CITY OF COLORADO SPRINGS

DEPARTMENT OF PUBLIC WORKS • PHONE 634-4881 • P.O. BOX 1575
MUNICIPAL BUILDING • COLORADO SPRINGS, COLORADO 80901

July 7, 1971

Hartzell-Pfeiffenberger and Associates, Inc.
210 St. Paul Street
Denver,
Colorado 80206

ATTENTION: Andy Pfeiffenberger

Dear Andy,

Enclosed herewith please find one approved copy of the Drainage Basin Study for Cheyenne Mountain Ranch.

You will note that we have approved this subject to detailed drainage plans being submitted with subdivision plats.

Should you have any questions, please feel free to contact me.

Sincerely,

George Jury

George Jury
City Engineer

GWJ:naw

Enc.

Hartzell - Pfeiffenberger and Associates, Inc.

210 St. Paul Street · Denver, Colorado 80206 · Phone 399-0360

June 1, 1971

Mr. DeWitt L. Miller
Director of Public Works
City Hall
107 North Nevada Avenue
Colorado Springs, Colorado 80902

Dear Deke:

We are enclosing herewith the results of our Drainage Basin Hydrologic Studies for the remainder of the Cheyenne Mountain Ranch property of Gates Land Company. This report, in essence, completes the drainage basin investigation for the proposed Gates project.

Should you desire to have additional copies for the Drainage Board or make a formal presentation to the board members, we will be happy to provide an explanation personally.

Very truly yours,

HARTZELL - PFEIFFENBERGER AND ASSOCIATES, INC.

A. R. Pfeiffenberger

mlm

Enclosure

cc: Mr. Thomas O. Speer w/encl.

DRAINAGE BASIN HYDROLOGIC STUDIES

CHEYENNE MOUNTAIN RANCH

El Paso County, Colorado

BY: HARTZELL - PFEIFFENBERGER

May 17, 1971

Developer:

GATES LAND COMPANY
155 West Lake Avenue
Colorado Springs, Colorado 80906

Engineering Consultants:

HARTZELL - PFEIFFENBERGER AND ASSOCIATES, INC.
210 St. Paul Street
Denver, Colorado 80206

DRAINAGE BASIN HYDROLOGIC STUDIES
FOR
GATES LAND COMPANY

GENERAL

This report presents a summary of the results of the hydrologic studies made in connection with the master planning for the drainage system for a portion of the Cheyenne Mountain Ranch of the Gates Land Company. The study was made of major drainage basins designated as Areas III through VIII and supplements an earlier report covering Areas I and II (Reference 1).

The major part of the area lies between State Highway 115 and Cheyenne Mountain south of the City of Colorado Springs. The land slopes generally to the east, ranging from about 2% near the highway to very steep on the mountain slopes. A number of drainage channels carry storm runoff from the west, most of which eventually finds its way into Fountain Creek. All of these channels normally carry little or no surface flow, but for short periods of time they may carry large volumes of water resulting from the high intensity storms which sometimes occur in the region. The prediction of the magnitude and frequency of occurrence of such flood flows is a part of the science of hydrology.

Drainage systems can be divided into two broad general categories. The first may be referred to as the major drainage system which deals with relatively large quantities of flow, makes extensive use of natural drainage channels and has as its objective the prevention of major property damage or loss of life. Because of the importance of this system to the safety of a community it usually is designed for a storm of high intensity and very rare occurrence. A design storm often used has a return frequency of 100 years, or, more accurately, is one that has a 1% probability of occurring in a given year.

A second type of drainage system, referred to as the initial drainage system, has as its primary purpose the prevention of inconvenience, minor property damage or excessive maintenance. Normally this consists of a series of storm sewers and channels for the control of runoff from relatively small areas and which carry the flow to the major system. Since it is usually not economically feasible, nor necessary from a practical standpoint, to construct such a system for storms of rare occurrence, more frequent and less intense storms are generally recognized as acceptable for design purposes. Storm recurrence frequencies of from 2 years for residential areas to 10 years for downtown business sections are commonly used (References 2 and 3).

DESIGN STORM RAINFALL

The predictions of the magnitude, intensity, and frequency of storms are based on official U. S. Weather Bureau records. These records for the City of Colorado Springs began in 1889 and because of the length of record they can, when used in conjunction with other stations similarly located, provide reliable information as to storm frequencies, especially for the smaller storms. Figure 1 shows graphically the results of Weather Bureau data from Technical Papers 24 and 40 (References 4 and 5), and from the more recent Isopluvial Charts of Colorado dated October, 1967 (Reference 6). These data show a maximum total rainfall of 2.65 inches in one hour for the 100-year storm and 1.70 inches per hour for the 10-year frequency. Since records from Climatological Data for Colorado (Reference 7) of the U. S. Department of Commerce show a maximum recorded rainfall for 24 hours to be only 3.09 inches (1954) at the Colorado Springs station in the 80-year period, it should be evident that the one-hour values given should be very conservative for design purposes. It may be noted that the City of Colorado Springs currently requires the use of a 2-inch, 1-hour storm for the design of all drainage systems, regardless of type.

For the development of flood hydrographs it is necessary to know the storm time distribution pattern as well as its total magnitude. Because of the relatively small size of the basins under study a 3-hour storm totaling 3.18 inches of rainfall, with 2.65 inches the first hour, was chosen for the 100-year flood hydrograph determinations. Based on observations of storm intensities of shorter duration the design storm was further subdivided into 10-minute periods and the probable precipitation for the various periods determined graphically, as shown in Figure 1. The values thus found are listed in Table 1 and are then rearranged, as shown, in the pattern likely to produce the most severe runoff conditions. This storm time distribution was then used for the determination of flood hydrographs for all streams in the region.

FLOOD HYDROGRAPHS

In order to provide complete information on the probable stream flow at various points for future design, the major basins were subdivided into smaller areas at the junction points of the better defined streams. The boundaries of these major basins and sub-basins are shown in Figure 16. Also shown are the specific design points at which flows were calculated. In cases where major tributaries came together the hydrographs for each were first determined and the total flow at the junction then found by adding the individual values, taking into account variations, if any, in the times of the occurrence of the peaks. Thus the magnitude of the peak at a particular point is not necessarily in all cases the sum of the peaks of the tributaries joining at that point.

For drainage basins of this size the unit hydrograph method is generally considered to be the most reliable for the determination of flood hydrographs.

This is based on actual observations of the behavior of streams after storms on particular or similar watersheds. Since no records of stream flow in this area were available it was necessary to develop the flood hydrographs from synthetic unit hydrographs. These are calculated on the basis of watershed characteristics such as area, slope, shape, length of stream, infiltration capacity and artificial drainage structures, if any. The method used is referred to as the Colorado Urban Hydrograph Procedure as recommended by the Drainage Criteria Manual of the Denver Regional Council of Governments. The procedure is outlined in detail in Reference 2 and will not be described here.

The flood hydrographs found for the 100-year storm for the various basins are shown in Figures 2 - 15. These assume existing natural conditions except that rainfall detention and infiltration losses have been based on the planned future development of the area insofar as it is known. In most cases this resulted in runoff factors of nearly 80% of the first hour of rainfall, or a net runoff of approximately 2 inches. All highway structures were assumed to pass the calculated flows without retardance and no detention storage was considered. It may be noted that the highway culvert near the remnants of the Curr dam is not of sufficient size to pass the flows shown on the hydrographs. However, the detention storage available west of the highway before the road is overtopped is so small in comparison to the flood volume that the culvert will have virtually no effect on the natural flood peak.

The results of the flood hydrograph calculations are summarized in Tables 2 and 3. As is the usual case, the flood peaks and volumes are larger for the large basins, but the runoff intensity per unit of area, in cubic feet per second per square mile, is greater for the small areas. Because of the small volume of runoff of the latter it is most easily modified by detention storage.

It is expected that the Curr Reservoir will be reconstructed in the near future and that the detention flood storage available will have a significant effect on the flood flow downstream. These effects are being reported in connection with the dam design. Included in the current studies are hydrographs showing the flood flow into the reservoir as well as that which will bypass the reservoir under natural conditions. This latter flow has a peak of more than 1300 cfs and exceeds the capacity of the Highway 115 culvert at this location by a substantial amount. It therefore appears that occasional overtopping of the highway and flooding of the area west of the road is likely unless corrective measures are taken.

Respectfully submitted,

HARTZELL - PFEIFFENBERGER AND ASSOCIATES, INC.

Warren W. DeLapp, P.E.

REFERENCES

1. "Drainage Study, Broadmoor Mesa First Filing", Hartzell - Pfeiffenberger and Associates, Inc., August, 1969.

2. "Urban Storm Drainage", Denver Regional Council of Governments, March, 1969.

3. "Design and Construction of Sanitary and Storm Sewers", American Society of Civil Engineers Manual No. 37. 1969.

4. U. S. Weather Bureau Technical Paper No. 24, "Rainfall Intensities for Local Drainage Design in the United States". August, 1954.

5. U. S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States", May 1961.

6. "Isopluvial Charts of Colorado", Special Studies Branch, Office of Hydrology, U. S. Weather Bureau, October, 1967.

7. "Climatological Data for Colorado", U. S. Department of Commerce.

