50	.0167	.989	50.00	.0433	.959
27	39.00	.0018	.999	52.00	.0058	.995
28	40.50	0	1.000	54.00	.0002	1.000
29				56.00	0	1.000

HYDROLOGY: CRITERIA FOR DESIGN STORMS USED IN DEVELOPING EMERGENCY SPILLWAY DESIGN AND FREEBOARD HYDROGRAPHS

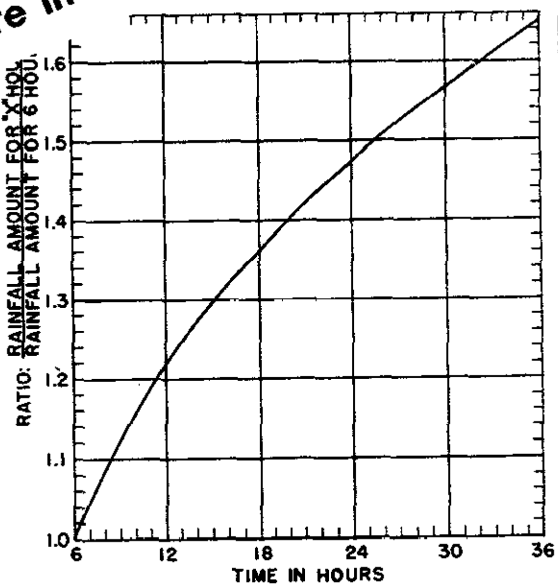


(a) RAINFALL RATIOS FOR DRAINAGE AREAS OF 10 TO 100 SQUARE MILES

Use Revised Figure in TR-60



(b) SIX HOUR DESIGN STORM DISTRIBUTION



(c) RELATIVE INCREASE IN RAINFALL AMOUNT FOR STORM DURATIONS OVER SIX HOURS

FIGURE 21.2

REFERENCE	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - CENTRAL TECHNICAL UNIT	STANDARD DWG. NO. ES- 1003 SHEET 1 OF 1 DATE 1-2-56 REVISED 9-10-63

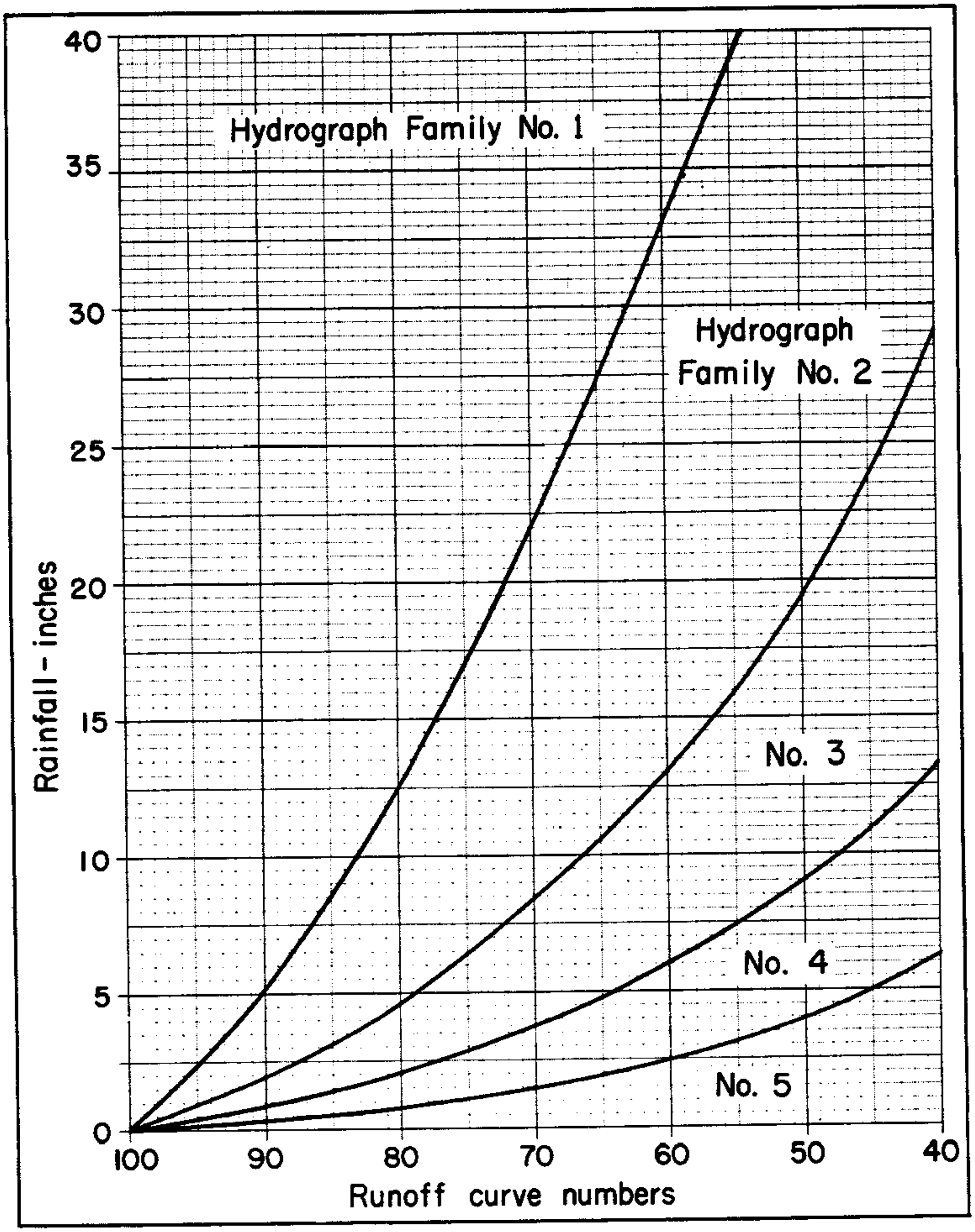


Figure 21-3. Chart for selecting a hydrograph family for a given rainfall and runoff curve number.

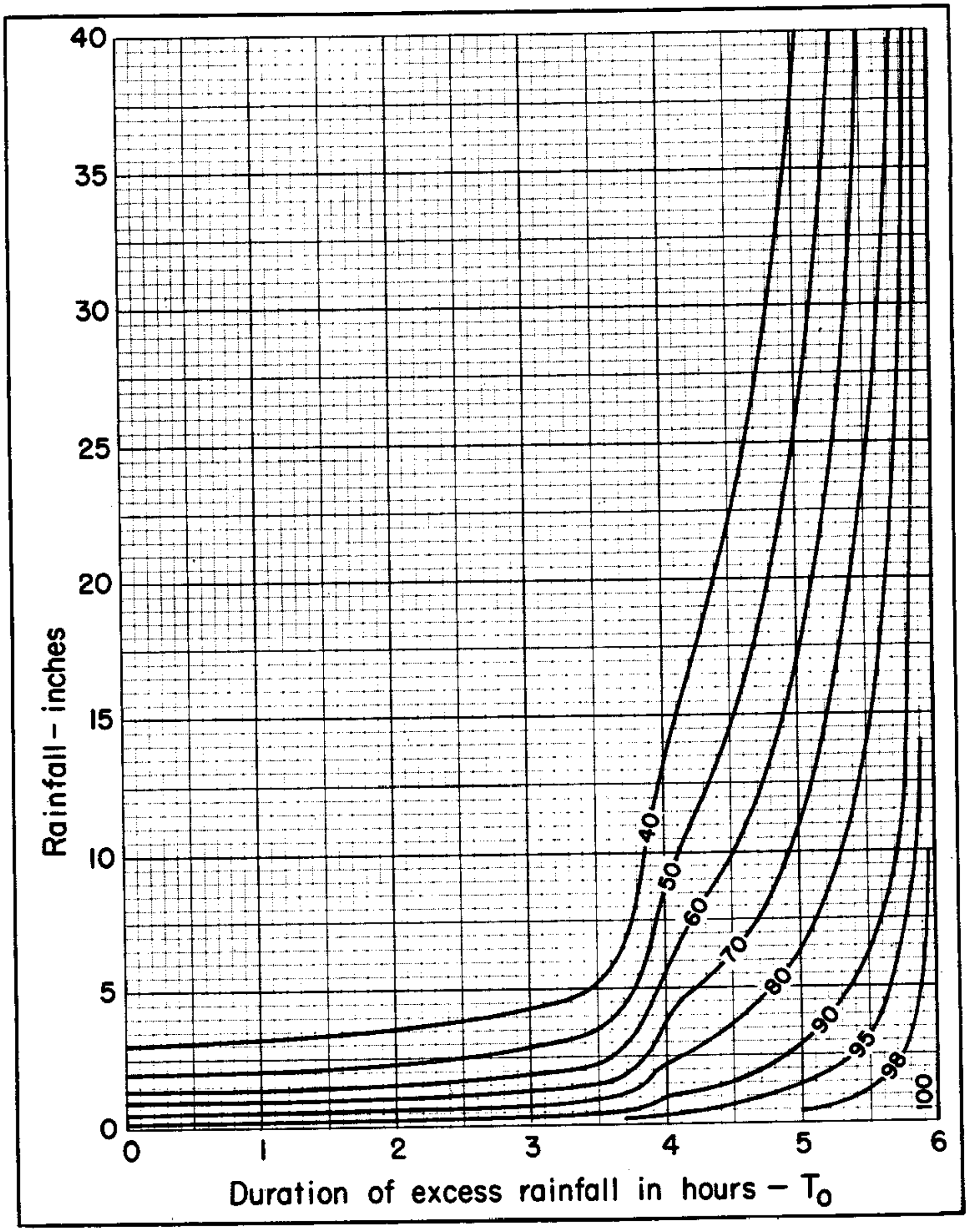


Figure 21-4. Duration of excess rainfall for a 6-hour rainfall and for runoff curve numbers 40 to 100.

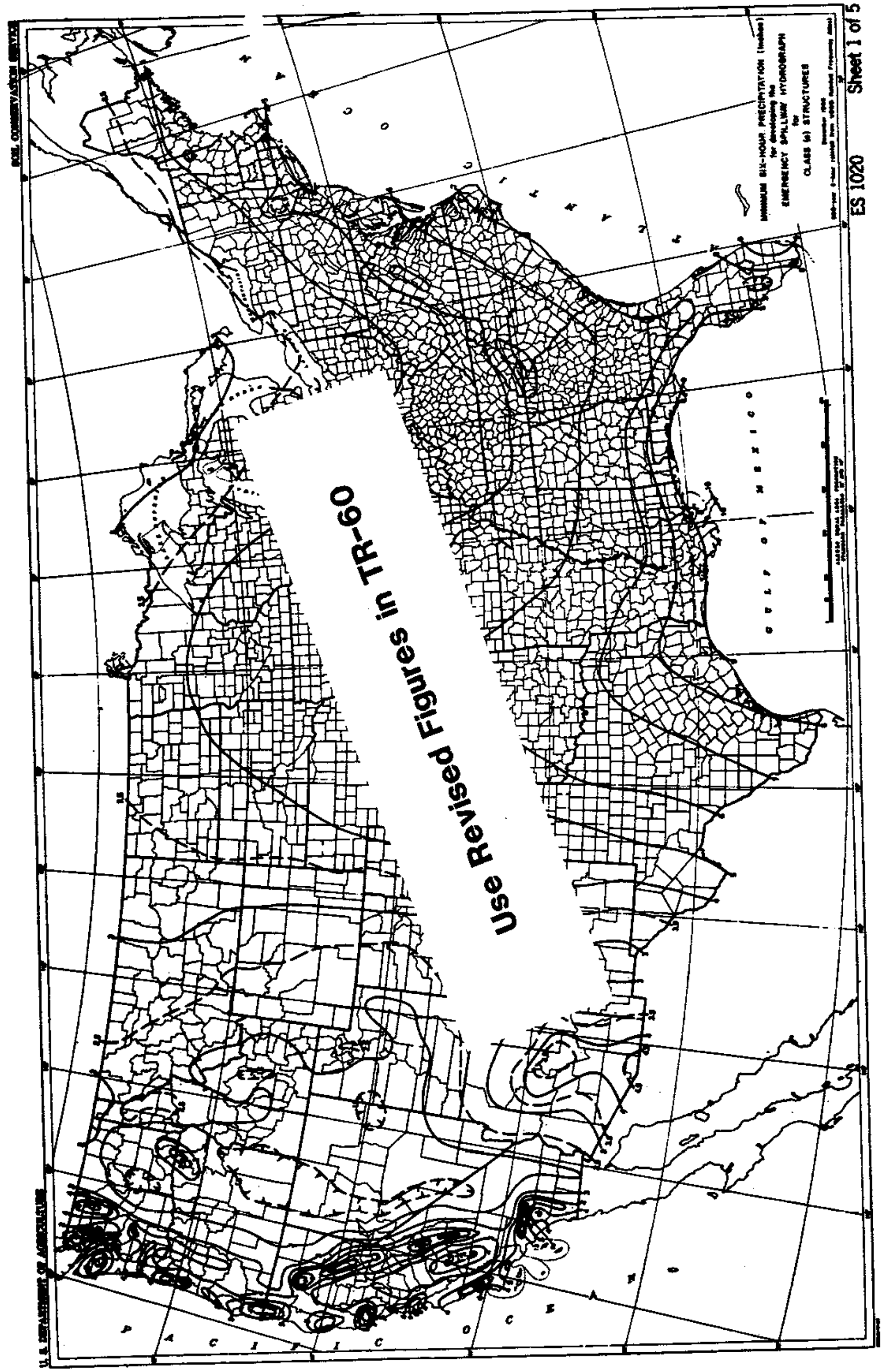


FIGURE 21.5 (1 of 5)

