Approved as to Concept Only
[signature]
12/17/73

MASTER DRAINAGE PLAN

HARRISON STREET - I-25 VICINITY

CHEYENNE MOUNTAIN RANCH

November 15, 1973

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

CERTIFICATION

I, Warren W. DeLapp, a registered engineer in the State of Colorado, hereby certify that the attached master drainage plan and report for Cheyenne Mountain Ranch in the Harrison Road - I-25 Vicinity were prepared under my direction and supervision and are correct to the best of my knowledge and belief. I further certify that said drainage report is in accordance with all City of Colorado Springs Ordinances and specifications and criteria, to the best of my knowledge.

WARREN W. DELAPP
REGISTERED
2645
PROFESSIONAL ENGINEER
STATE OF COLORADO

Date: November 15, 1973

The developer has read and will comply with all of the requirements specified in this drainage report as approved by the City Engineer.

GATES LAND COMPANY

By ______________________

Title Project Engineer

November 15, 1973

MASTER DRAINAGE PLAN
HARRISON STREET - I-25 VICINITY
CHEYENNE MOUNTAIN RANCH

The purpose of this report is to outline the proposed method of providing for storm drainage from a portion of the Gates Land Company Cheyenne Mountain Ranch. As shown on Exhibit A the area lies south of Harrison Road and west of Interstate Highway 25 and comprises a total of approximately 1250 acres. The area is divided naturally into three major basins, one with a channel along Harrison Road, another passing through the Stratton home and known as the North Gully, and the third to the south which will be referred to as the Quail Lake basin. The largest of these is the North Gully originating west of Highway 115 and having a total length to the outfall at I-25 of nearly 4 miles with an average slope of approximately 2%.

The probable 100-year storm flows for selected points in this region were determined in an earlier study and tabulated in a report to the City of Colorado Springs dated August 18, 1969. The designation of outflow points in the present study corresponds insofar as possible with those of the earlier study. Some revisions and additions have been made to increase the accuracy and to make the results more complete. Some of the flows shown are different from those in the original report for various reasons. These include road relocations and land grading which has caused rerouting of the flows, and the effects of detention storage, both existing and planned, which was not included in the original basin studies.

With regard to flow reduction by temporary storage, the most significant effect is that of the Quail Lake dam which reduces the flow at the dam site from a peak of 1040 cfs to 105 cfs for the 100-year storm. In the North Gully there is presently detention storage in a small area west of

Highway 115. The culvert at this point is a 24" CMP which is inadequate for major storms and will cause the water to flow over the highway. Two other detention areas are planned. One will result from the construction of an access road across the gully east of the Stratton home boundary, design point K', where a 72" CMP culvert will cause the 100-year flow to overtop the road for a short period of time and by a small amount. Farther east an existing low dam has been breached at some time in the past, apparently as the result of an inadequate spillway. It is planned to repair the dam and use the old reservoir site for additional detention storage. There is no reason why this should interfere with the use of the detention area for recreation purposes since with proper design flooding of the ground will be of very rare occurrence and of short duration.

Although the detention volumes in the North Gully are relatively small, they do have a significant effect on the peak flows, reducing that at the junction with Highway 85, design point E, from the previously calculated value of 1092 cfs to a peak of 590. Each of the detention ponds not only reduces the peak flow but also delays the movement of the water downstream which aids the depletion of the runoff from the lower reaches before that from the upper basin has arrived. Only the dam and spillway repair will require additional construction costs and these can easily be justified by the reduction in size of the downstream conduits, regardless of the type finally selected.

Construction in some portions of the area has been completed and other subdivisions are being developed. Internal drainage of these various developments is described in other drainage reports. Since the subdivision design storm meets the minimum city requirements of 2 inches in one hour this storm was also used to determine the flows along Harrison Road. For the remainder of the basins, flows were determined for the 100-year storm, precipitation values for which are shown in the accompanying table. Because of the complexity of the drainage system involving detention ponding, it was necessary to develop flood hydrographs for each of the drainage basins. This was done by the Colorado Unit Hydrograph Procedure as described in the Urban Storm Drainage Manual and the flows then combined at various points with due allowance for the time differences in the hydrograph peaks. Inflow-outflow hydrographs were determined for each of the detention areas in order that the downstream effects could be assessed accurately. The peak flows thus determined are shown on Exhibit A.

There are at the present time only two major drainage conduits under Interstate Highway 25. One of these is a box culvert 6 ft. high and 10 ft. wide near the Harrison High School. This has a capacity of approximately 420 cfs with the upstream water level near the top of the box but as constructed its capacity is very limited due to the fact that the ground in the vicinity is lower than the box crown. It is proposed to raise the height of the service road near the culvert and block the ditch to the south in order that its full capacity can be utilized. The flow from the Harrison street channel will then be routed through this culvert in an open channel between I-25 and the service road as shown on Exhibit A. The water will then be carried across land owned largely by the Gates Land Company to Fountain Creek. Final design of this channel will be made at the time the land is developed in accordance with City of Colorado Springs standards.

The remainder of the flow from the North Gully south is to be carried along the east side of Highway 85 to the culverts under I-25 near the southeast corner of the Gates property. The largest of these is a box 14 ft. wide and 11 ft. 8 inches high which carries runoff from major storms and also serves as a one-way underpass to the east for the service road. A 48-inch RCP near the box carries the smaller flows. By closing the ditch to the south a maximum depth of about 8 ft. can be reached in the box at which level the water will begin to flow down the highway drainage ditch into the next basin to the south. With the 8 ft. depth the capacity of the box is about 900 cfs and that of the pipe 200 cfs. The total capacity is somewhat less than the calculated 100-year storm peak shown but greater than that for the 50-year storm. Only minimal inconvenience should result in case the culvert capacities are exceeded at this point.