W.D. 1105 original

TABLE I

100-YEAR DESIGN RAINFALL

FOR THE COLORADO SPRINGS REGION

Time from Beginning of Storm (min.)	Total Rainfall (in.)	Incremental Rainfall (in.)	Design Rainfall (in.)
0	0	0	0
10	1.30	1.30	.35
20	1.72	.42	.42
30	2.07	.35	1.30
40	2.28	.21	.21
50	2.48	.20	.20
60	2.65	.17	.17
70	2.72	.07	.07
80	2.78	.06	.06
90	2.84	.06	.06
100	2.90	.06	.06
110	2.94	.04	.04
120	2.98	.04	.04
130	3.02	.04	.04
140	3.05	.03	.04
150	3.08	.03	.03
160	3.12	.04	.03
170	3.15	.03	.03
180	3.18	.03	.03
Totals		3.18	3.18

TABLE 2

100-YEAR STORM FLOWS IN AREA III SUB-BASINS
UNDER EXISTING CONDITIONS

Design Point	Drainage Area Ac.	Time to Peak Min.	Flood Peak CFS	Flood Volume Ac.Ft.	Peak CFS/Sq.Mi.	Includes Area
A	132	40	506	23.1	2460	
B	906 84	60	1542	155.5	1090	B, C, D
C	372	50	834	64.0	1435	
D	450	60	870	77.2	1240	
E	481 90	60	924	79.5	1230	E,F,G,H,I
F	50	40	205	8.7	2560	
G	144	40	404	23.8	1830	
H	341 95	50	709	57.0	1310	G, H, I
I	102	50	283	17.5	1425	
J	68	40	204	10.9	1920	
K	53	40	177	8.7	2130	
L	714 170	60	1129	122.5	1020	L, M, N
M	544 75	50	1005	95.5	1198	M, N
N	469	50	989	84.0	1355	
P	332	40	855	58.5	1645	
Q	62	40	239	10.8	2470	
R	65	40	210	11.4	2060	
S	2686	70	3711	461.0	885	Total less Q,R
T	1167	60	1700	201.0	930	J,K,L,P
A+B+E	1519	60	2683	258.1	1132	Curr Inflow
L+J+K	835	60	1337	142.1	1030	Curr By-pass at Hwy 115

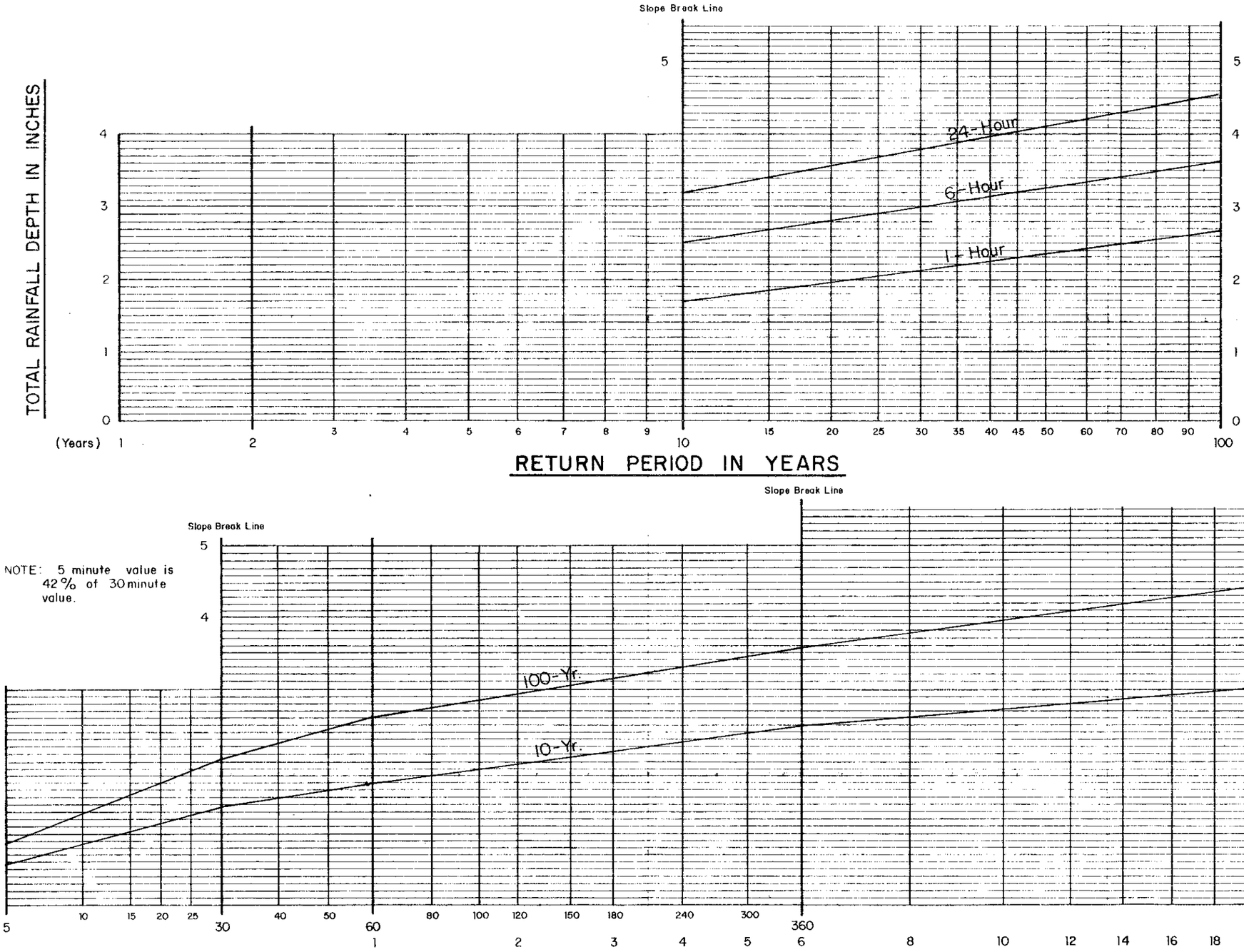
S is flow at east property line without reservoir storage.

T is flow at east property line including Curr Reservoir by-pass.

TABLE 3

100-YEAR FLOWS IN AREAS IV - VIII

Design Point	Drainage Area Ac.	Time to Peak Min.	Flood Peak CFS	Flood Volume Ac.Ft.	Peak CFS/Sq.Mi.	Includes Area
4 A	42	40	138	6.7	2120	
B	163	50	424	28.0	1670	4A
C	235	50	505	41.0	1375	4A, B
5 A	168	40	557	27.3	2120	
B	297	50	643	50.0	1385	5A
6 A	366	50	769	60.6	1350	
B	459	60	818	77.1	1140	6A
C	660	60	1120	109.5	1090	
7	44	40	162	7.3	2350	
8	85	40	351	14.7	2700	



Section ___, T. ___, R. ___ W.