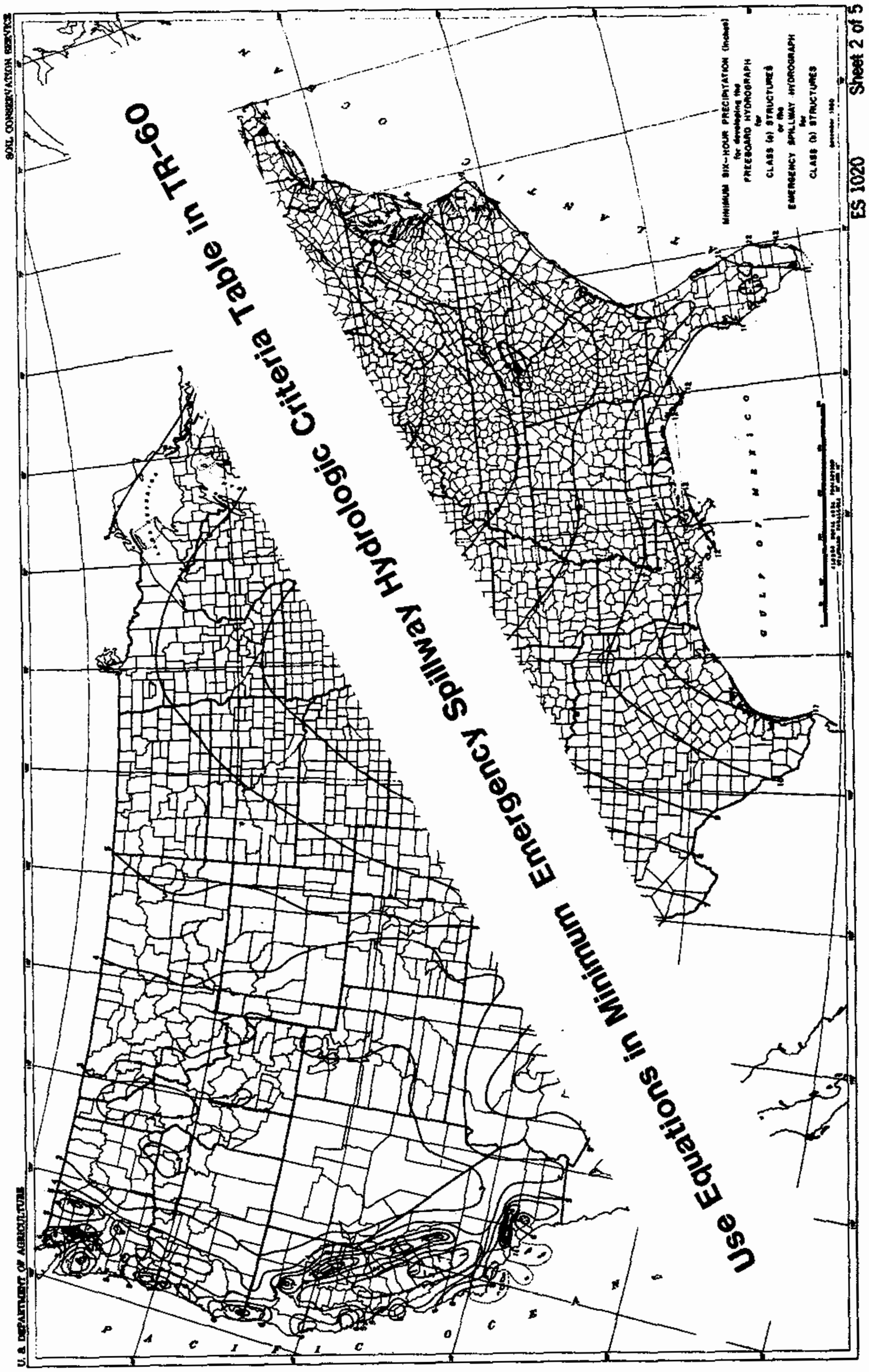


FIGURE 21.5 (2 of 5)

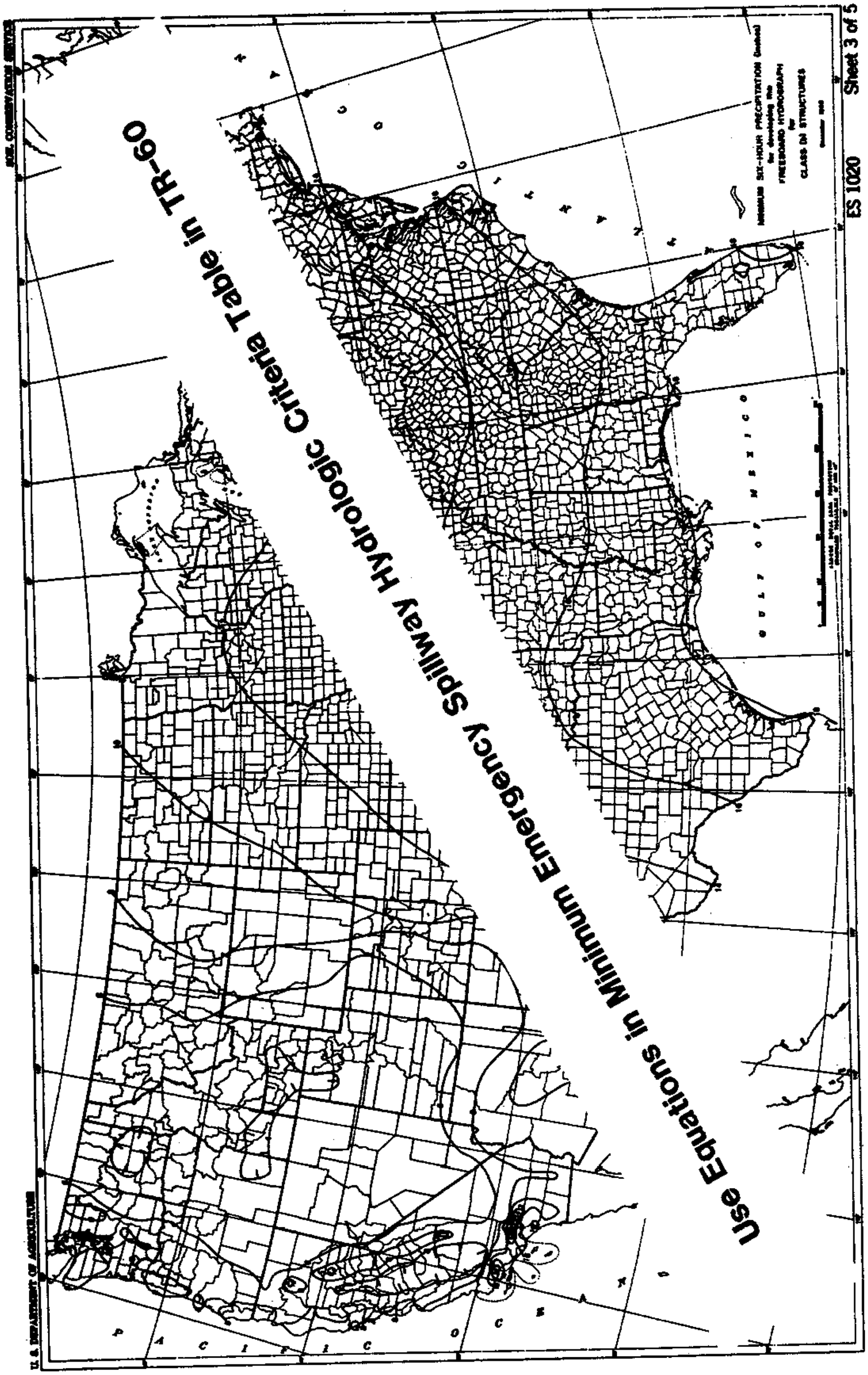


FIGURE 21.5 (3 of 5)

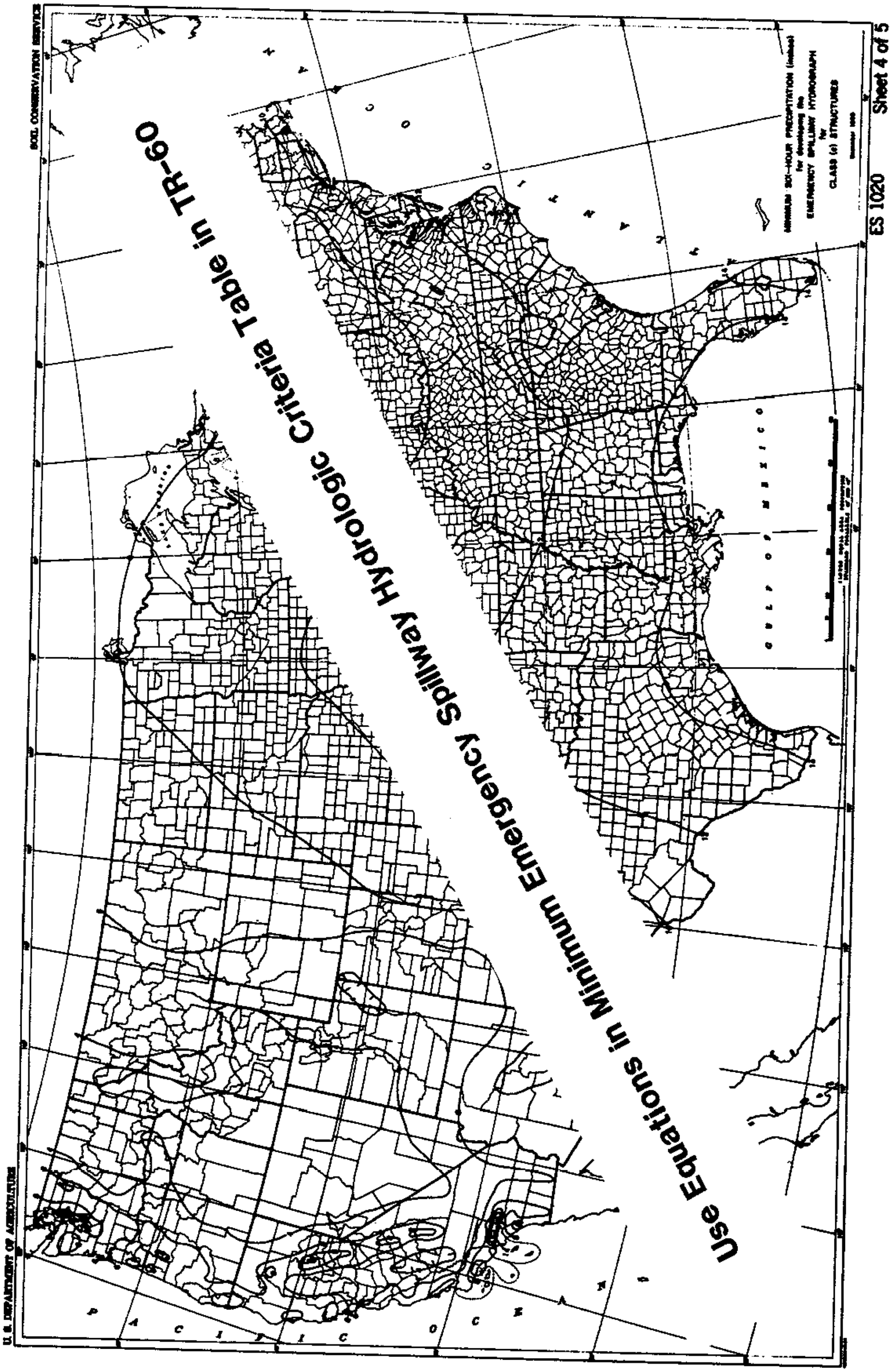


FIGURE 21.5 (4 of 5)

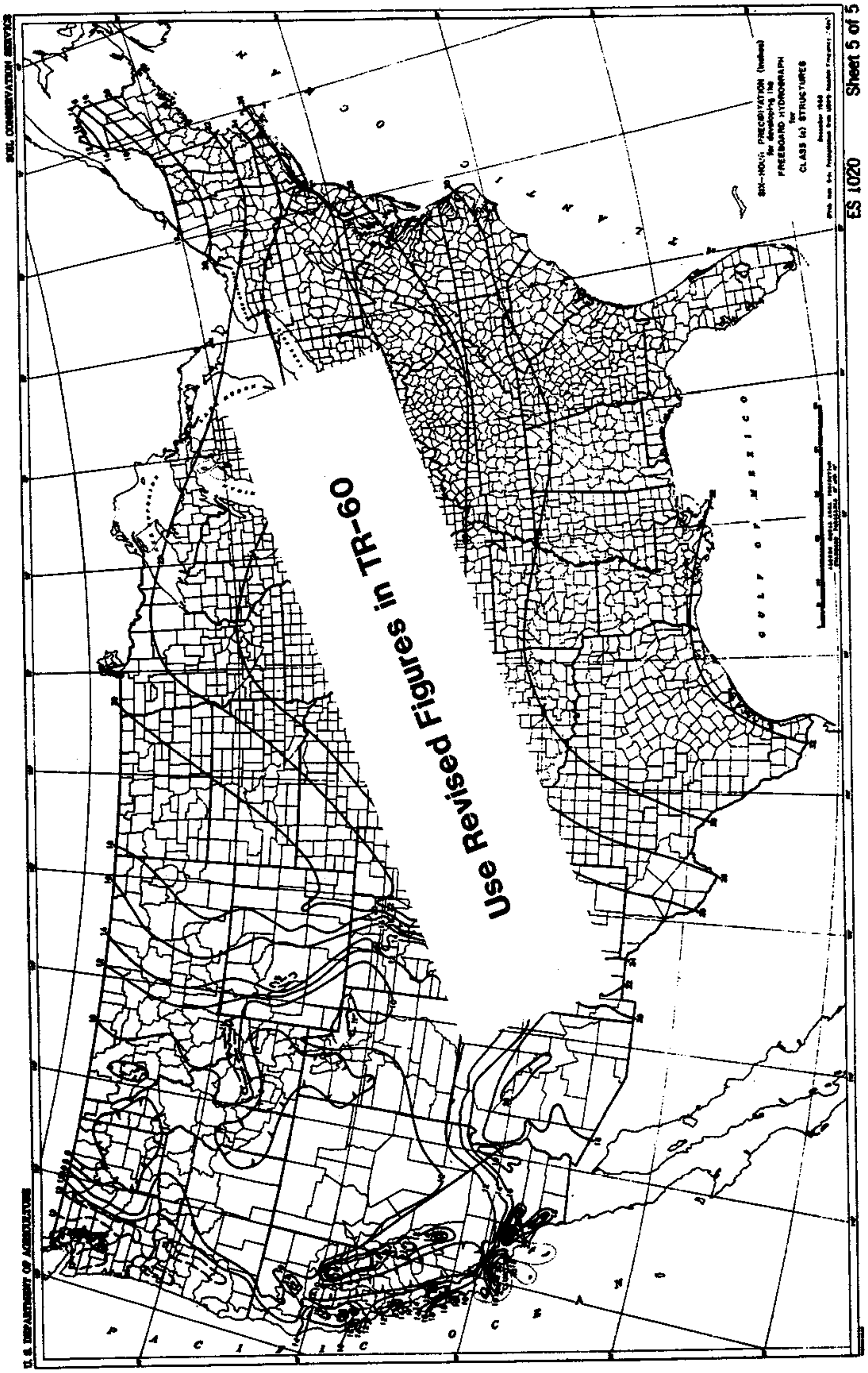


FIGURE 21.5 (5 of 5)