East of the interstate the water will be carried in as direct a course as practical to Fountain Creek. The owner of the property across which this flow will pass has indicated his willingness to cooperate in the project.

Because of the limited drainage facilities provided at the time of construction of I-25 there appears to be no other practical way of routing the storm runoff. The quantities shown are believed to be very conservative and are based on the most severe conditions that are likely to occur. As more information becomes available regarding details of the subdivision developments and internal drainage plans, the quantities and channel types and sizes are subject to revision.

Respectfully submitted,

Warren DeLapp

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

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DRAINAGE BASIN DESIGN PEAK FLOWS

Design Point	Drainage Area Acres	Time to Peak Minutes	Flood Peak CFS	Flood Volume Ac.Ft.	Peak CFS/Mi^2	Remarks
QUAIL LAKE BASIN						
I	222	40	1040	42.7	2970	Quail Lake Inflow
I-2	222	100	105	42.7	300	Quail Lake Outflow
C	323	40	370	61.5	733	Includes I-2
NORTH GULLY						
O	205	45	620	38.3	1960	Storage Inflow
O-2	205	53	498	38.3	1550	Storage Outflow
K'	276	57	625	51.6	1450	Storage Inflow
K'2	276	75	385	51.6	870	Storage Outflow
K	310	80	402	57.5	830	
J	157	40	475	26.5	1940	
J+K	467	40	700	84.0	960	Storage Inflow
K-2	467	55	530	84.0	725	Storage Outflow
E	517	55	590	91.4	730	
U.S. 85 & I-25						
D	46	35	246	9.3	3420	
V	78	40	284	13.6	2330	
R	964	30	1055	175.8	1095	
T	81	30	354	16.2	2800	
U	1045	30	1255	192.0	770	Includes T
HARRISON STREET & I-25						
S	126	25	242	16.2	1230	
B	194	40	352	24.9	1160	

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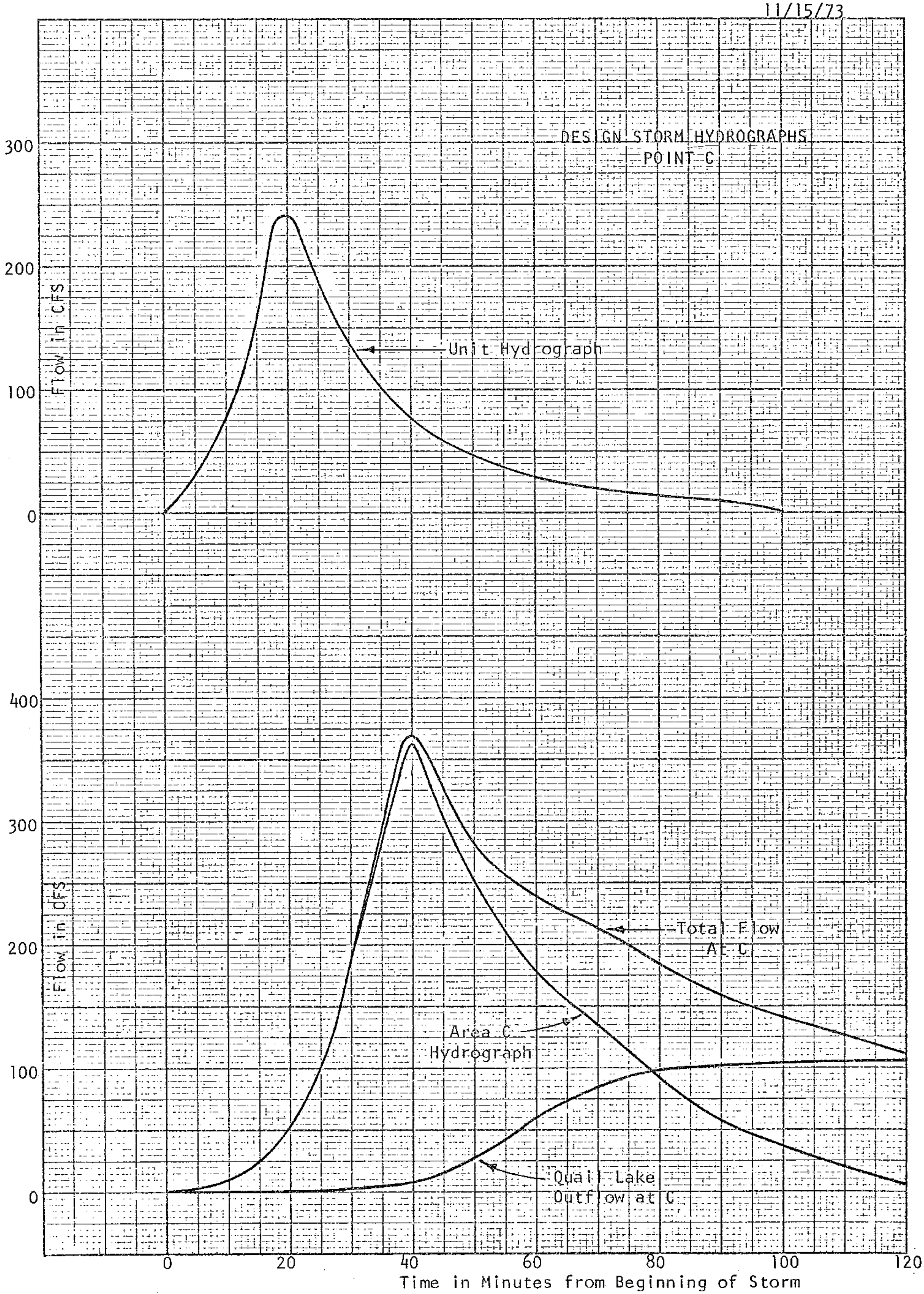
DESIGN STORM HYDROGRAPHS
POINT C
Unit Hydrograph
Flow in CFS
300
200
100
0
400
300
200
100
0
Total Flow
At C
Area C
Hydrograph
Quail Lake
Outflow at C
0
20
40
60
80
100
120
Time in Minutes from Beginning of Storm