RAINFALL
DEPTH - DURATION - FREQUENCY GRAPHS

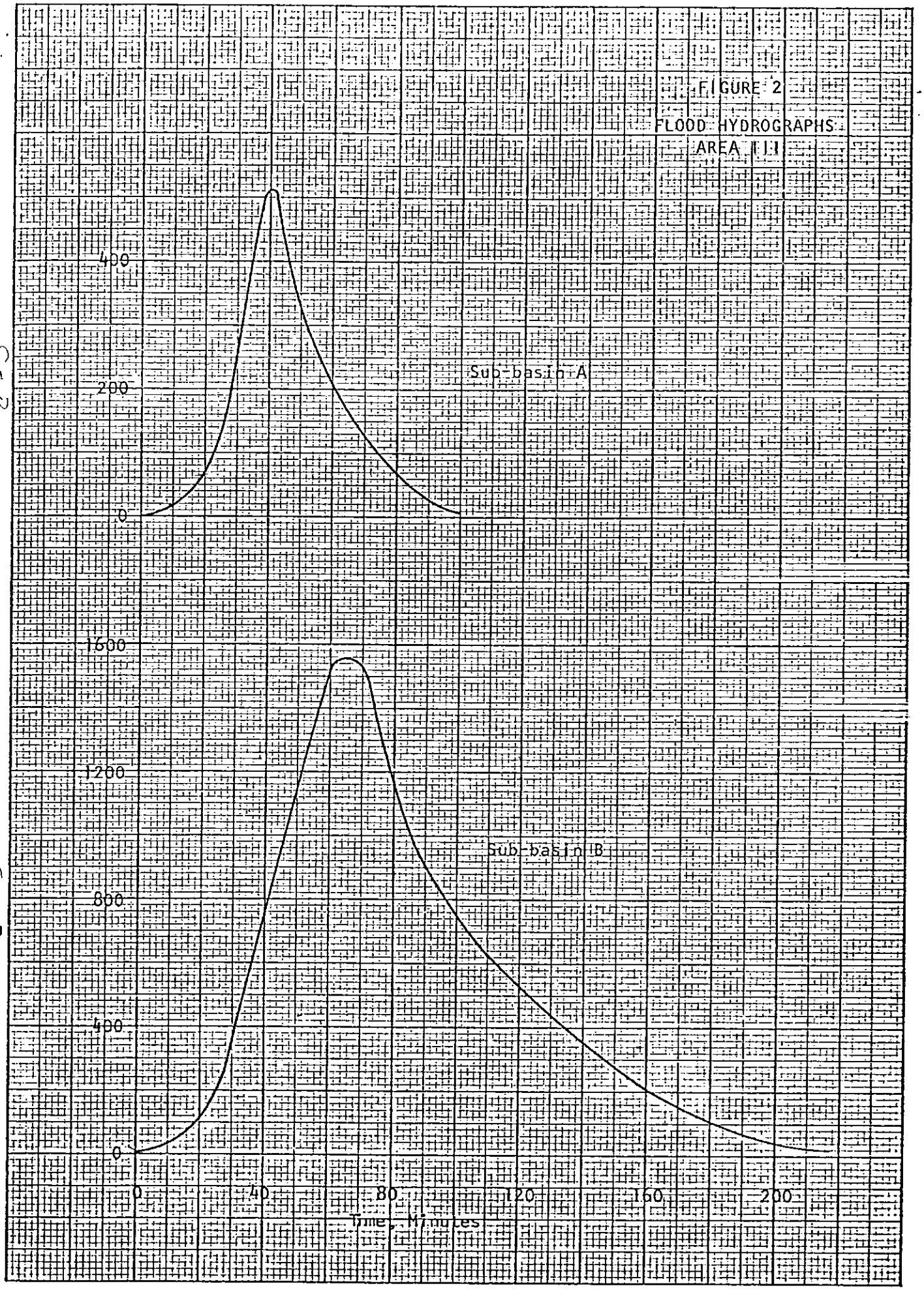
COLORADO SPRINGS REGION

Figure 1

FIGURE 2

FLOOD HYDROGRAPHS

AREA III



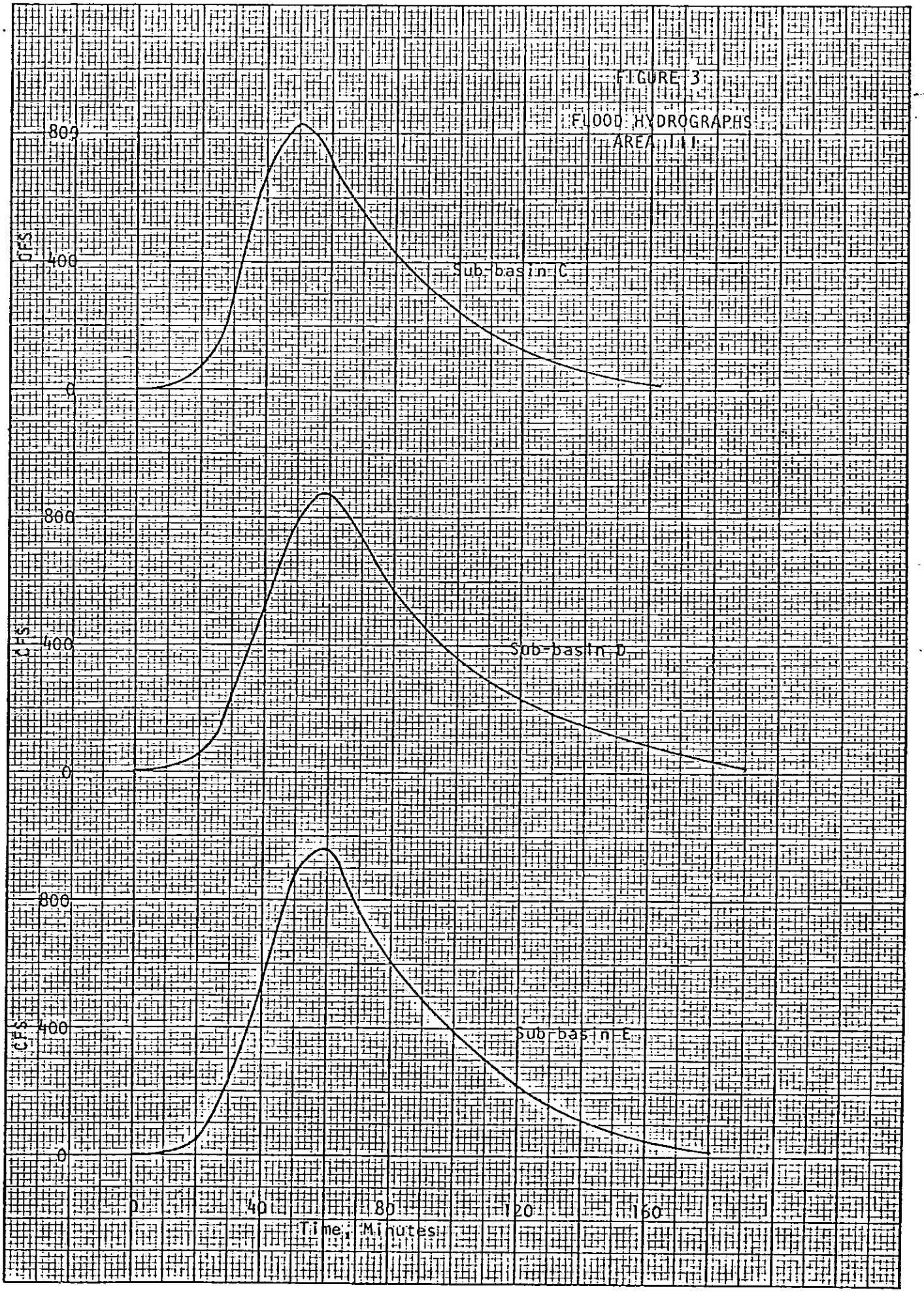
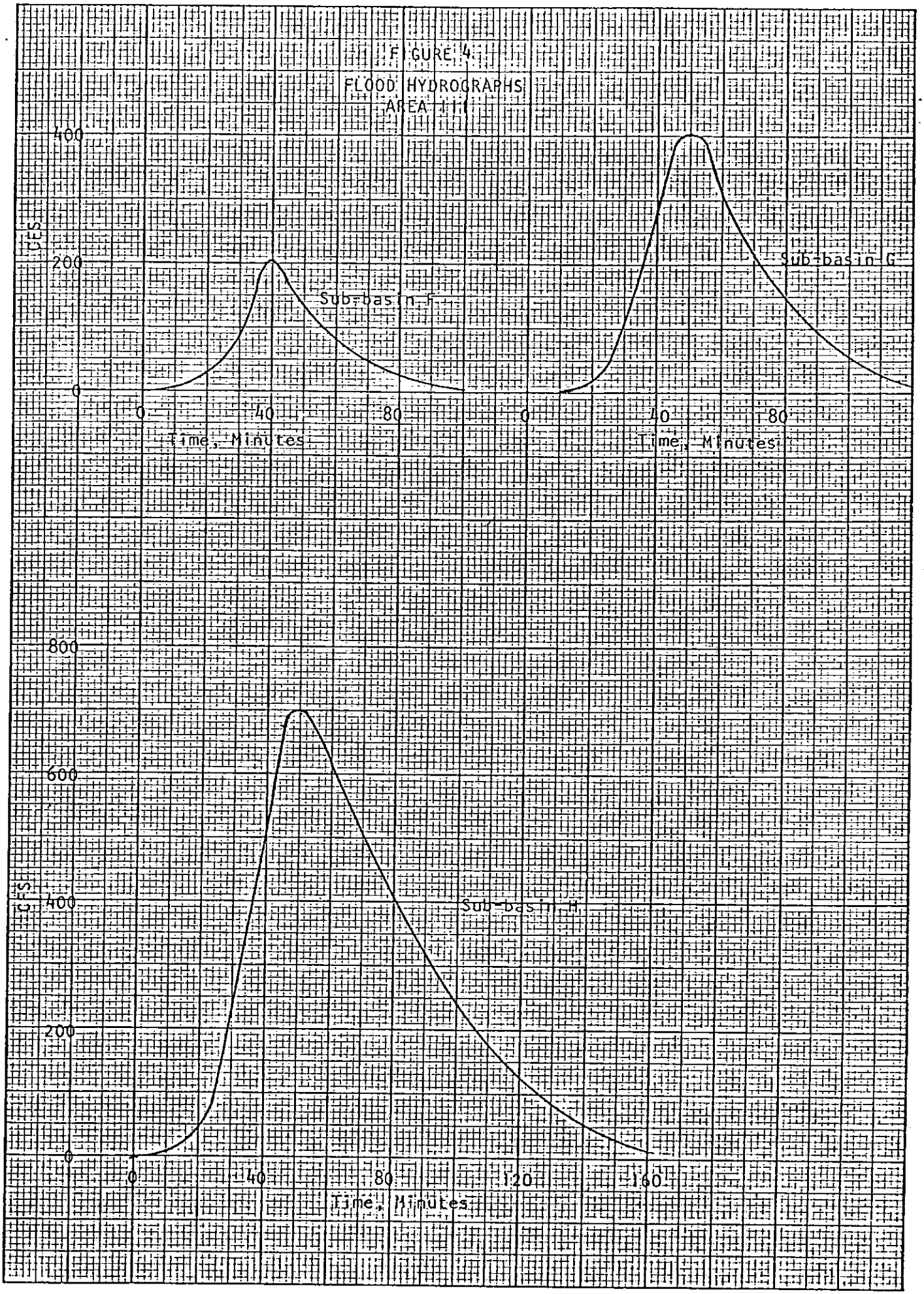


FIGURE 3
FLOOD HYDROGRAPHS
AREA I & II
800
400
0
CFS
Sub-basin C
Sub-basin D
Sub-basin E
0
40
80
120
160
Time, Minutes