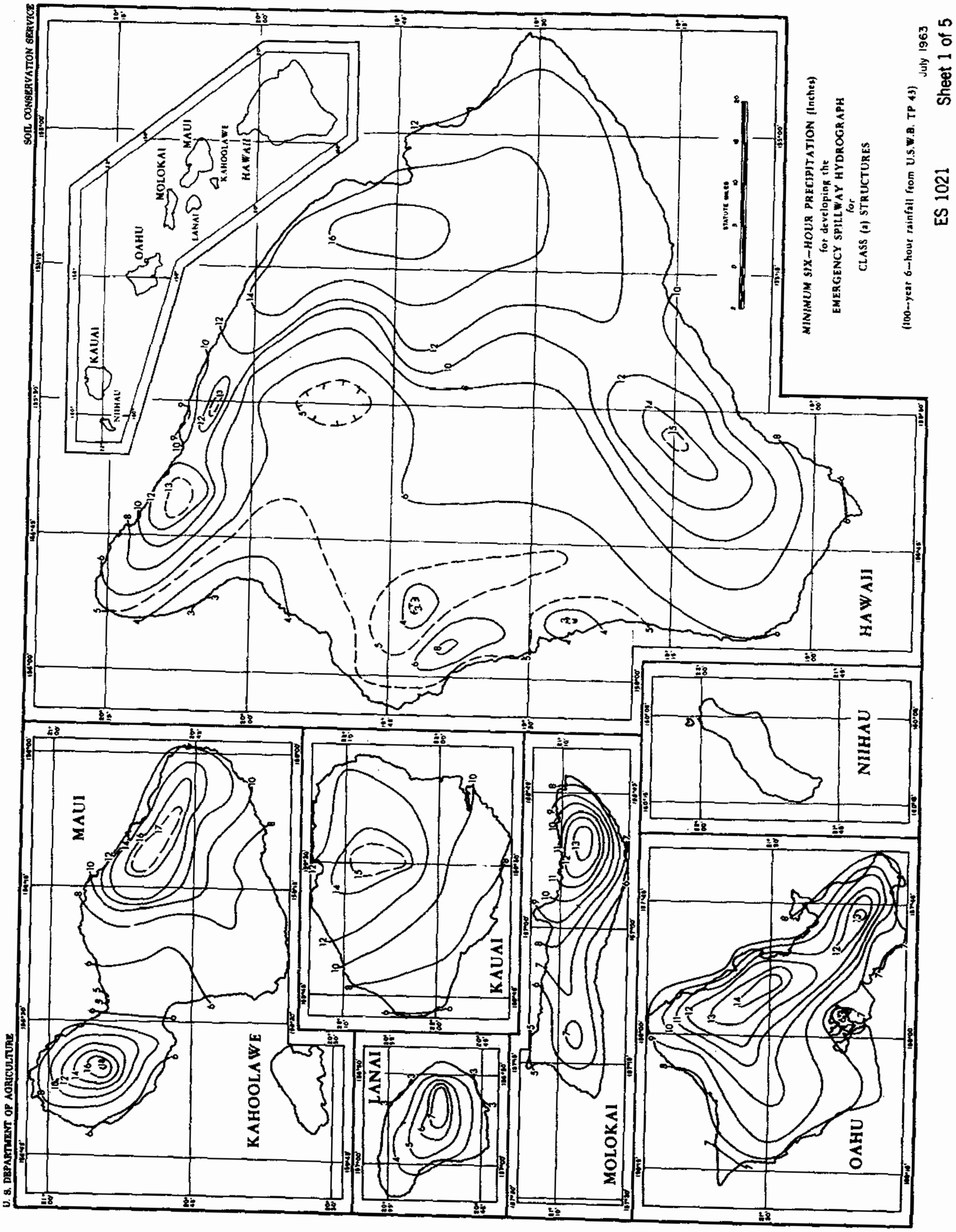


FIGURE 21.6 (1 of 5)

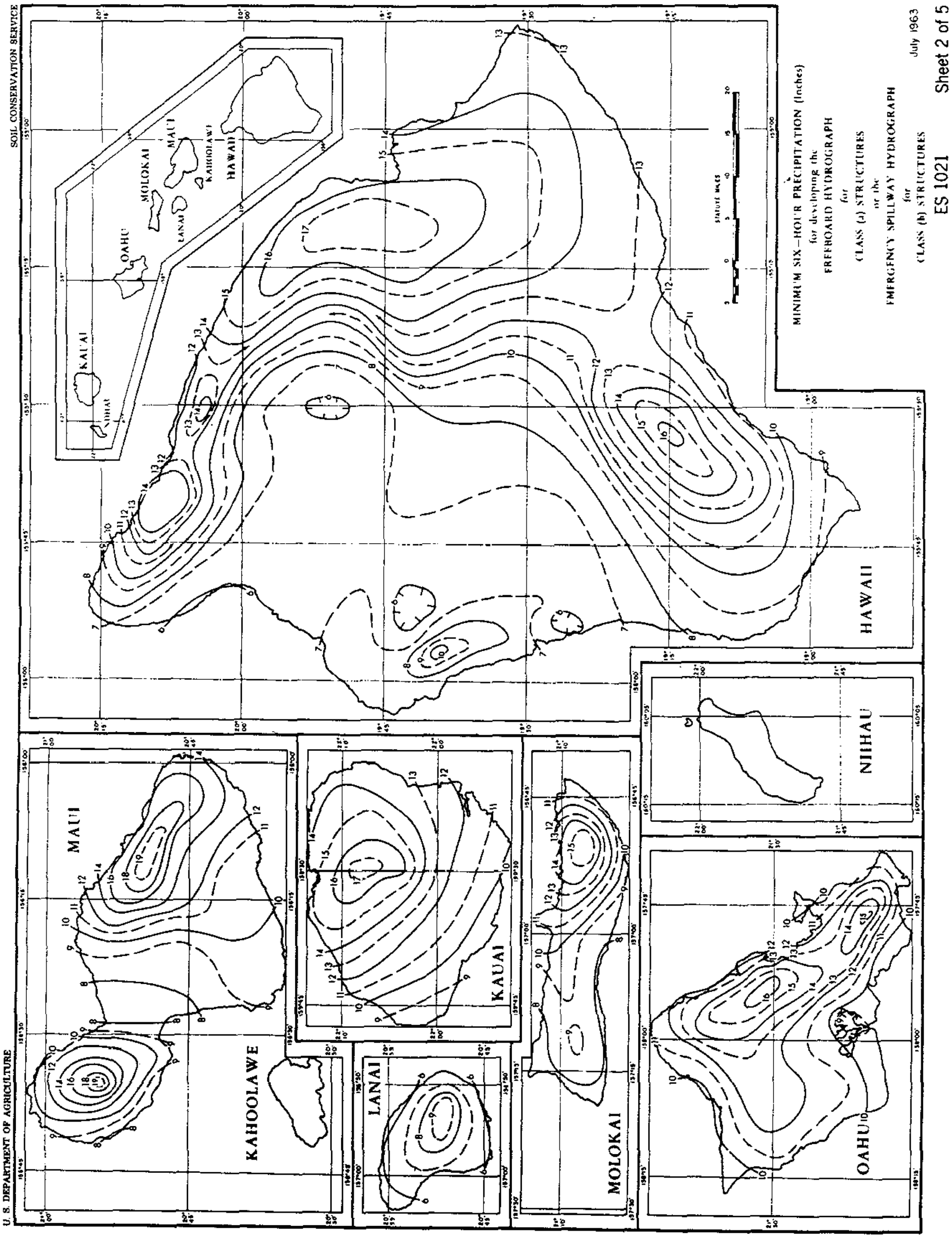


FIGURE 21.6 (2 of 5)

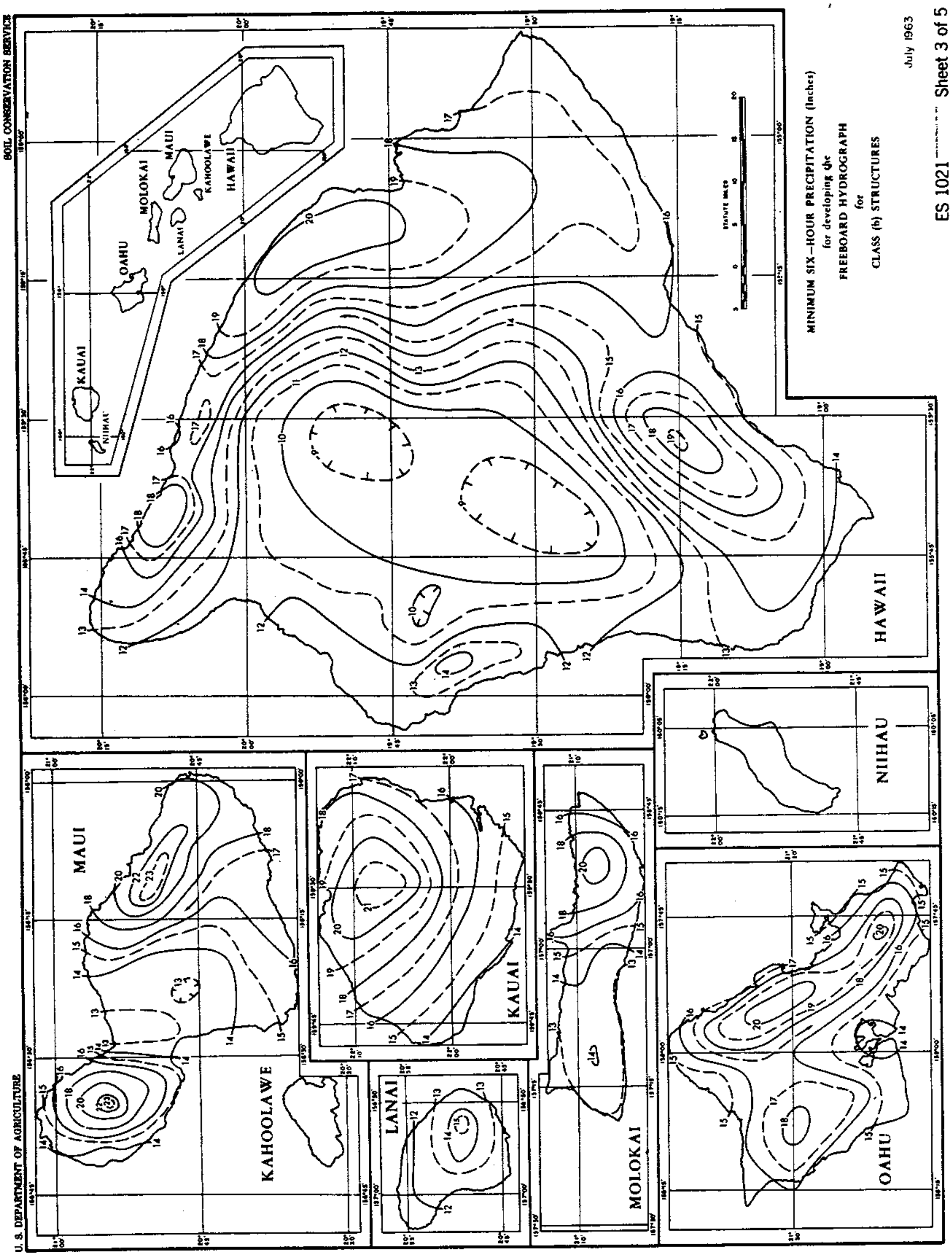


FIGURE 21.6 (3 of 5)

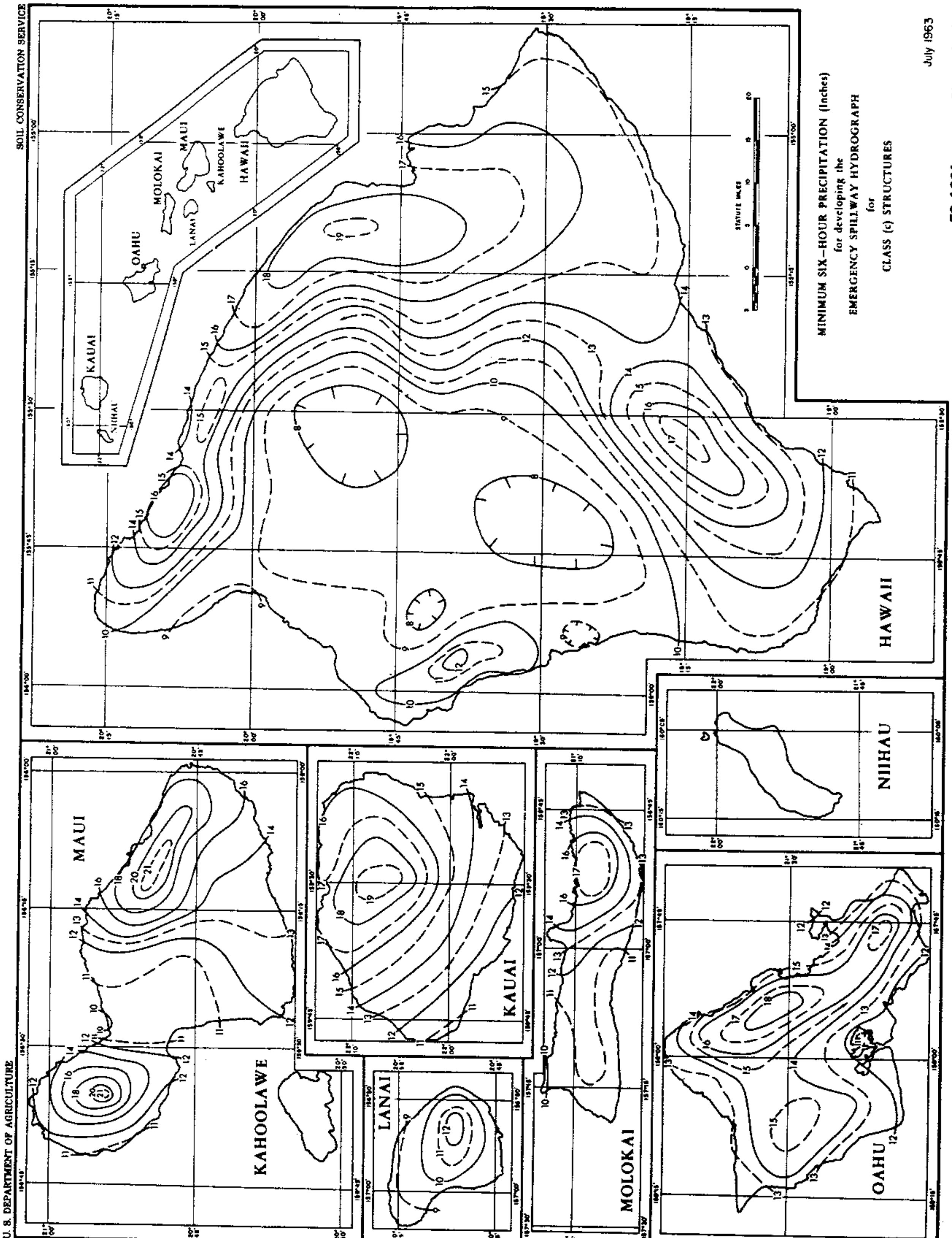


FIGURE 21.6 (4 of 5)