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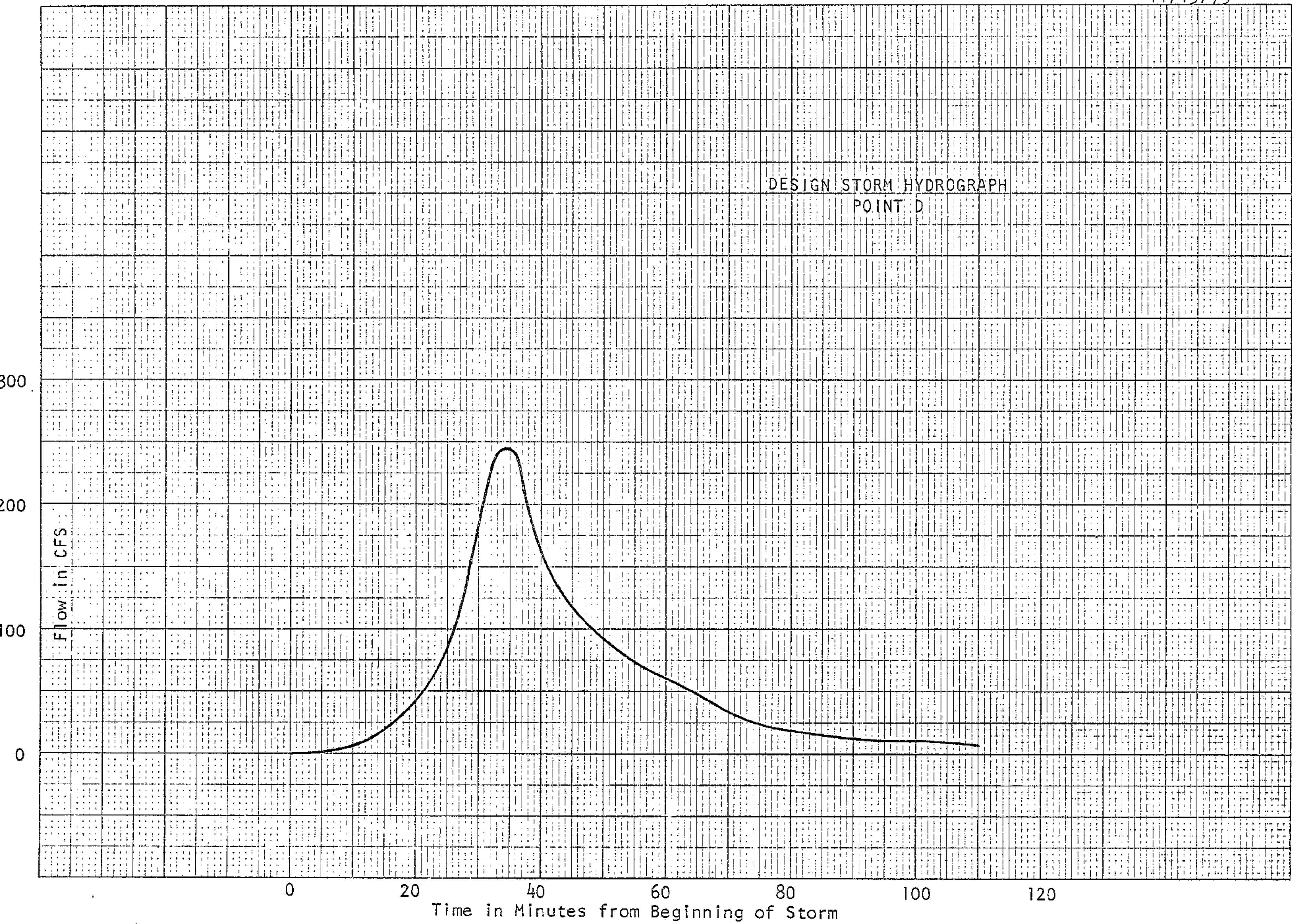
DESIGN STORM HYDROGRAPH
POINT D
300
200
100
0
Flow in CFS
0
20
40
60
80
100
120
Time in Minutes from Beginning of Storm

K+E 20 X 20 TO THE INCH • 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1242