FIGURE 4

FLOOD HYDROGRAPHS
AREA III



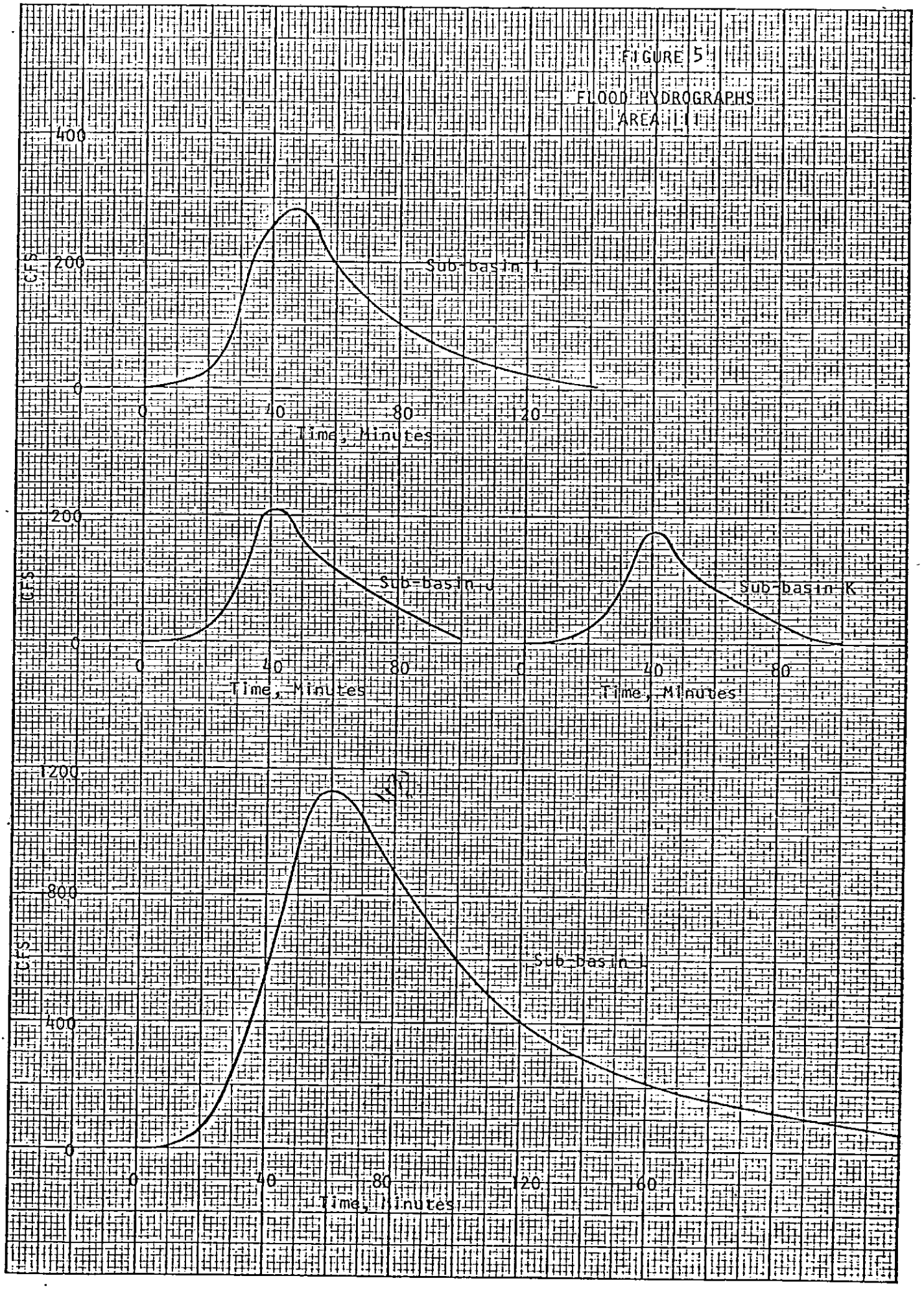


FIGURE 5
FLOOD HYDROGRAPHS
AREA III
Sub-basin I
Sub-basin J
Sub-basin K
Sub-basin L
CFS
Time, Minutes
0
40
80
120
160
200
400
800
1200

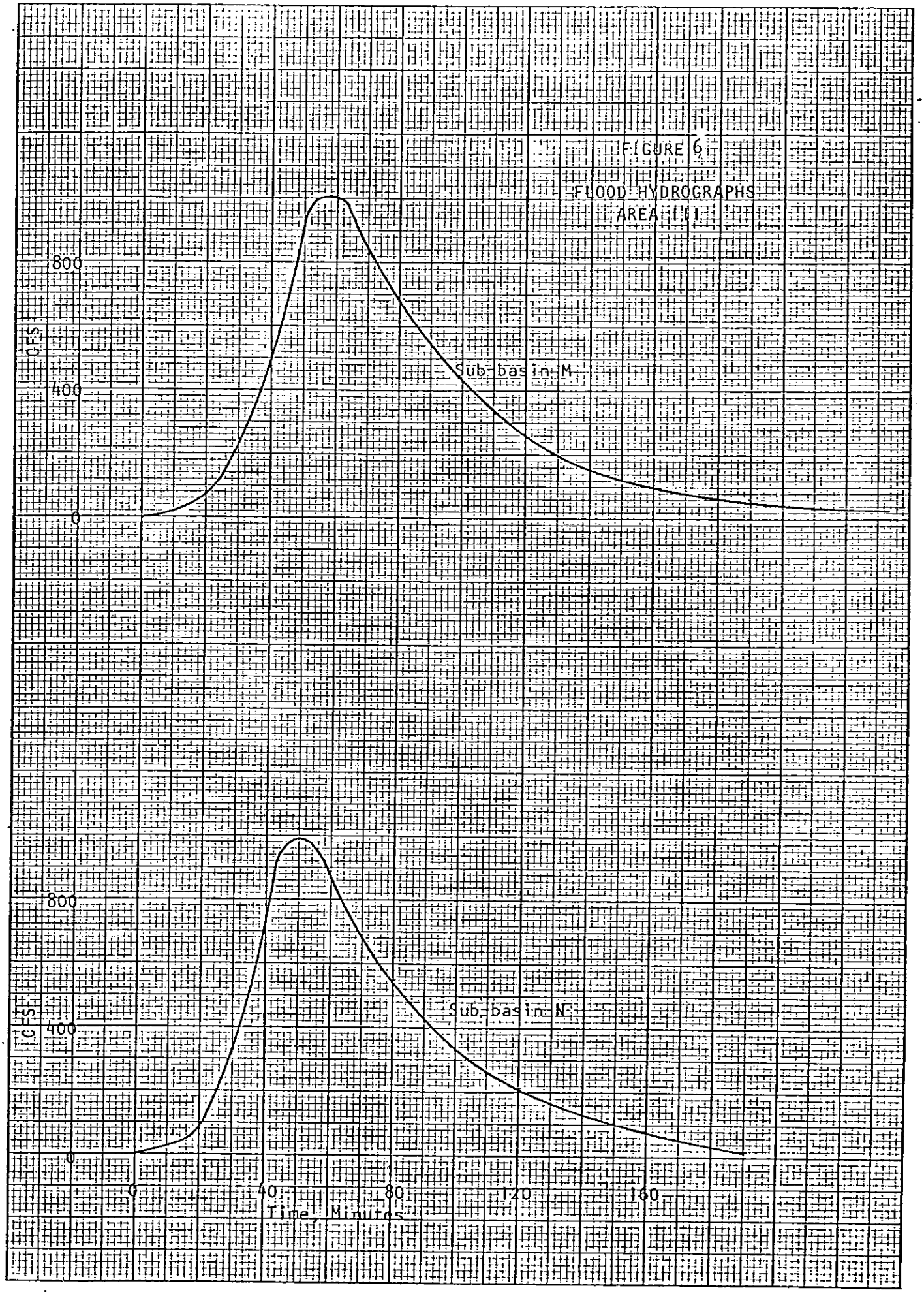


FIGURE 6
FLOOD HYDROGRAPHS
AREA III
800
400
0
CFS
Sub-basin M
800
400
0
CFS
Sub-basin N
0
40
80
120
160
Time, Minutes

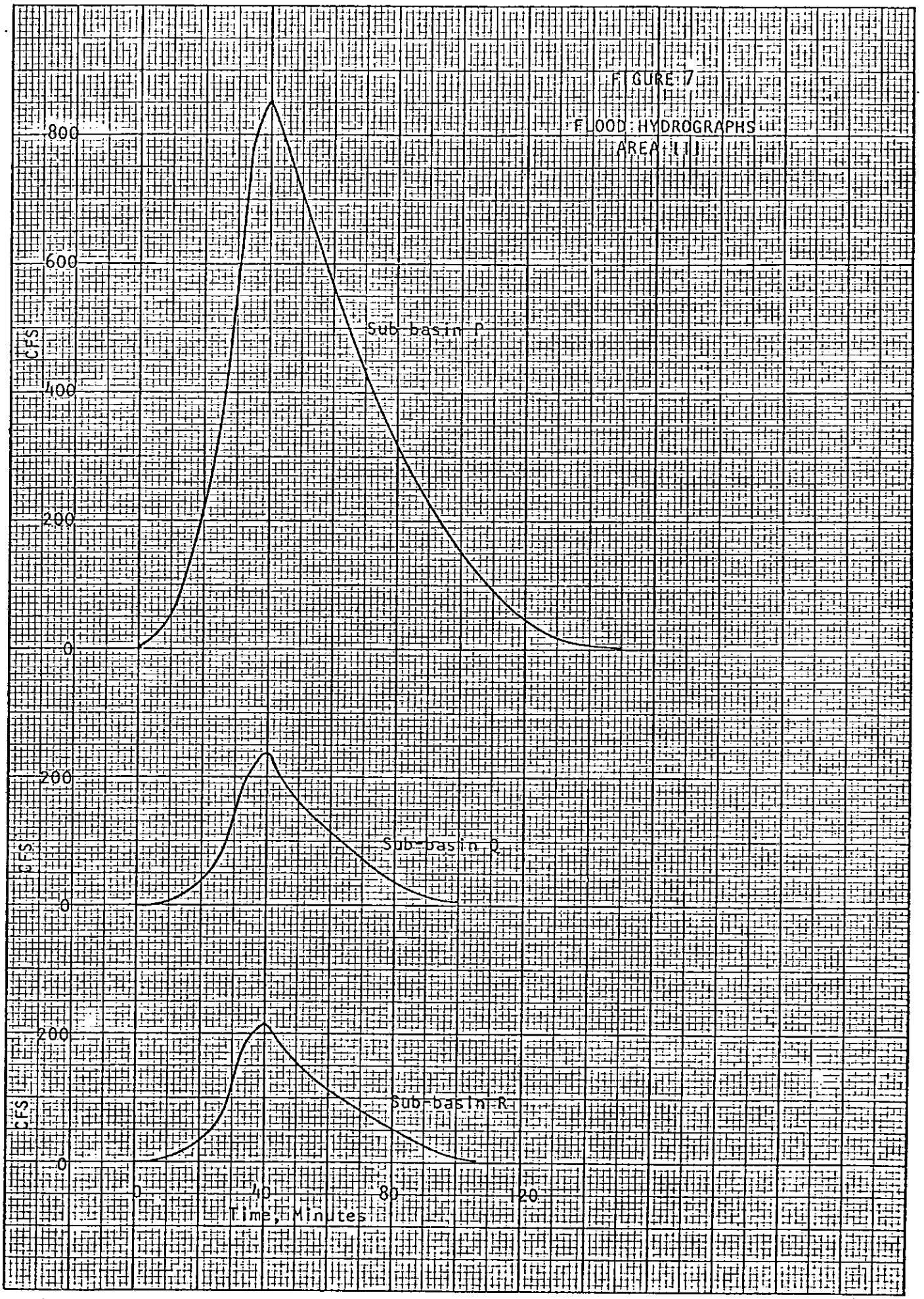


FIGURE 7
FLOOD HYDROGRAPHS
AREA III
800
600
400
200
0
CFS
Sub-basin P
200
0
CFS
Sub-basin Q
200
0
CFS
Sub-basin R
0
40
80
120
Time, Minutes