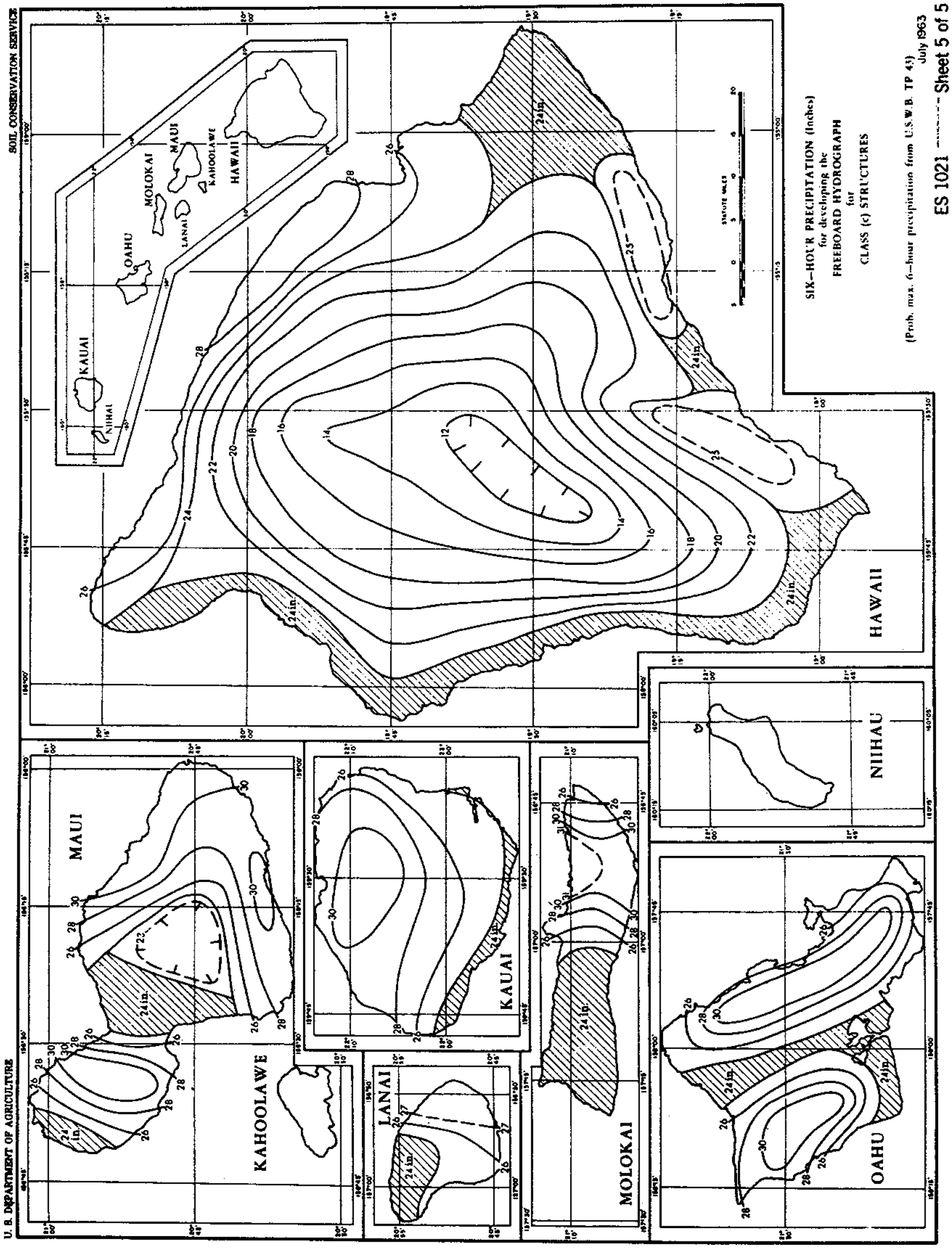


FIGURE 21.6 (5 of 5)

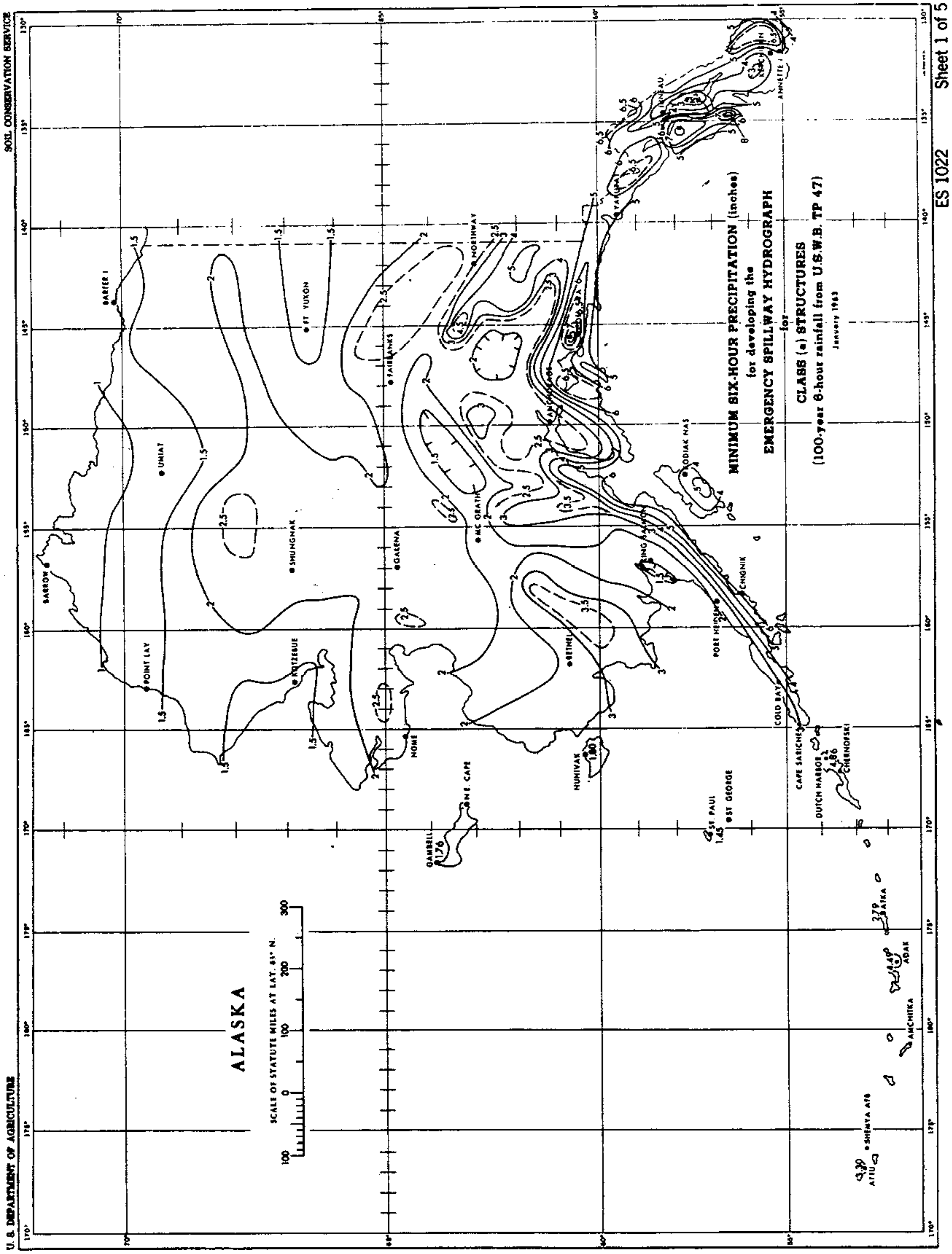


FIGURE 21.7 (1 of 5)

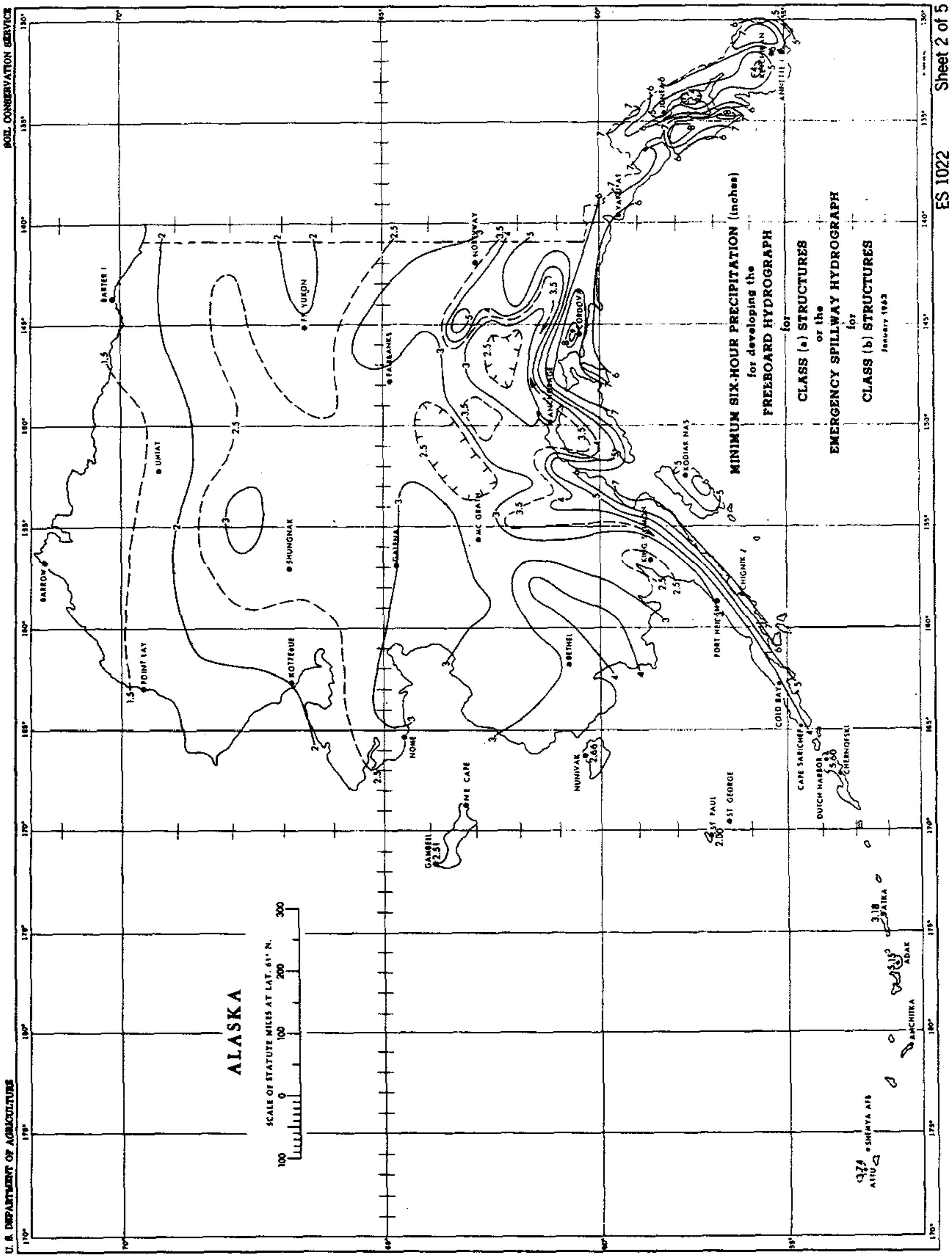


FIGURE 21.7 (2 of 5)