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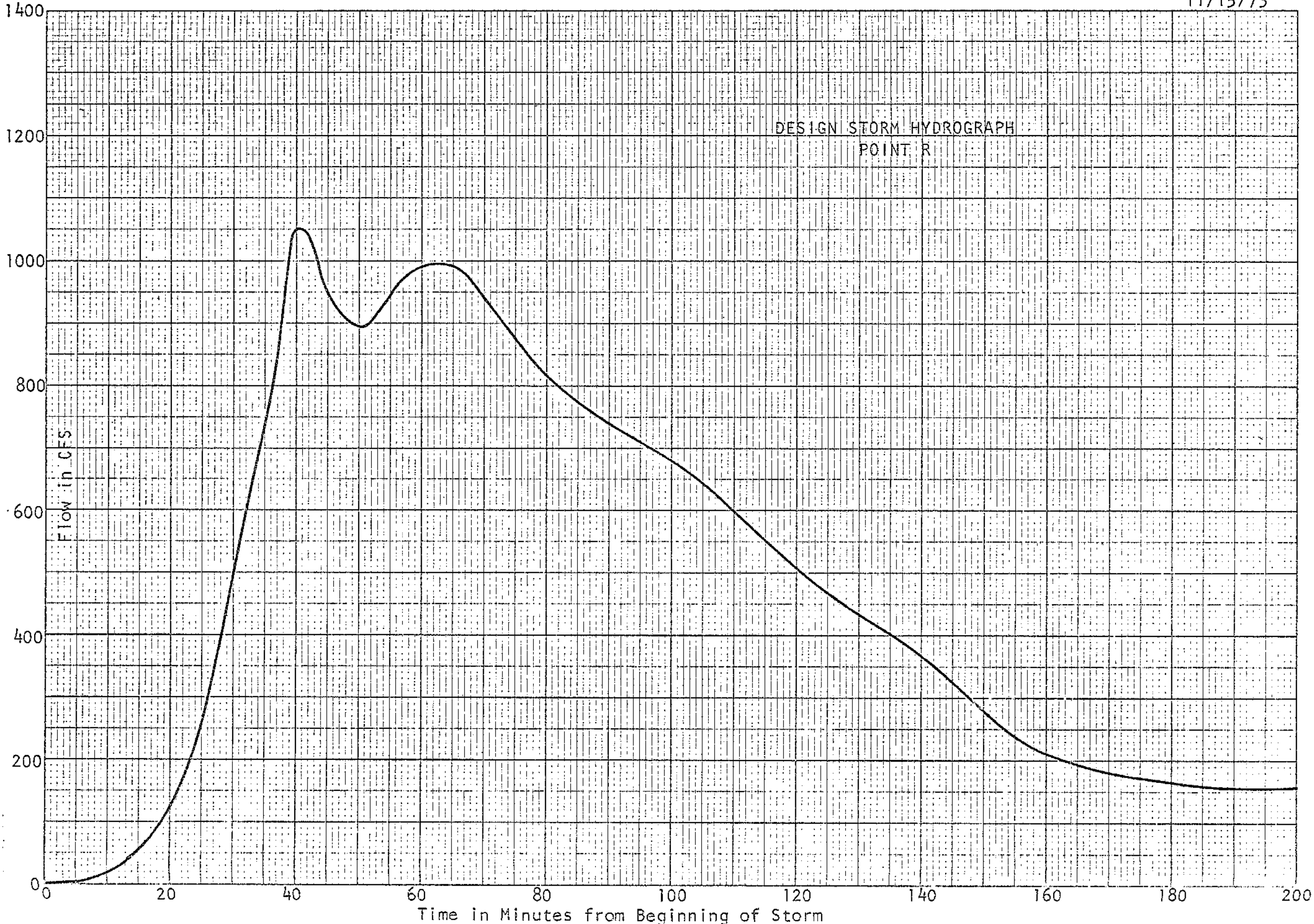

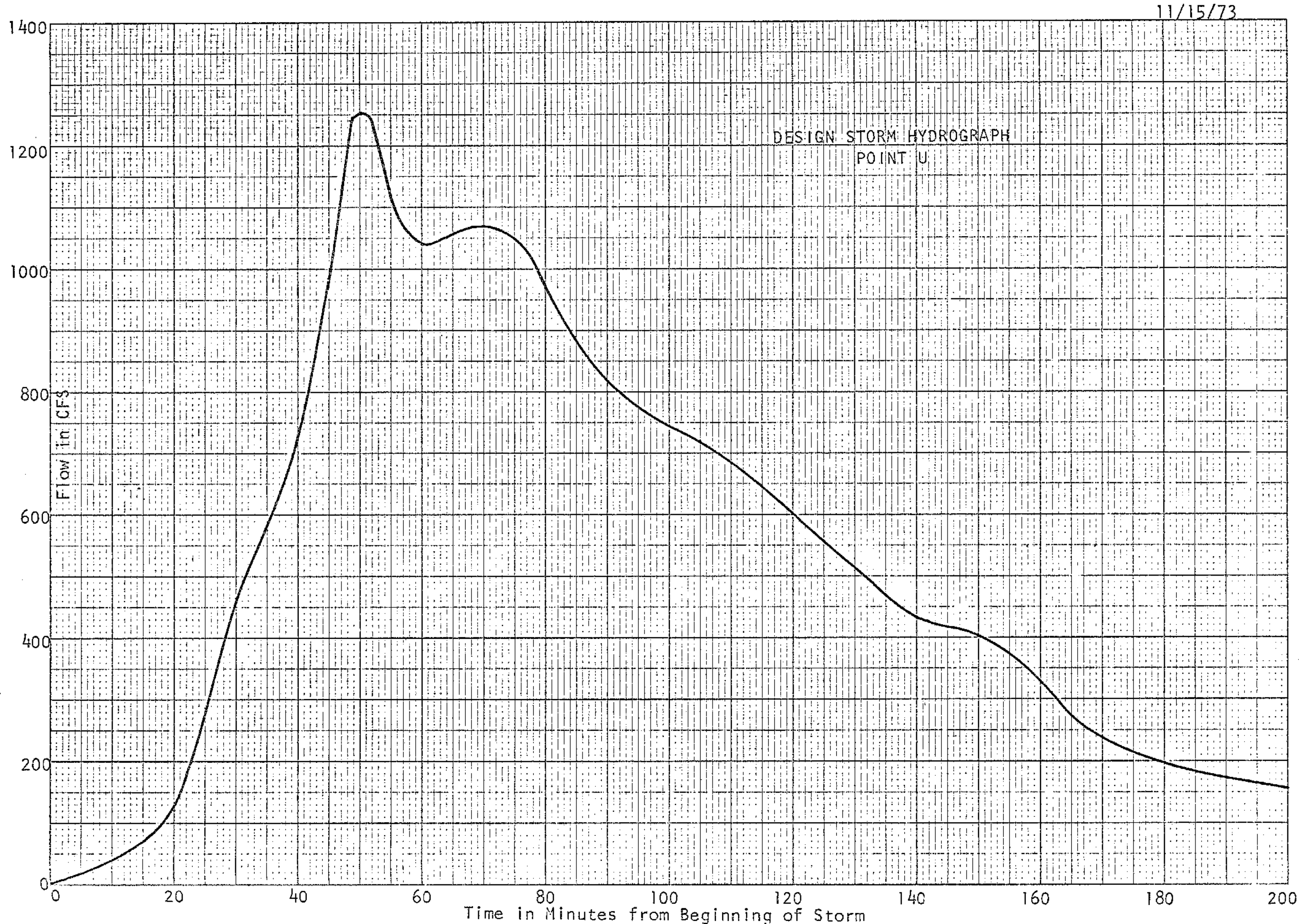
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DESIGN STORM HYDROGRAPH
POINT U
Flow in CFS
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
120
140
160
180
200
Time in Minutes from Beginning of Storm