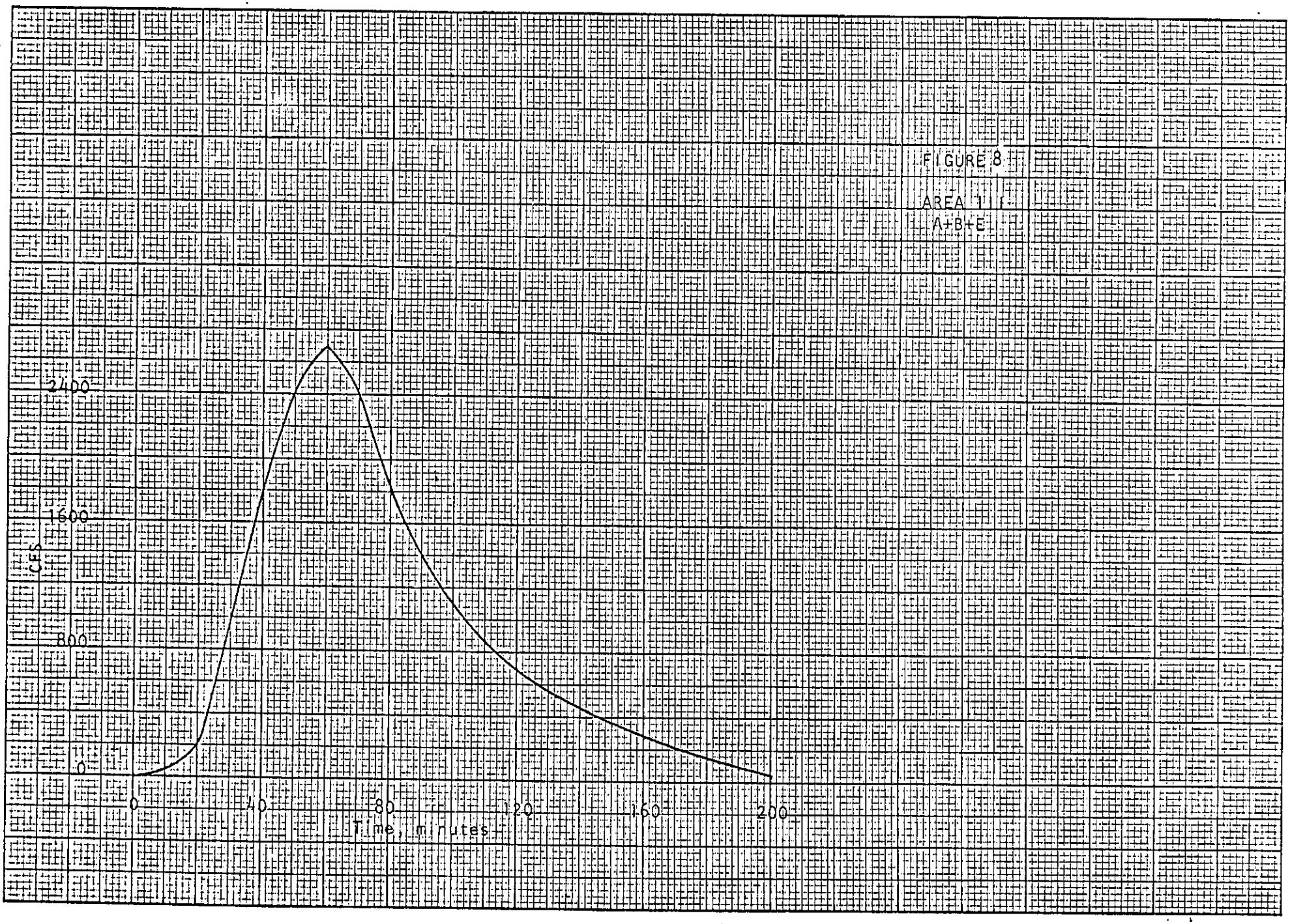


FIGURE 8
AREA 1 IE
A+B+E
2400
1600
800
0
CFS
0
40
80
120
160
200
Time, minutes

FIGURE 9

FLOOD HYDROGRAPH

AREA II