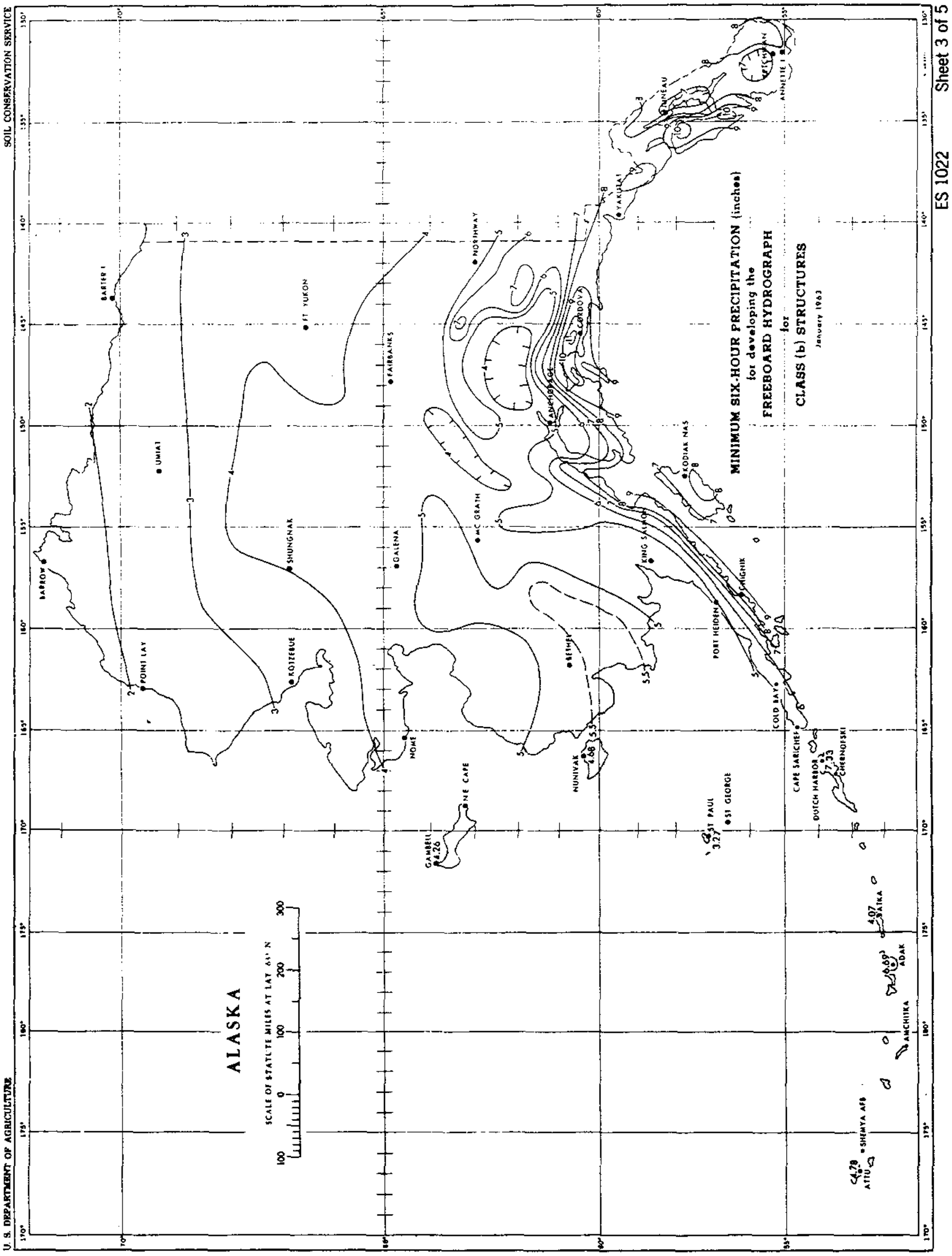


FIGURE 21.7 (3 of 5)

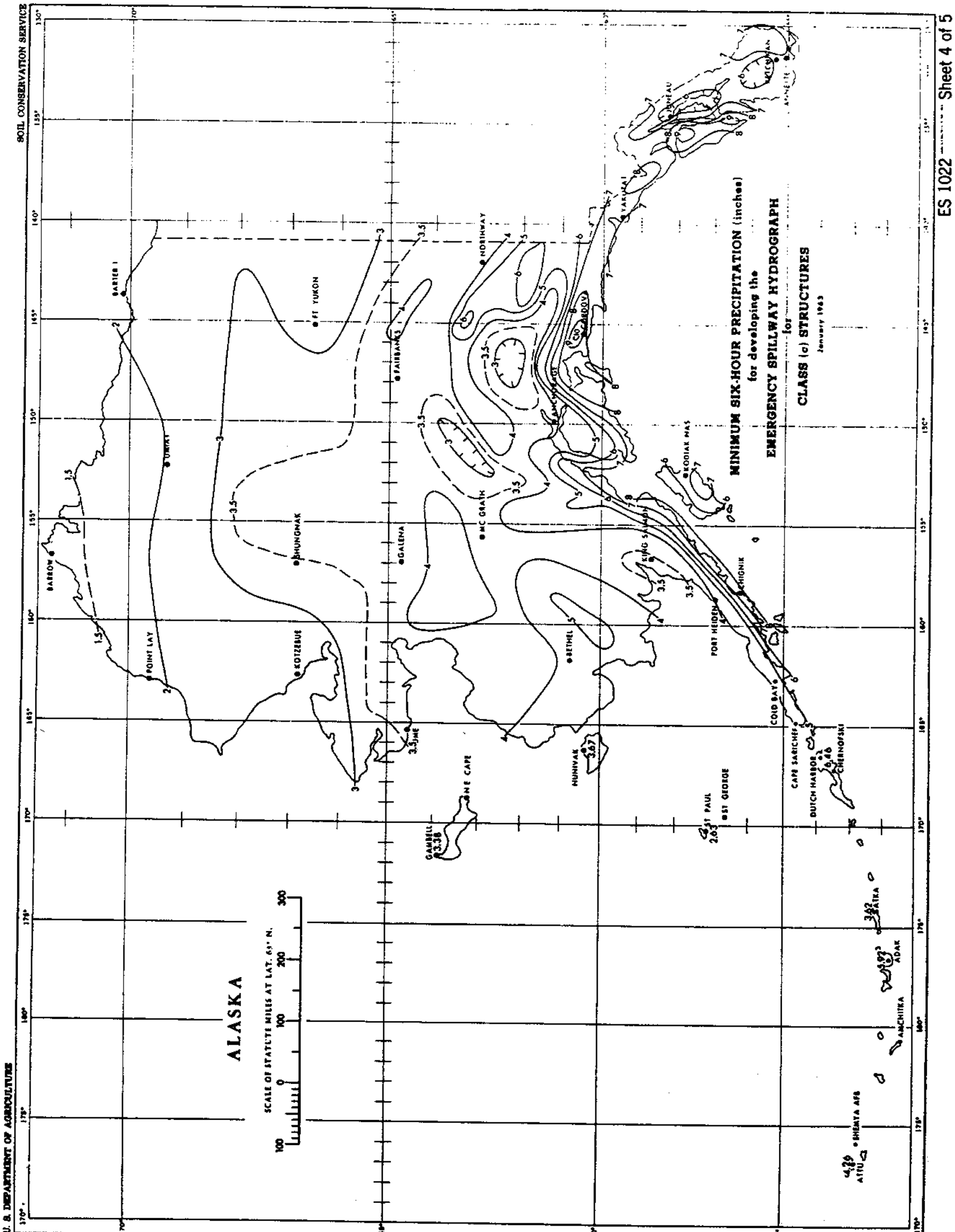


FIGURE 21.7 (4 of 5)

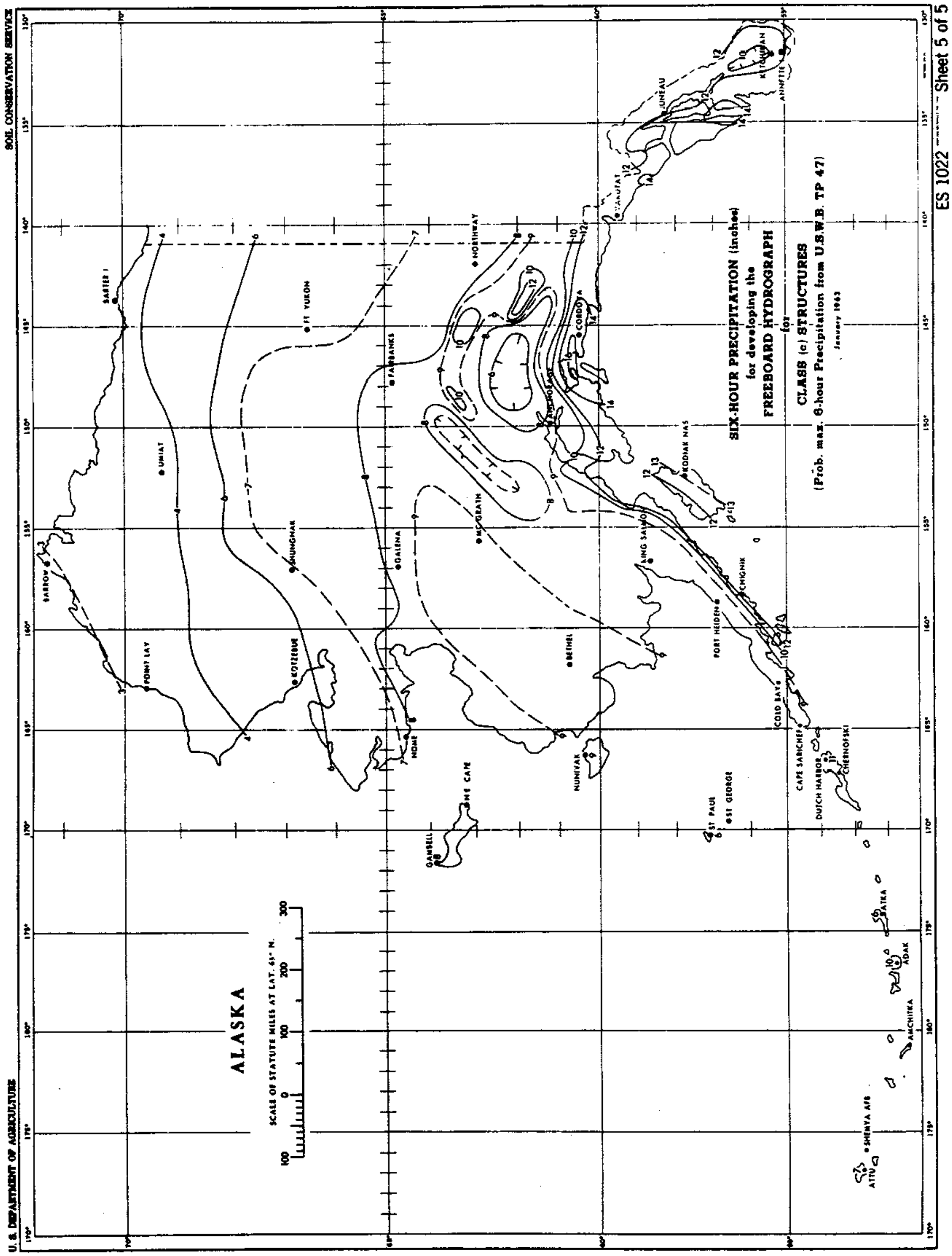
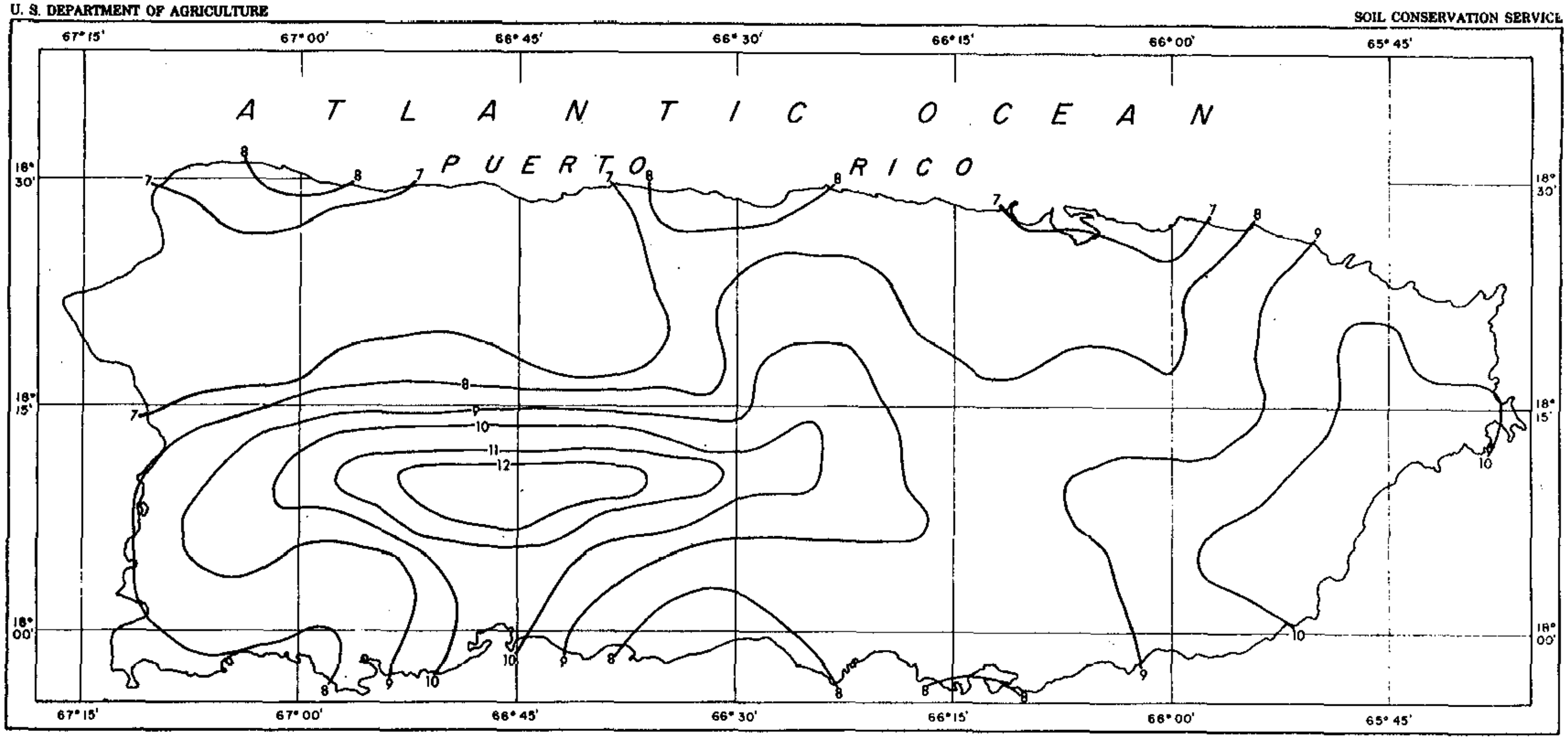


FIGURE 21.7 (5 of 5)