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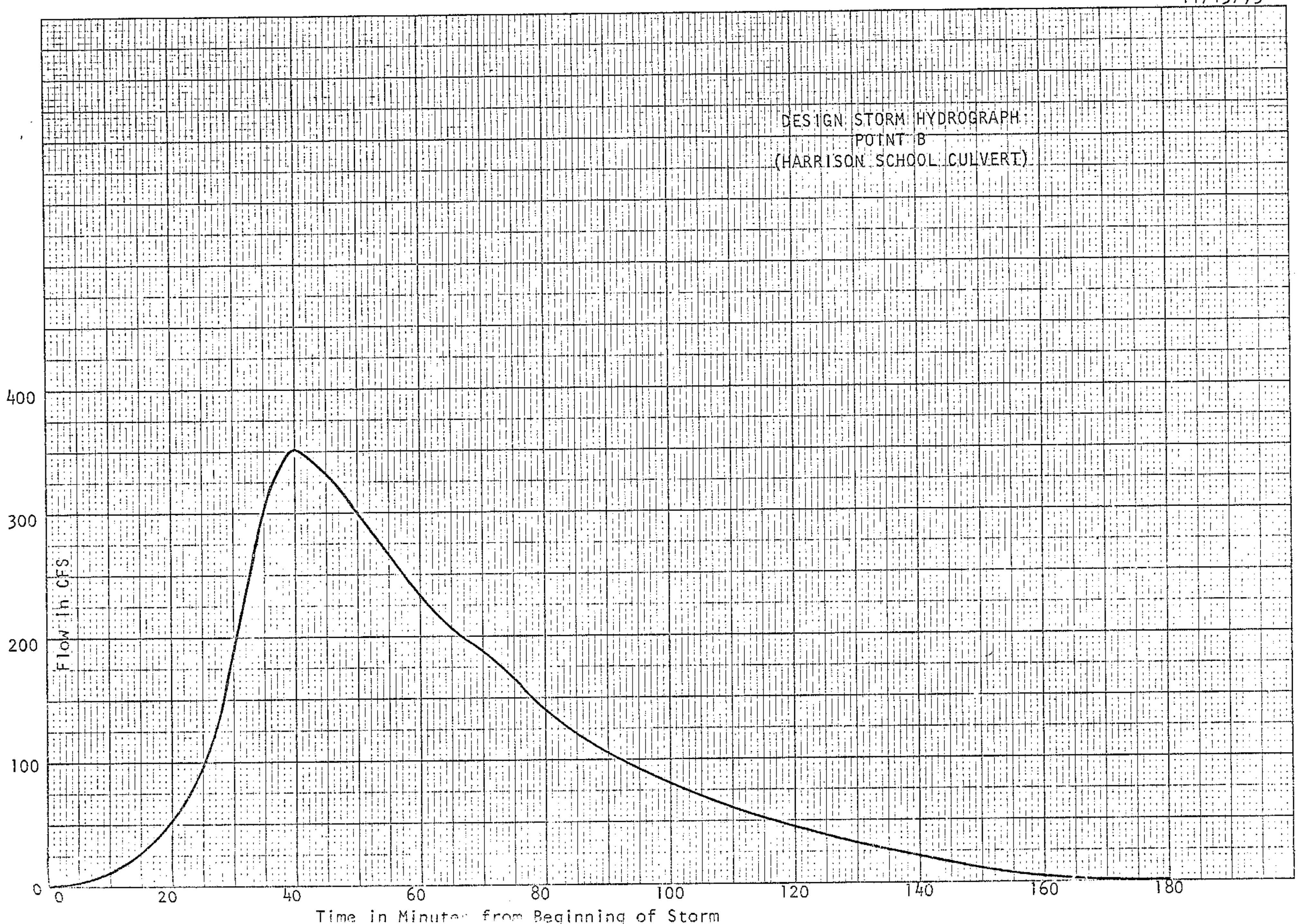
DESIGN STORM HYDROGRAPH
POINT B
(HARRISON SCHOOL CULVERT)
400
300
200
100
0
Flow in CFS
0
20
40
60
80
100
120
140
160
180
Time in Minutes from Beginning of Storm