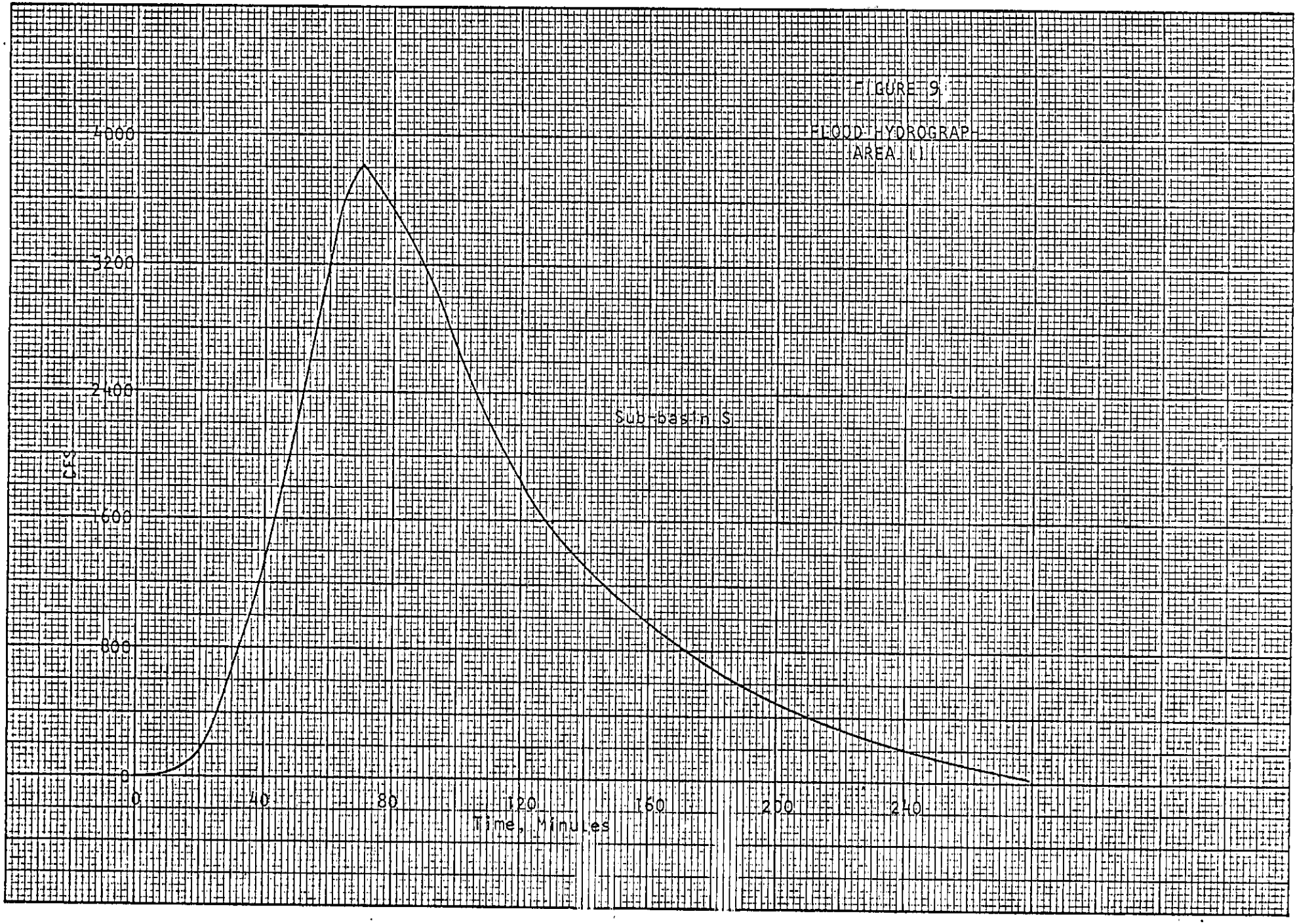


FIGURE 10

FLOOD HYDROGRAPH
AREA III
Sub-basin T

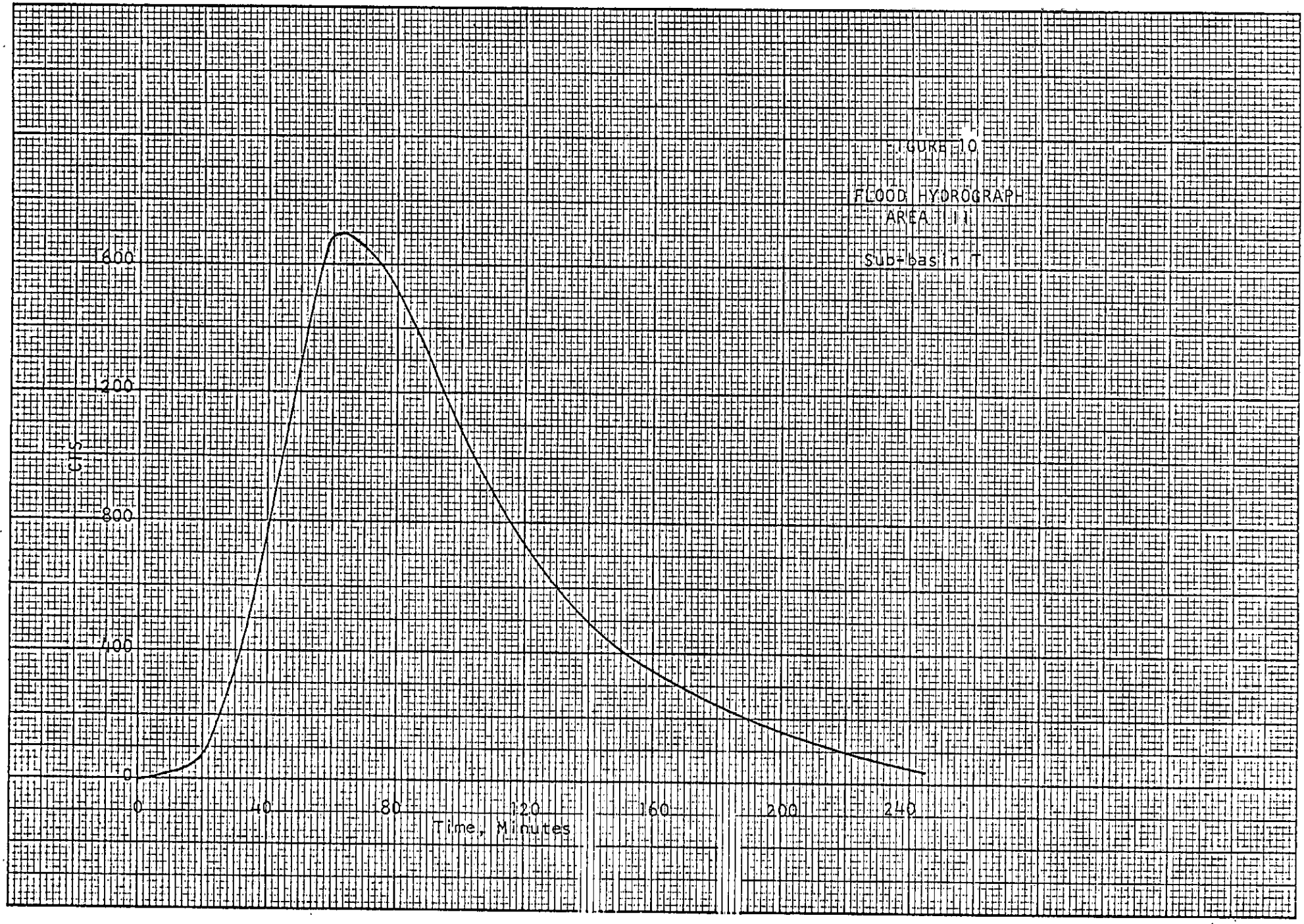
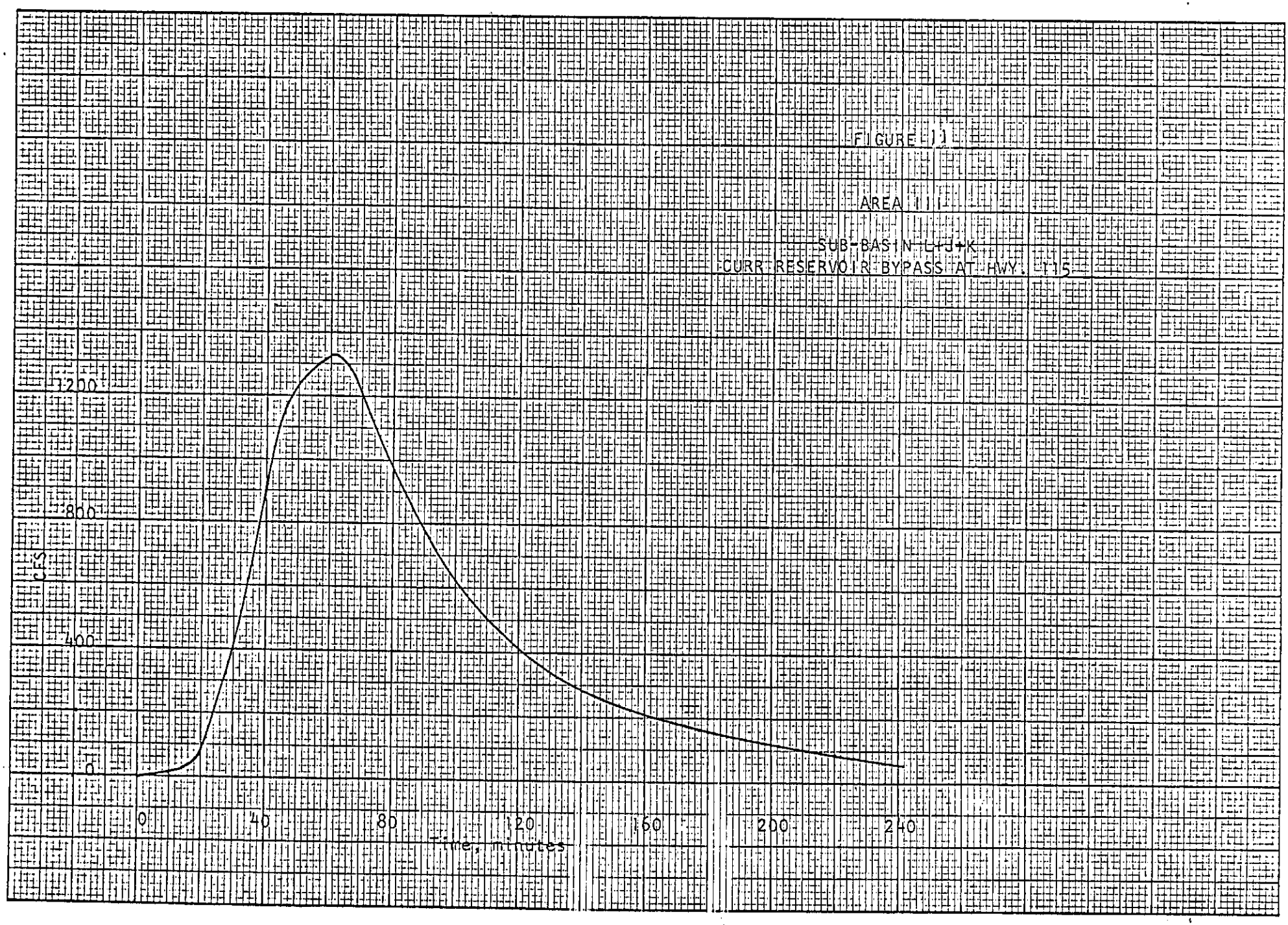