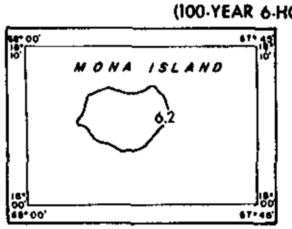
U. S. DEPARTMENT OF AGRICULTURE

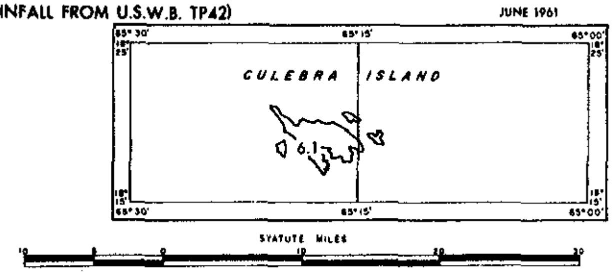
SOIL CONSERVATION SERVICE



MINIMUM SIX-HOUR PRECIPITATION (INCHES) FOR DEVELOPING THE EMERGENCY SPILLWAY HYDROGRAPH FOR CLASS (a) STRUCTURES
(100-YEAR 6-HOUR RAINFALL FROM U.S.W.B. TP42)

JUNE 1961





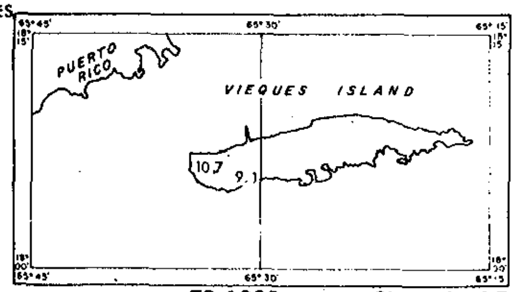


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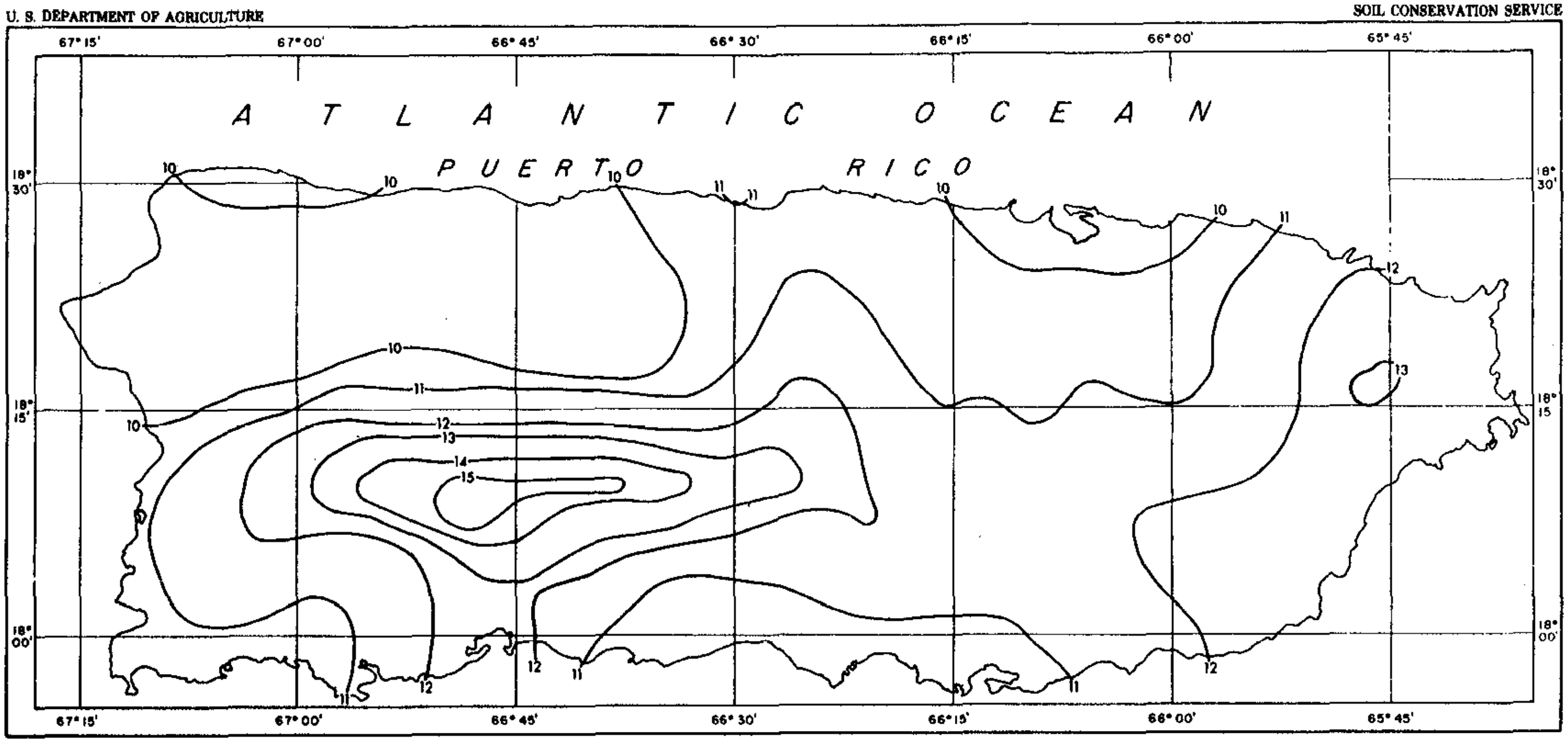
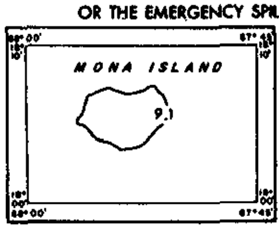
FIGURE 21.8 (1 of 5)

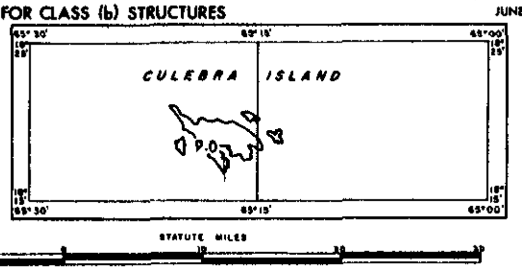
FIGURE 21.8 (2 of 5)



MINIMUM SIX-HOUR PRECIPITATION (INCHES) FOR DEVELOPING THE FREEBOARD HYDROGRAPH FOR CLASS (a) STRUCTURES OR THE EMERGENCY SPILLWAY HYDROGRAPH FOR CLASS (b) STRUCTURES

JUNE 1961





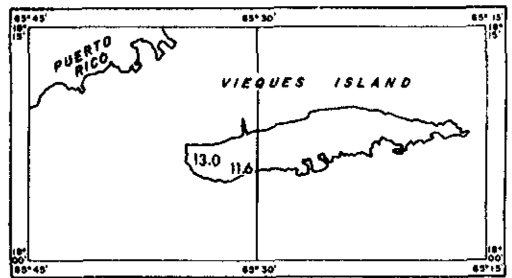
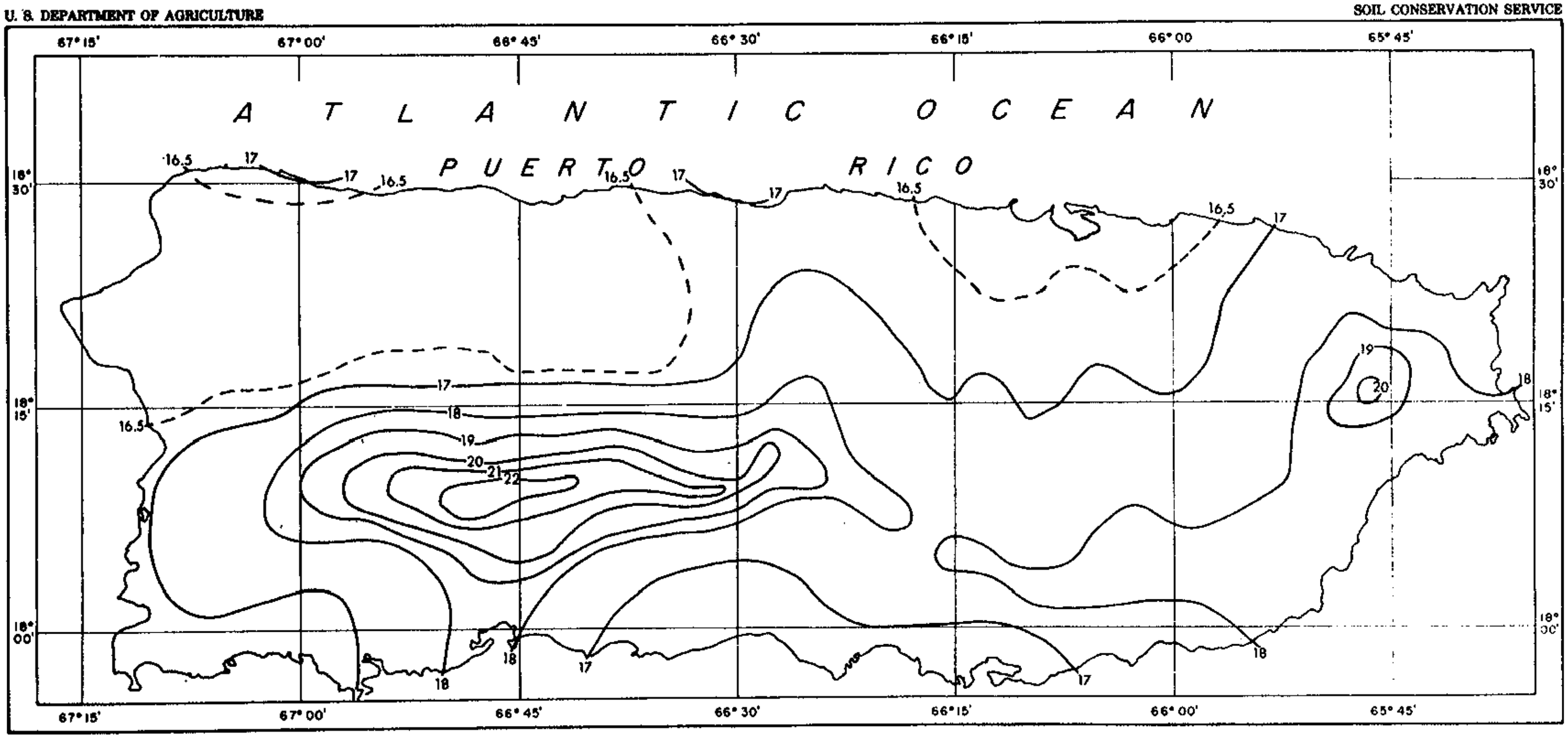


FIGURE 21.8 (3 of 5)

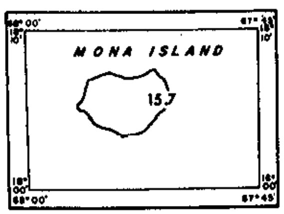
U. S. DEPARTMENT OF AGRICULTURE

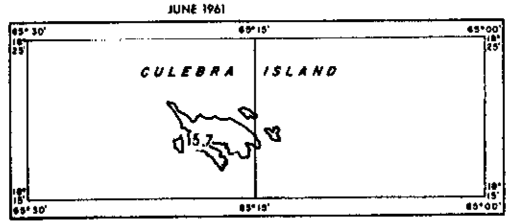
SOIL CONSERVATION SERVICE



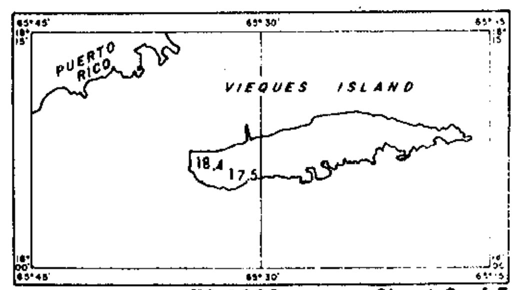
MINIMUM SIX-HOUR PRECIPITATION (INCHES) FOR DEVELOPING THE FREEBOARD HYDROGRAPH FOR CLASS (b) STRUCTURES

JUNE 1961





STATUTE MILES



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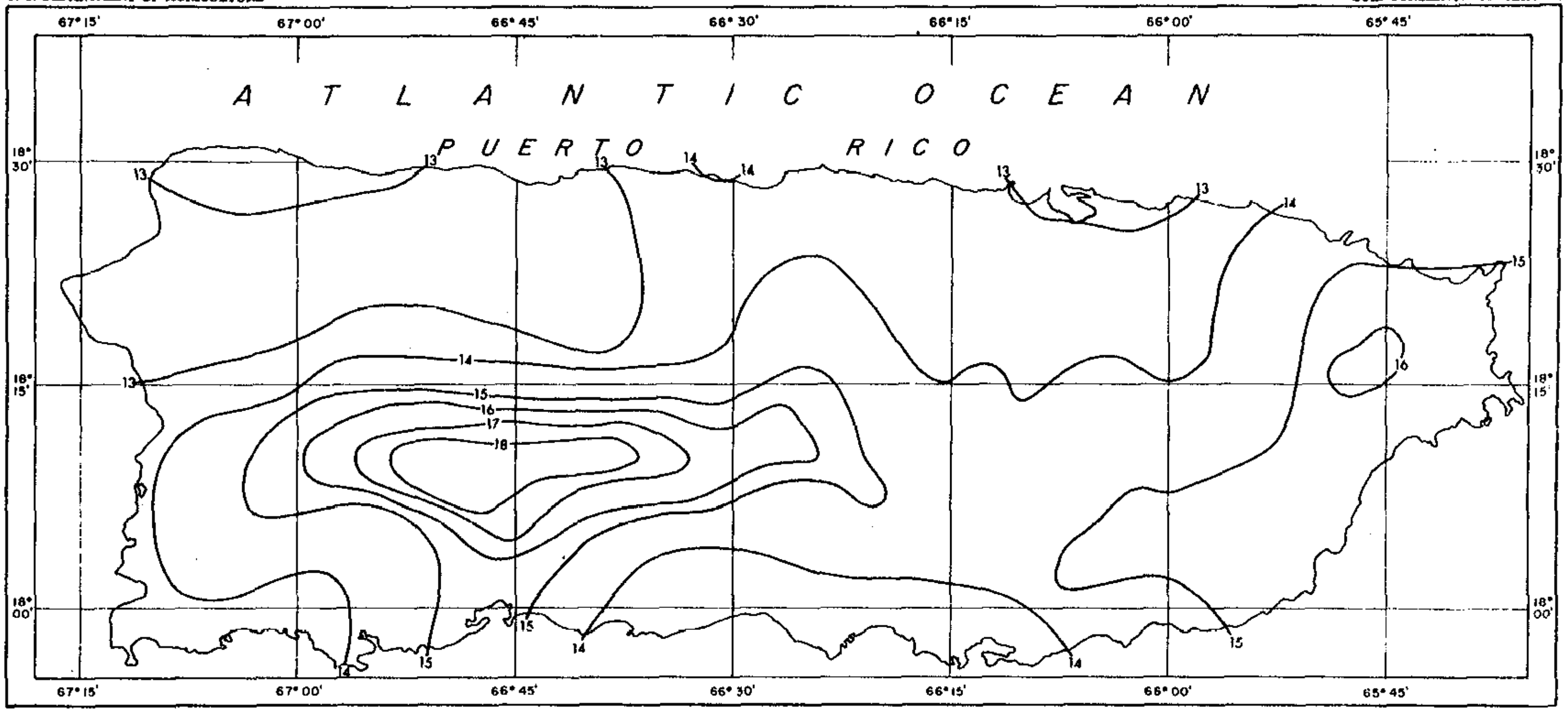
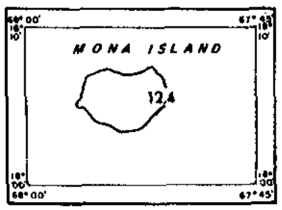
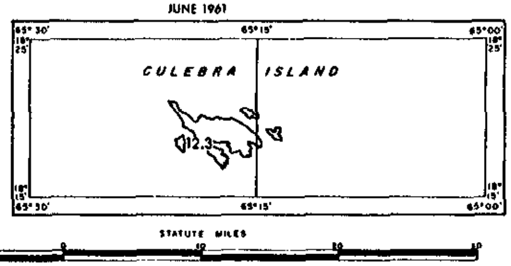
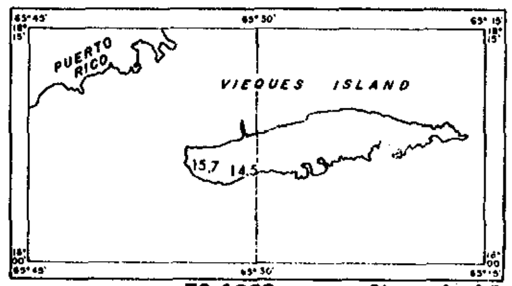