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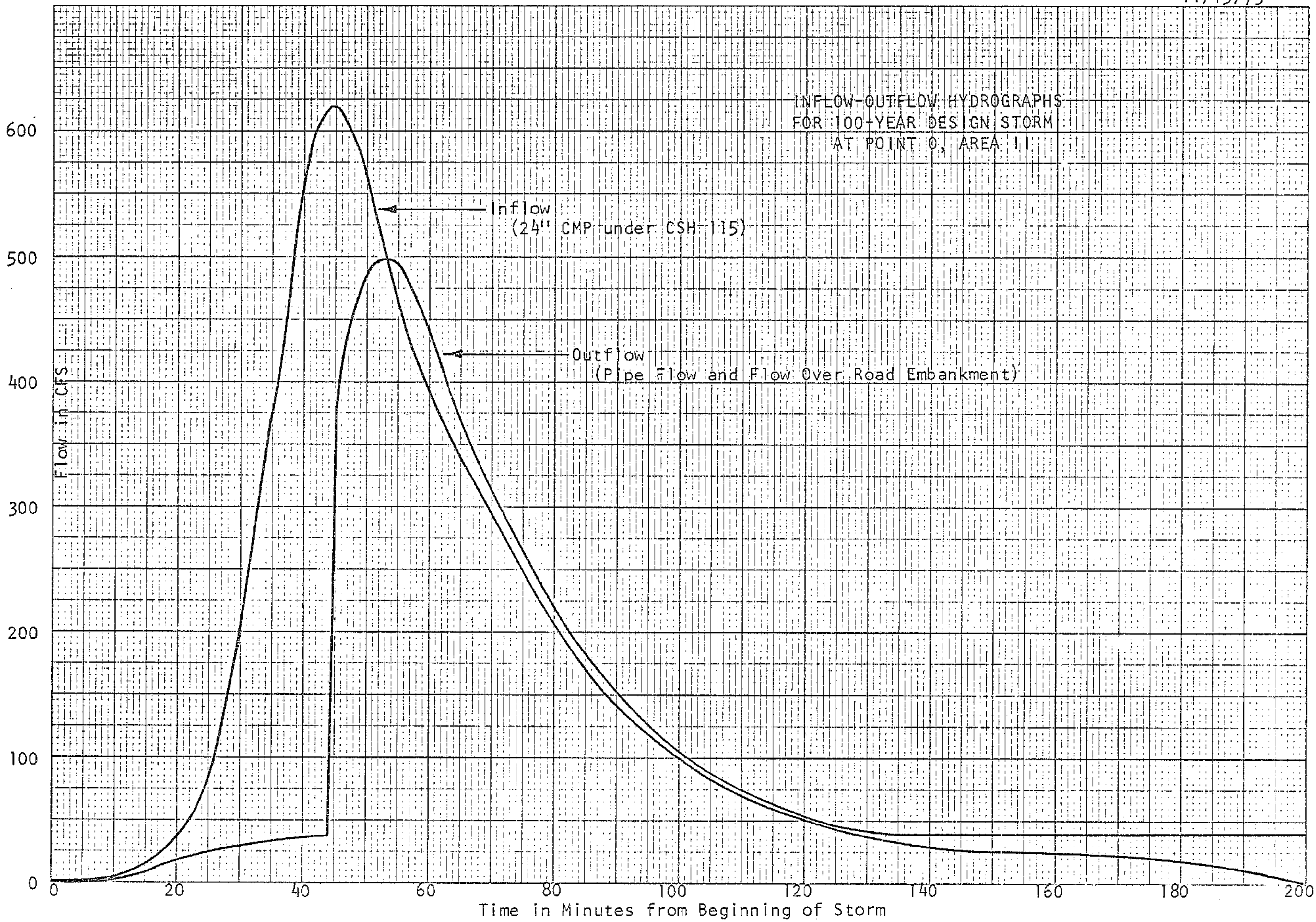
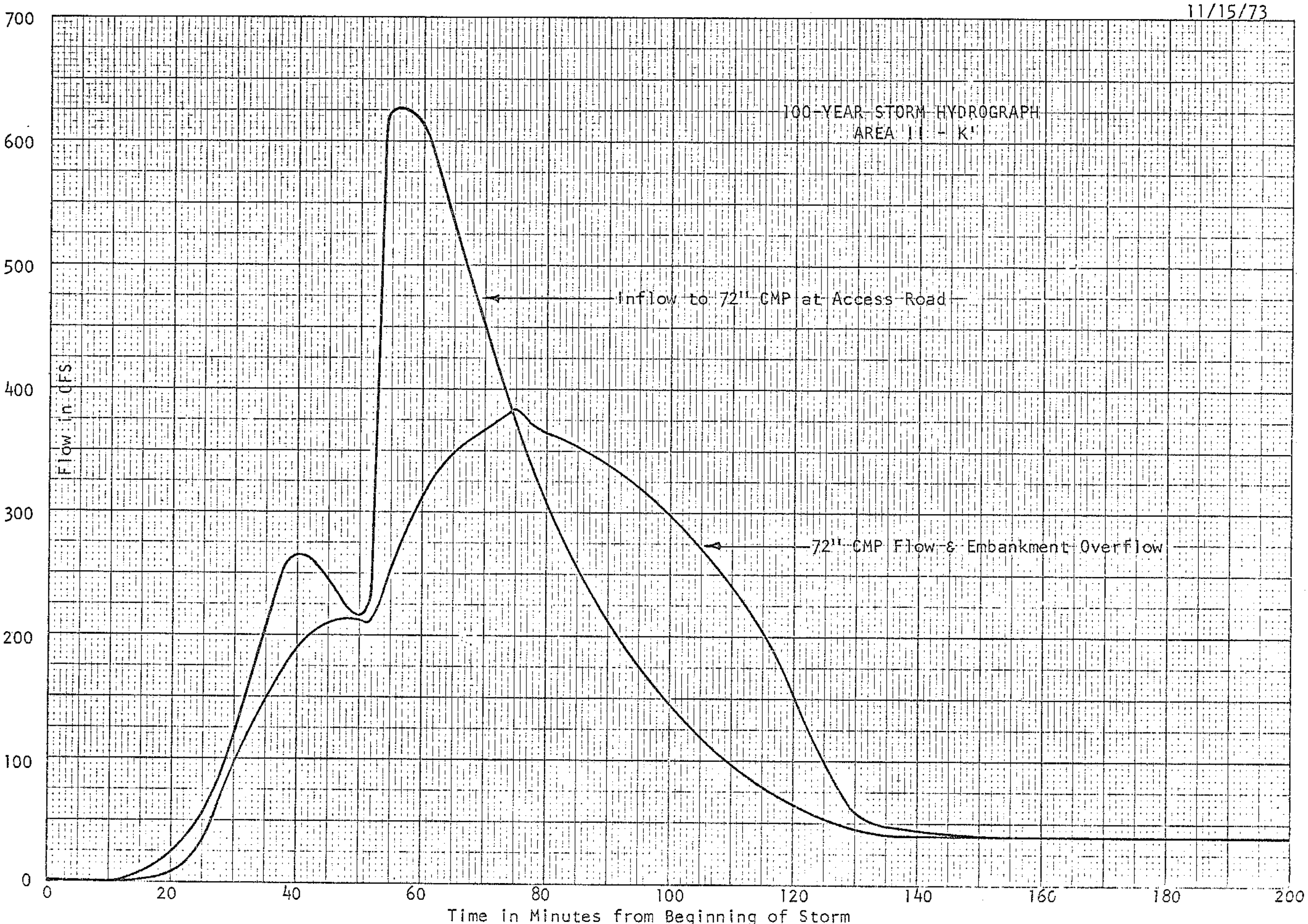