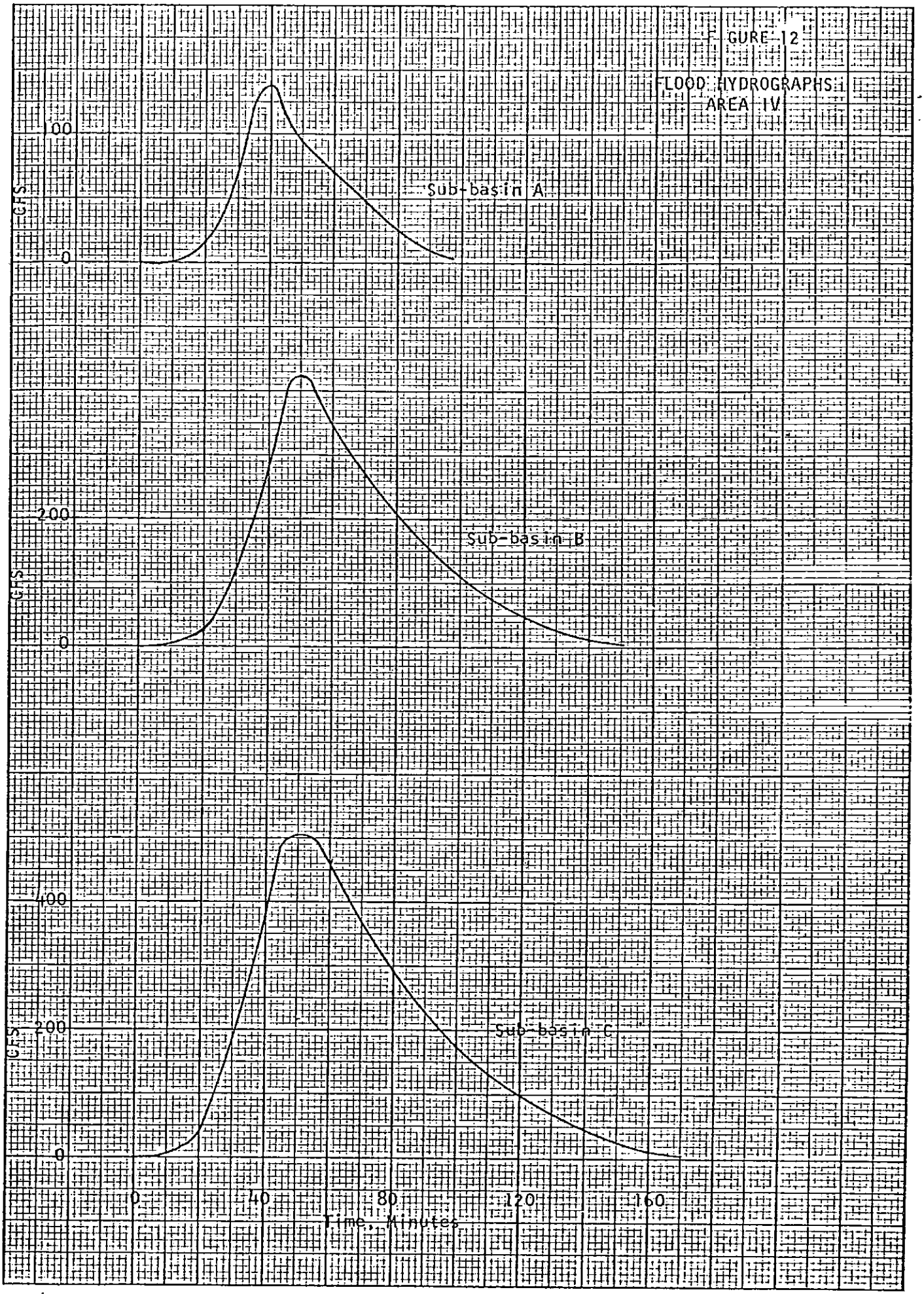
FIGURE 11

AREA III

SUB-BASIN L+J+K

CURR RESERVOIR BYPASS AT HWY. 115



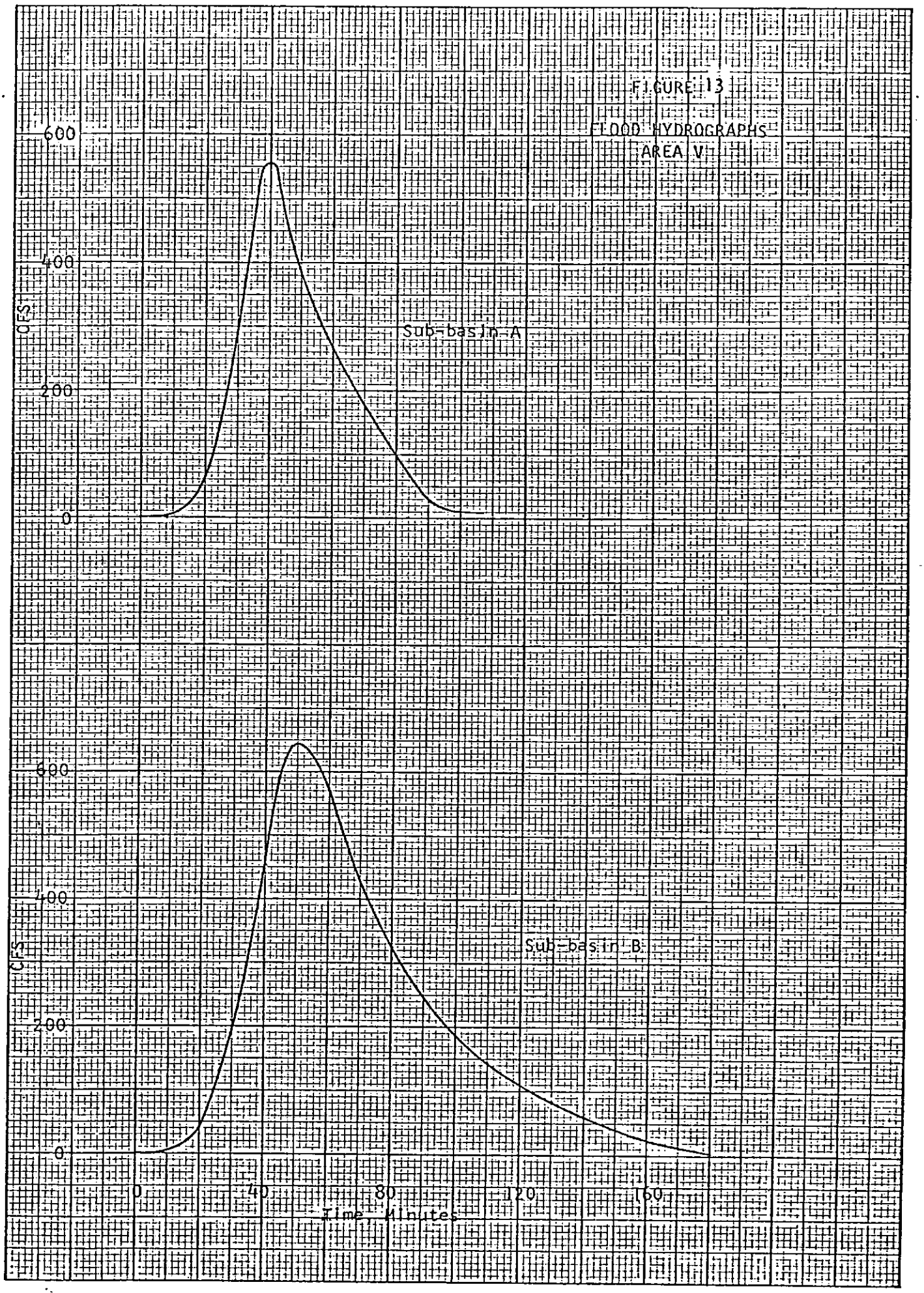

FLOOD HYDROGRAPHS
AREA IV
Sub-basin A
Sub-basin B
Sub-basin C
CFS
100
0
200
0
400
200
0
0
40
80
120
160
Time, Minutes

GURE 12

FIGURE 13

FLOOD HYDROGRAPHS

AREA V



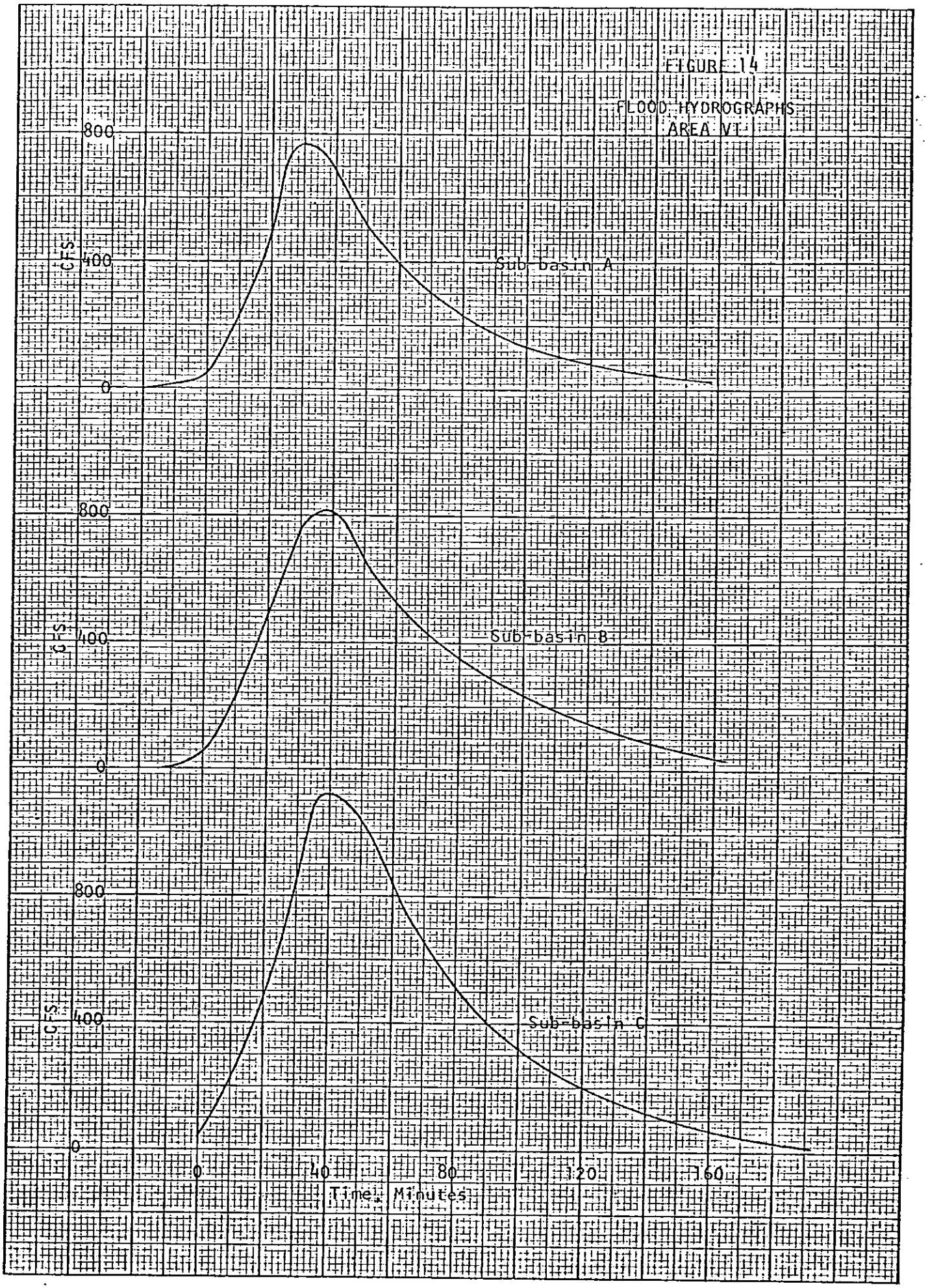


FIGURE 14
FLOOD HYDROGRAPHS
AREA VI
800
400
0
CFS
Sub-basin A
800
400
0
CFS
Sub-basin B
800
400
0
CFS
Sub-basin C
0
40
80
120
160
Time, Minutes