MINIMUM SIX-HOUR PRECIPITATION (INCHES) FOR DEVELOPING THE EMERGENCY SPILLWAY HYDROGRAPH FOR CLASS (c) STRUCTURES

JUNE 1961







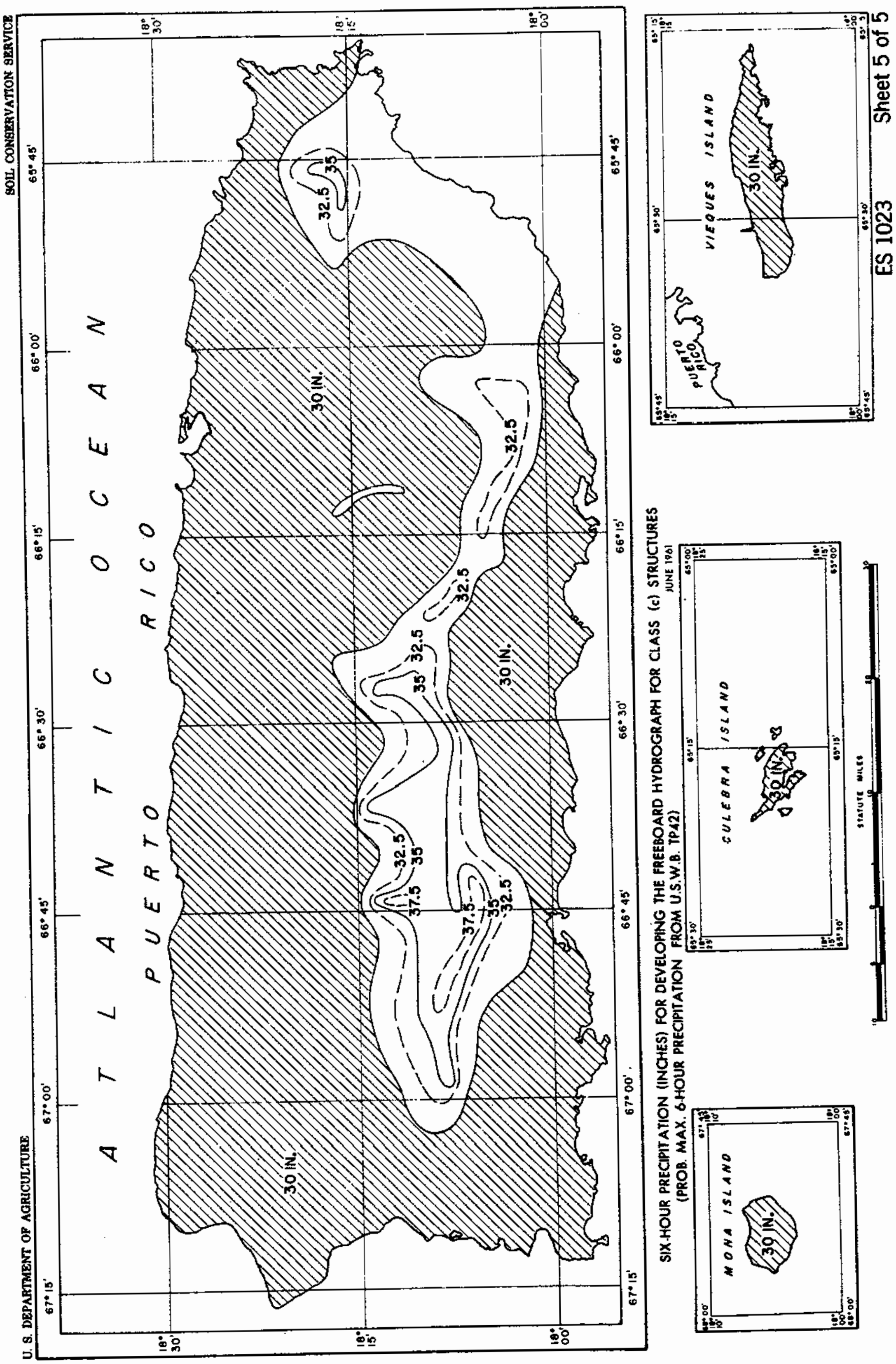
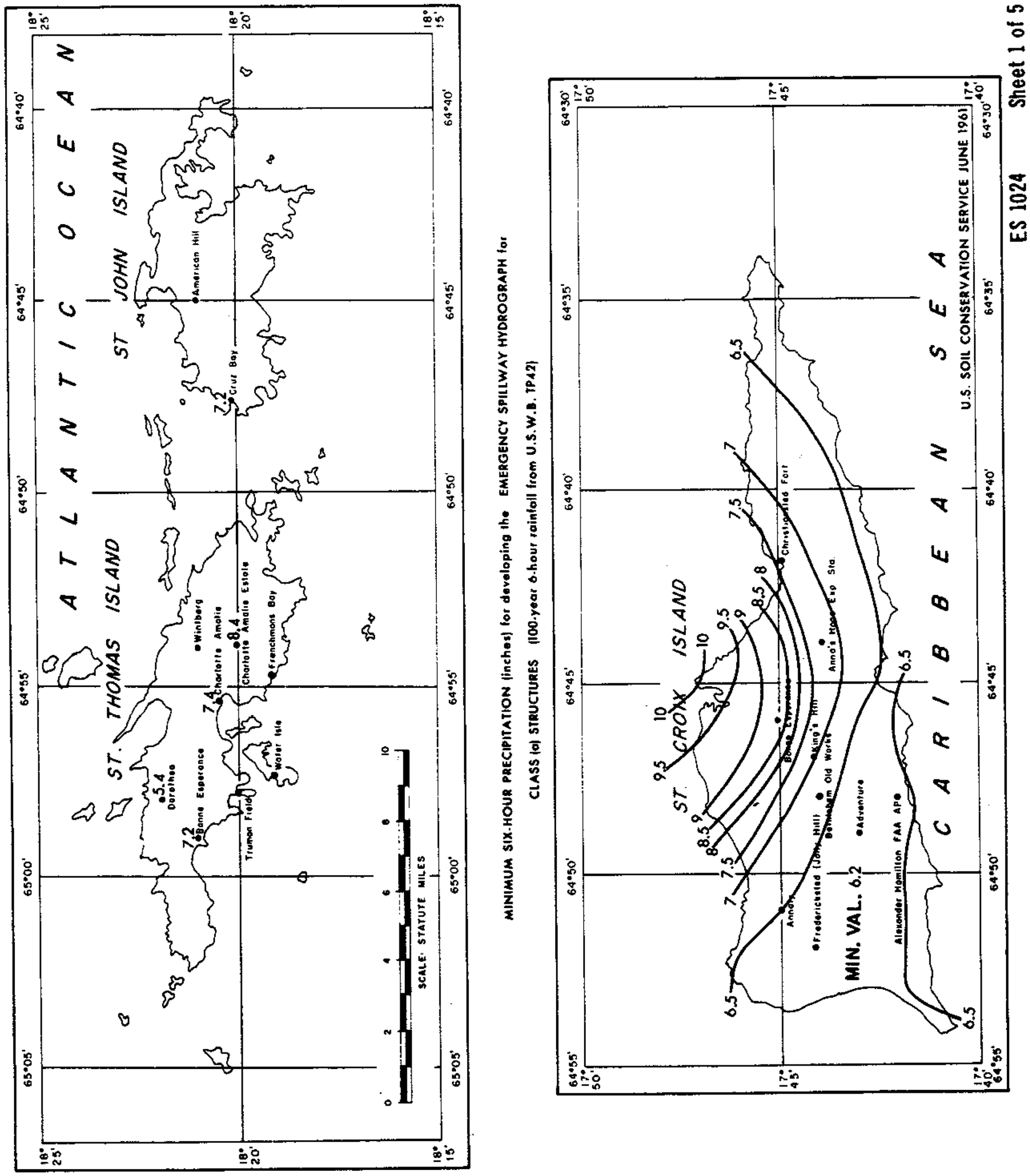
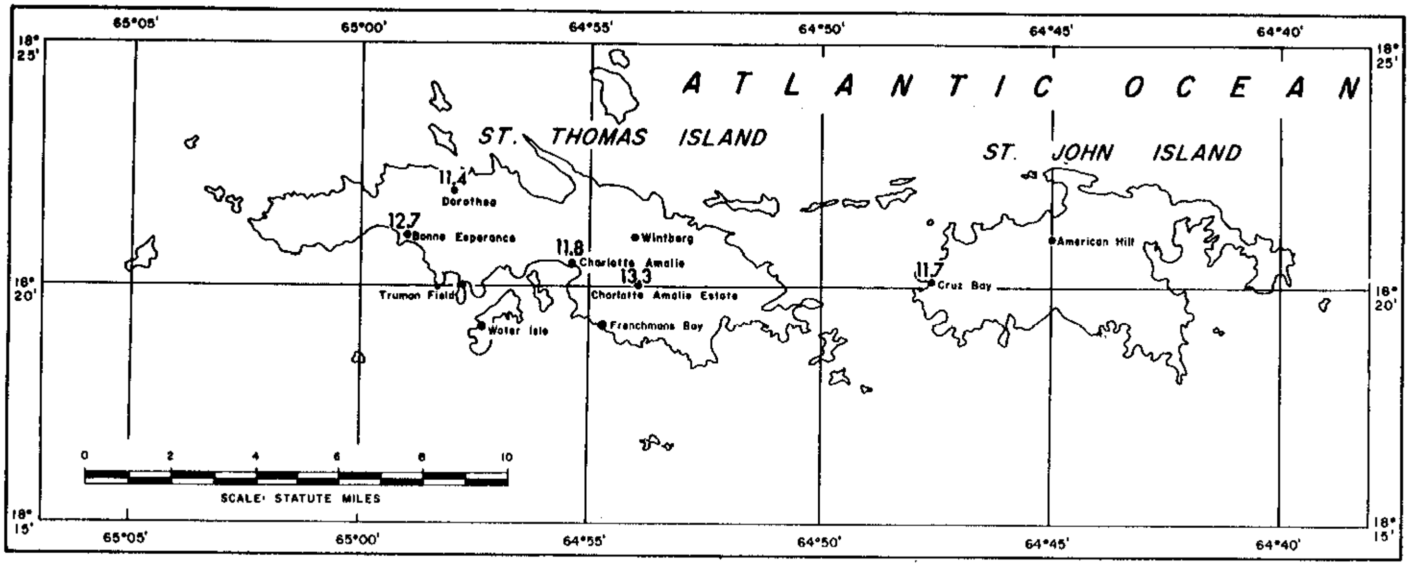


FIGURE 21.8 (5 of 5)

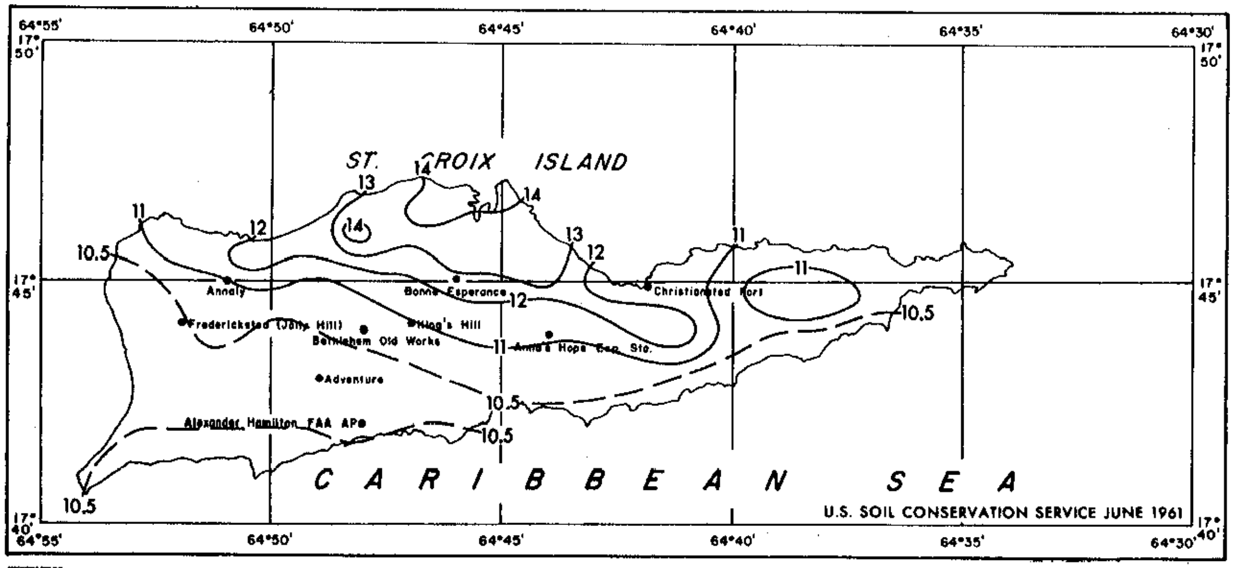


MINIMUM SIX-HOUR PRECIPITATION (inches) for developing the EMERGENCY SPILLWAY HYDROGRAPH for CLASS (a) STRUCTURES (100-year 6-hour rainfall from U.S.W.B. TP42)