INFLOW-OUTFLOW HYDROGRAPHS
FOR 100-YEAR DESIGN STORM
AT POINT 0, AREA II
Inflow
(24" CMP under CSH-115)
Outflow
(Pipe Flow and Flow Over Road Embankment)
Flow in CFS
0
100
200
300
400
500
600
0
20
40
60
80
100
120
140
160
180
200
Time in Minutes from Beginning of Storm

46 1242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100-YEAR STORM HYDROGRAPH
AREA II - K'
Inflow to 72" CMP at Access Road
72" CMP Flow & Embankment Overflow
Flow in CFS
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
200
Time in Minutes from Beginning of Storm

K+E 20 X 20 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

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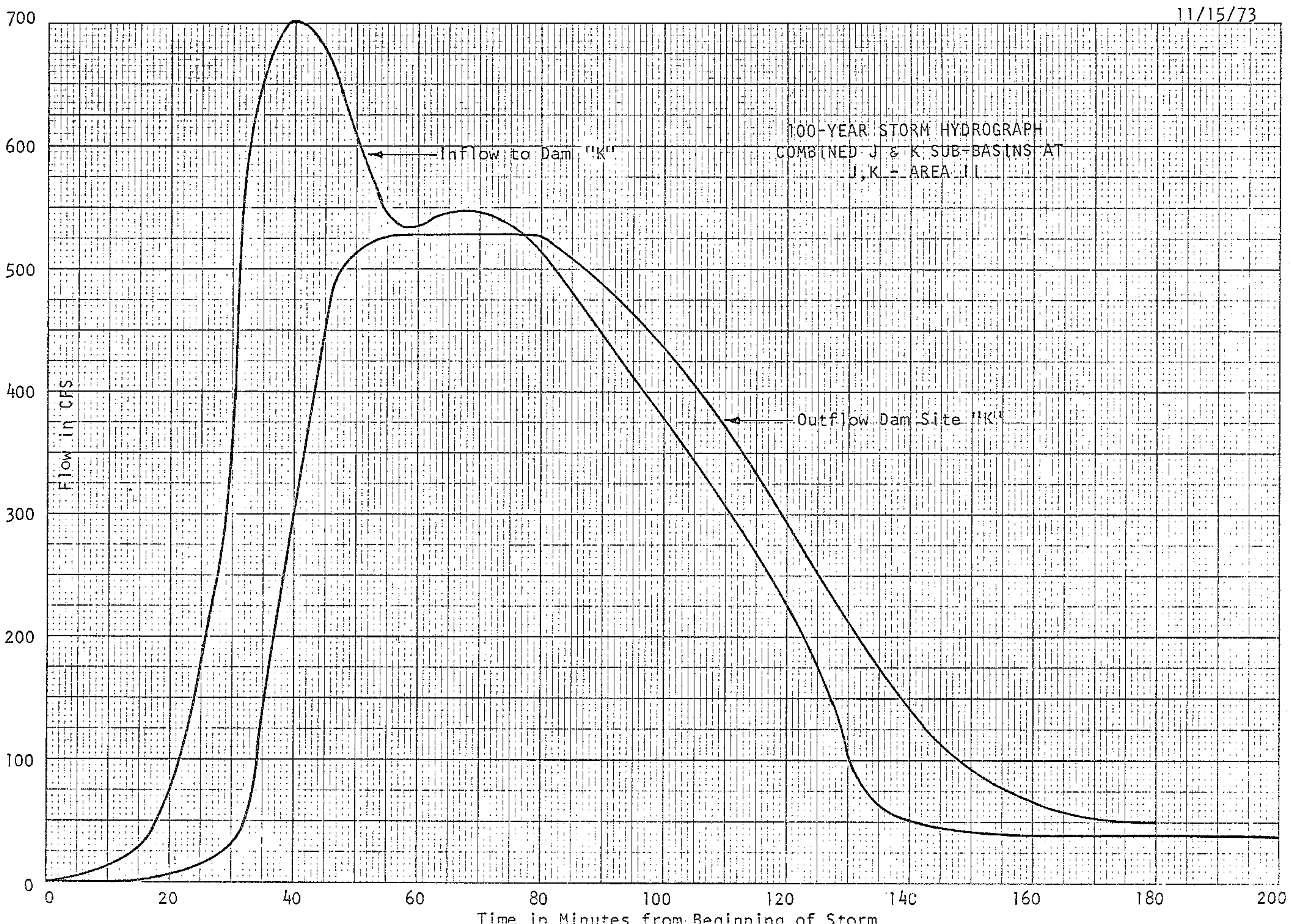