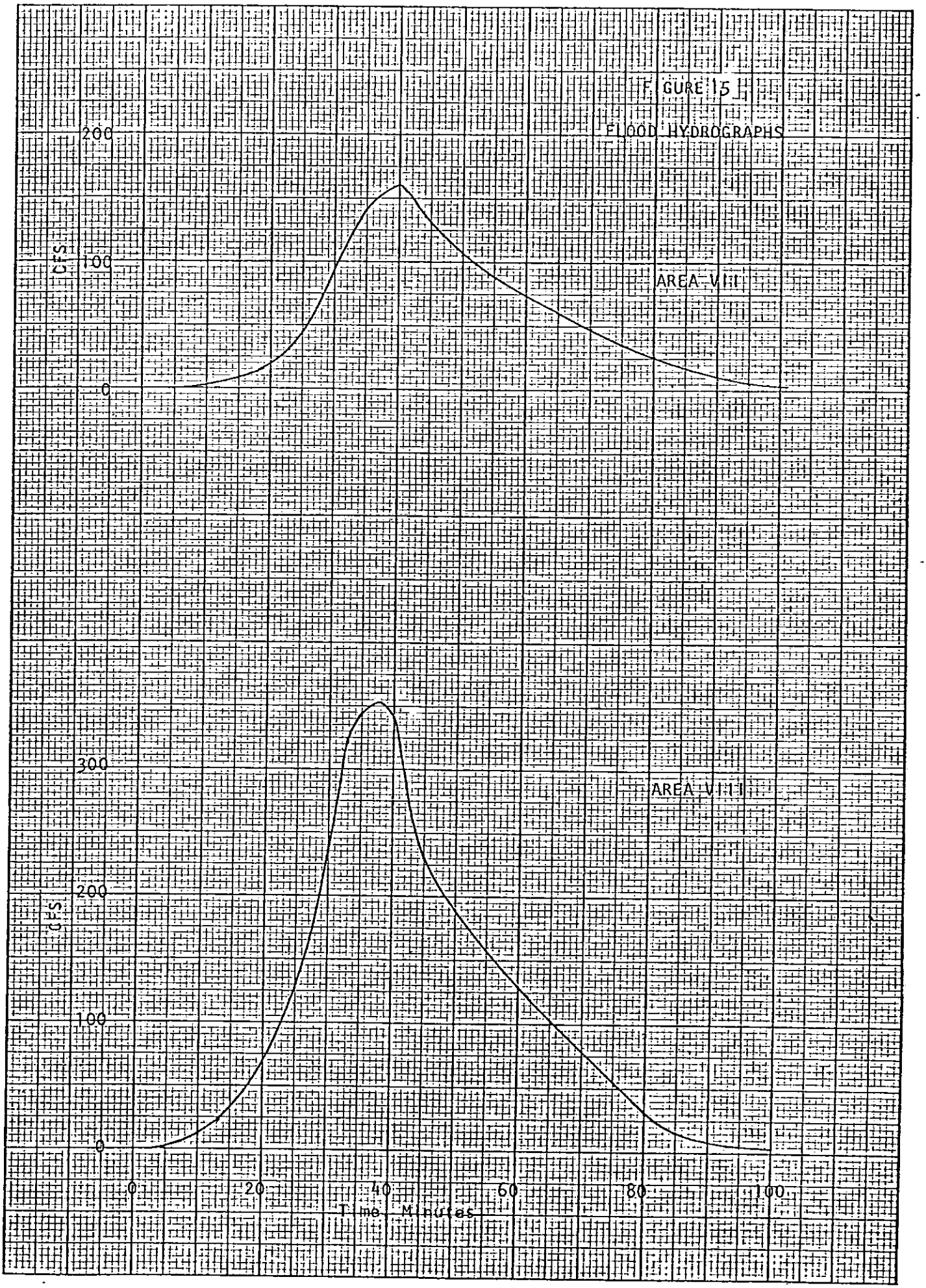
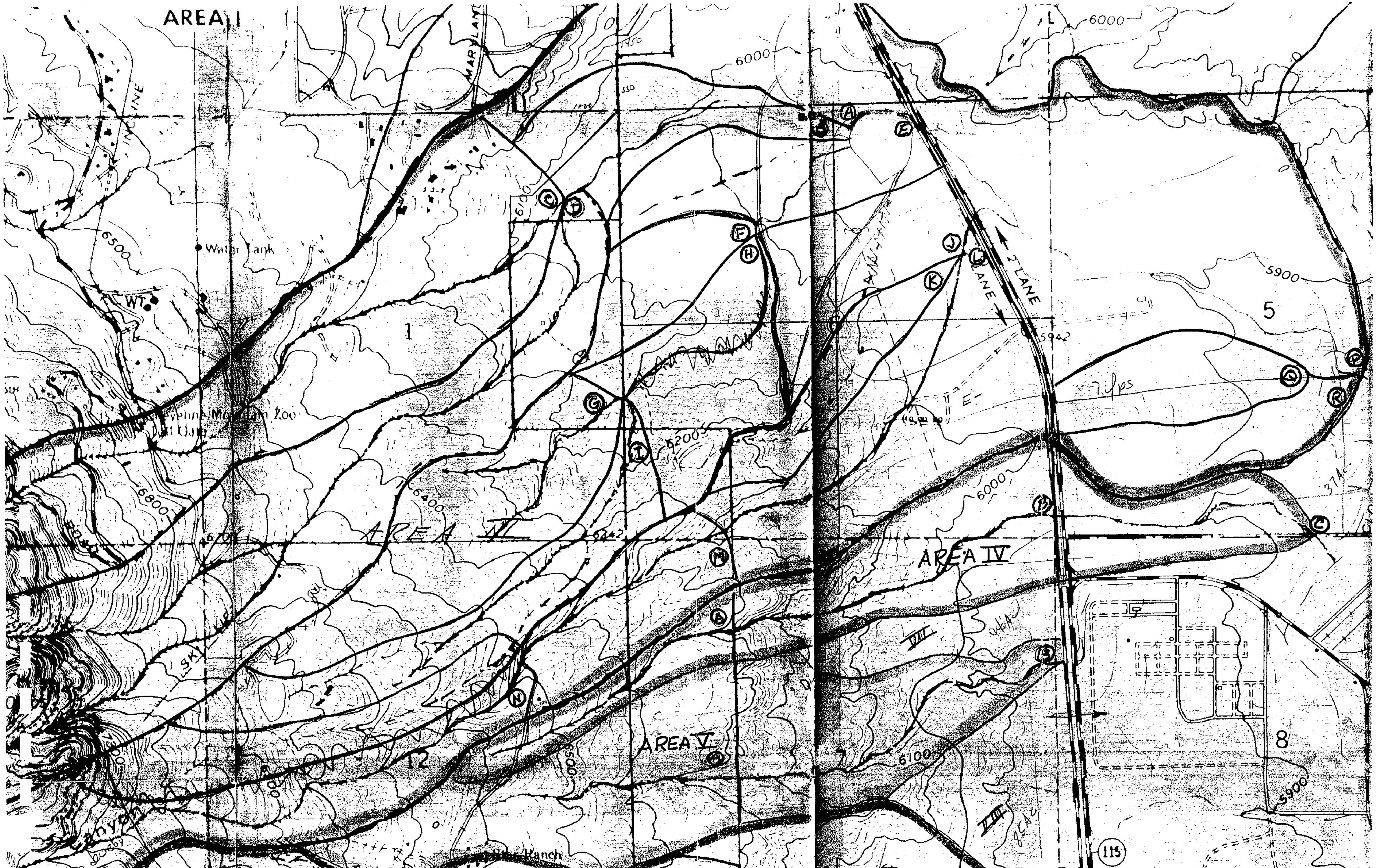
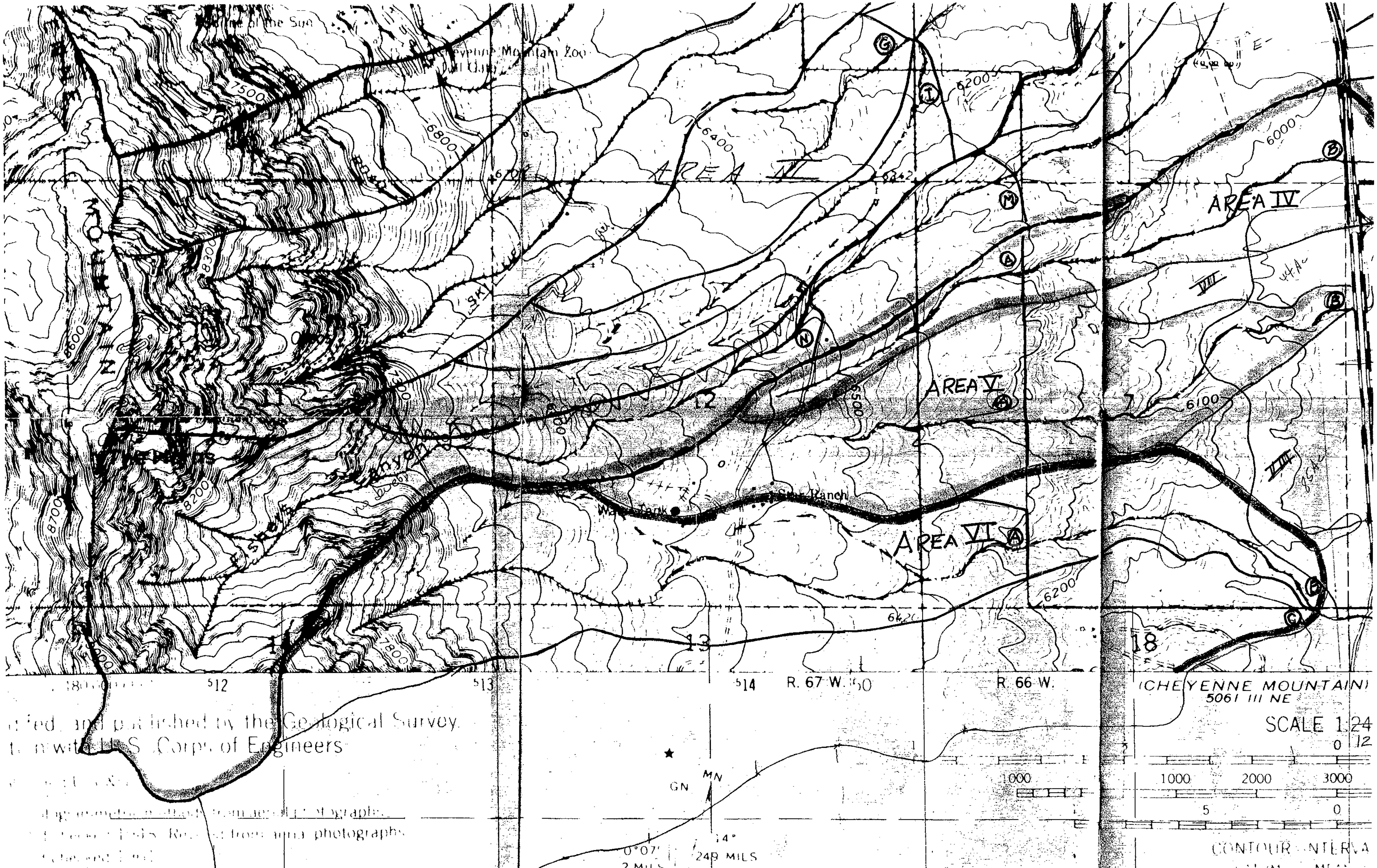


FIGURE 15
FLOOD HYDROGRAPHS
AREA VIII
AREA VIII
CFS
200
100
0
300
200
100
0
0
20
40
60
80
100
Time Minutes


AREA I
AREA II
AREA IV
AREA V
MARYLAND
INCLINE
Water Tank
WT.
Cheyenne Mountain Zoo
2 LANE
LANE
6000
5900
6500
6800
6400
6200
6100
1
5
8
12
115



Cheyenne Mountain Zoo
7500
6800
6400
6200
6000
8300
8200
8700
8600
6100
6200
AREA IV
AREA V
AREA VI
12
13
18
Water Tank
Ranch
512
513
514
R. 67 W.
R. 66 W.
(CHEYENNE MOUNTAIN)
5061 III NE
SCALE 1:24
1000
2000
3000
GN
MN
14°
249 MILS
CONTOUR INTERVA