FIGURE 21.9 (1 of 5)



MINIMUM SIX-HOUR PRECIPITATION (inches) for developing the FREEBOARD HYDROGRAPH for CLASS (a) STRUCTURES or the EMERGENCY SPILLWAY HYDROGRAPH for CLASS (b) STRUCTURES



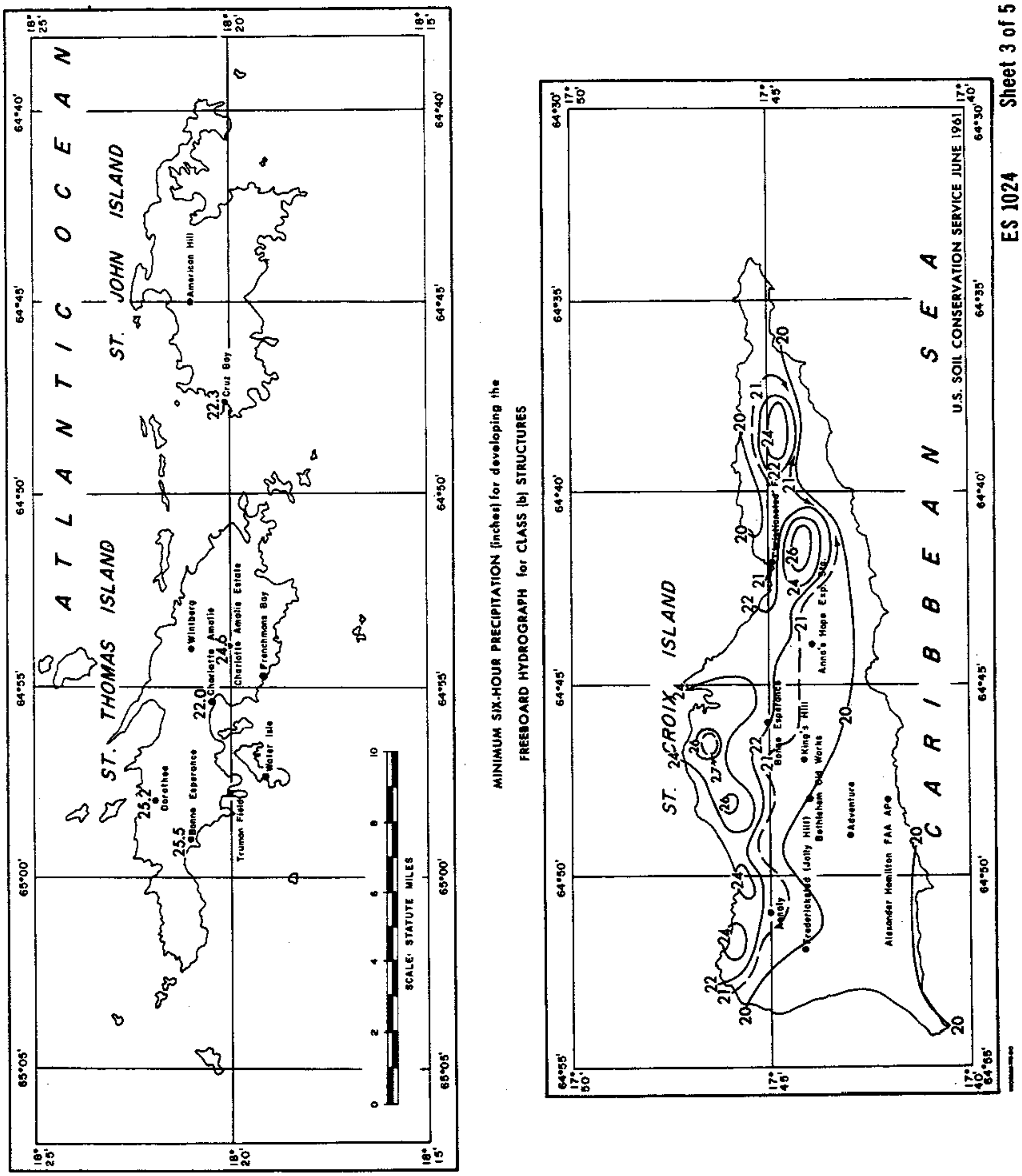


FIGURE 21.9 (3 of 5)

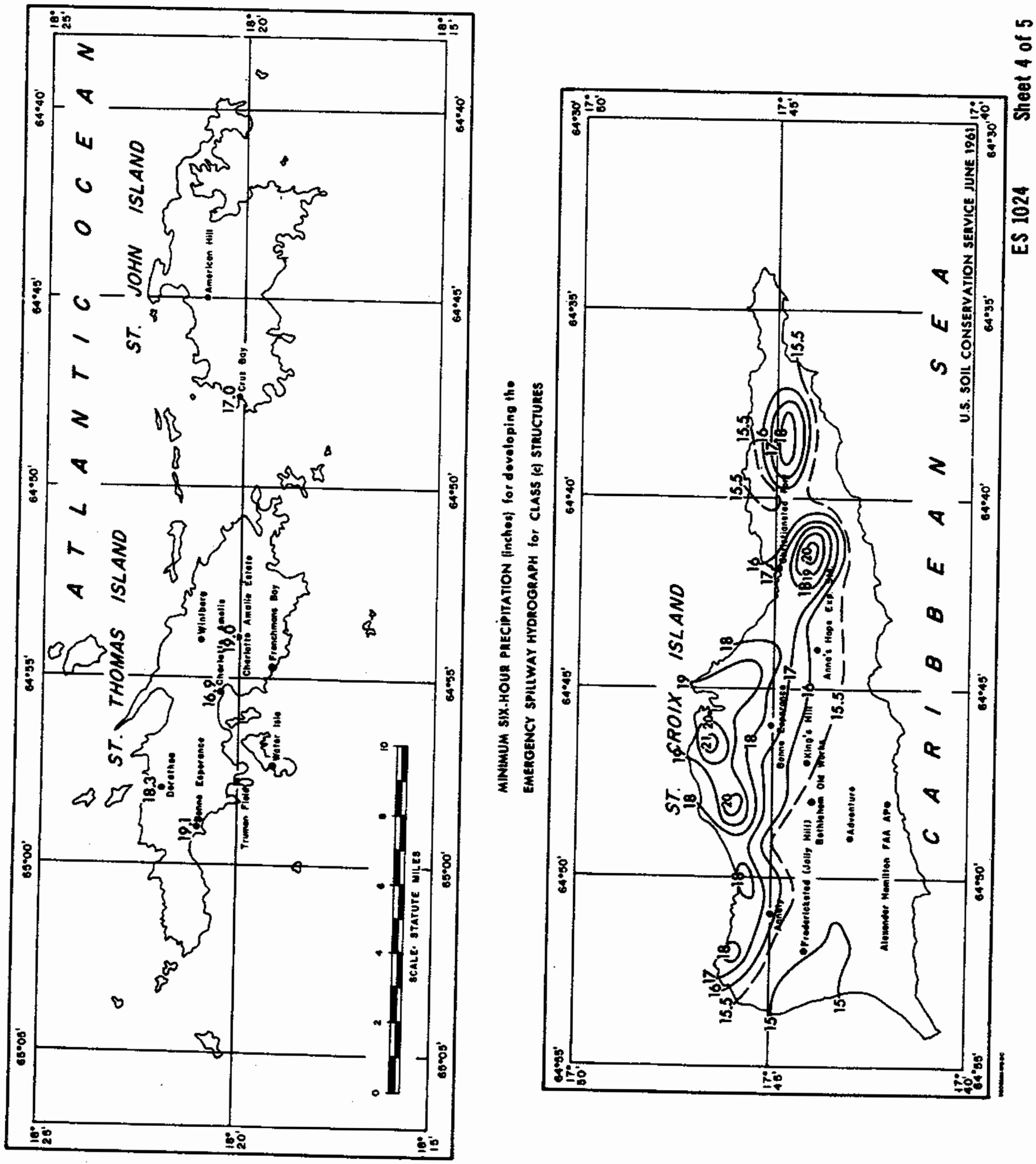
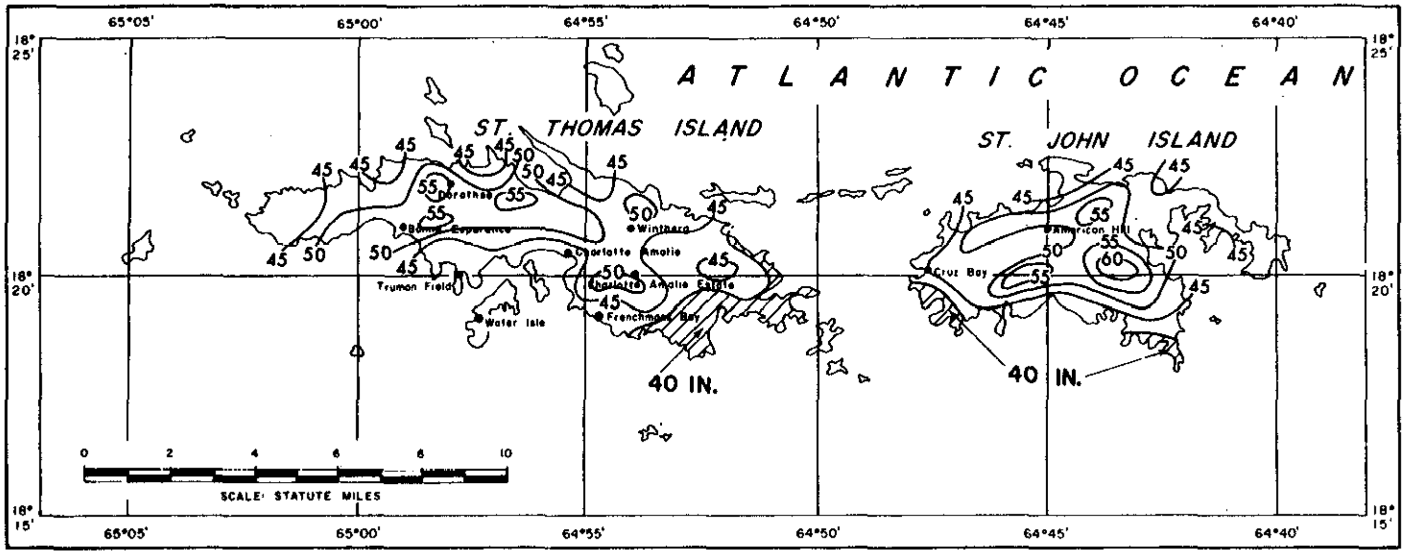


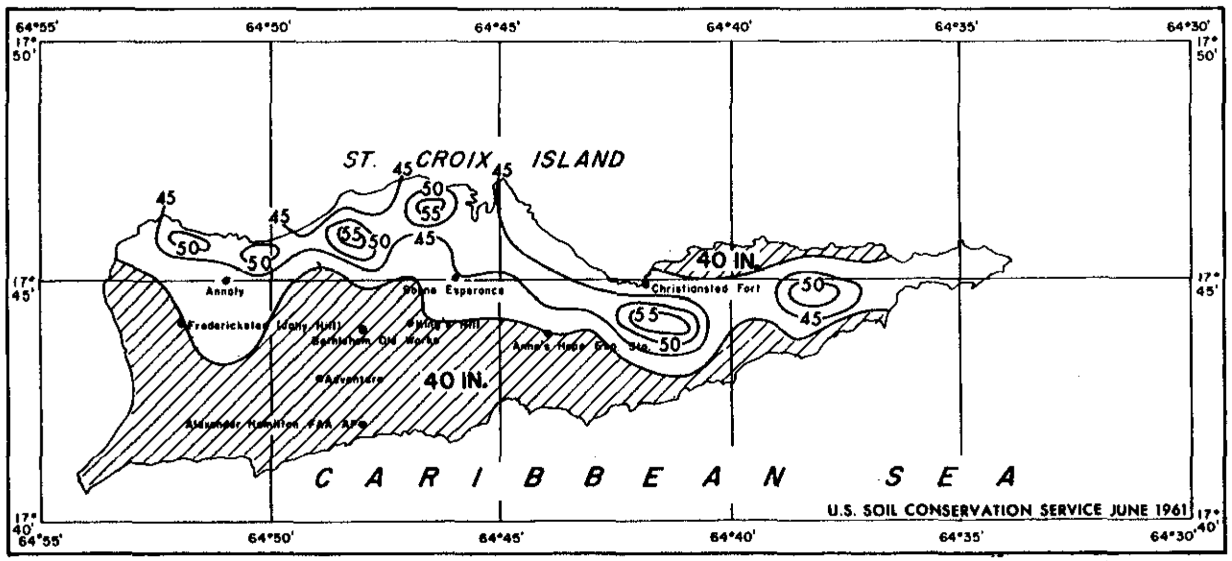
FIGURE 21.9 (4 of 5)

FIGURE 21.9 (5 of 5)



SIX-HOUR PRECIPITATION (inches) for developing the FREEBOARD HYDROGRAPH for CLASS (c) STRUCTURES

(Prob. max. 6-hour Precipitation from U.S.W.B. TP42)



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