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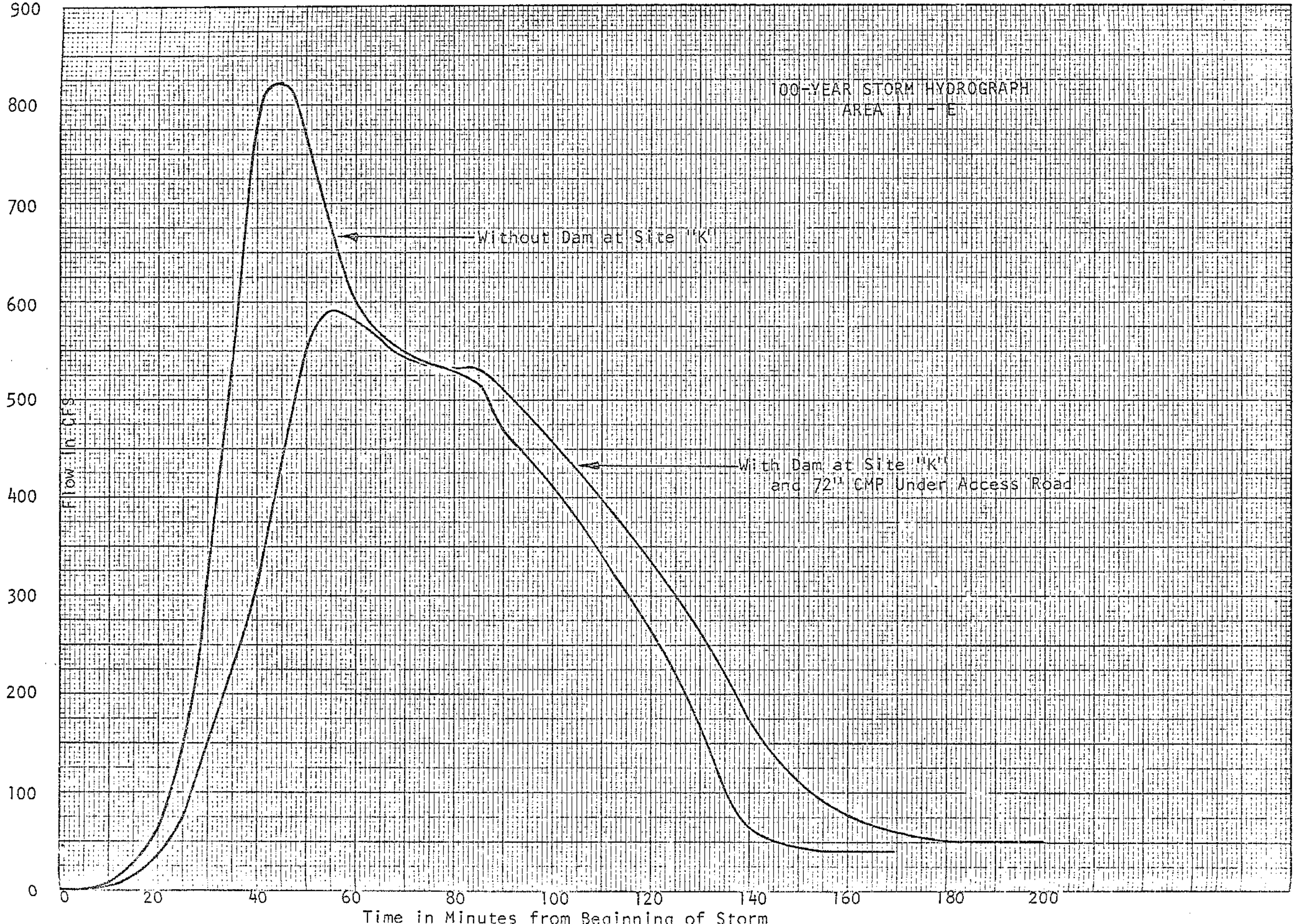

100-YEAR STORM HYDROGRAPH
AREA 11 - E
Without Dam at Site "K"
With Dam at Site "K"
and 72" CMP Under Access Road
Flow in CFS
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
200
Time in Minutes from Beginning of Storm

100 YR. STORM HYDROGRAPH

DESIGN POINT II-C

T	Qu	0.11	0.34	1.23	0.16	0.15	0.11	0.03	ΣQ
0	0								0
10	75	8							8
20	240	26	25						51
30	140	15	82	92					189
40	75	8	48	295	12				363
50	50	5	25	172	38	11			251
60	30	3	17	92	22	36	8		178
70	20	2	10	62	12	21	26	2	135
80	15	2	7	37	8	11	15	7	87
90	10	1	5	25	5	8	8	4	56
100	0		3	18	3	4	6	2	36
110				12	2	3	3	2	22
120					2	2	2	1	7
130						2	2	1	5
							1	0	1
								0	

STORM VOLUME 18.8 Ac. Ft.

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DETERMINATION OF EFFECTIVE RAINFALL

Location: *Cheyenne Mtn. Ranch*
Colorado Springs

Design Storm *100* Years
(Recurrence Interval)

Time (minutes) (1)	Total Precip. (in.) (2)	Incremental Precip. (in.) (3)	Storm Pattern Design (in.) (4)	Pervious Area *60%* Maximum Infiltration (in.) (5)	Storage (in.) (6)	Effective Precip. (in.) (7)	*60%* Eff. Precip. (in.) (8)	Impervious Area *40%* Storage (in.) (9)	Loss (in.) (10)	Effective Precip. (in.) (11)	*40%* Eff. Precip. (in.) (12)	Total Average Eff. Precip. (in.) (13)
0	0	0	0									0
10	1.30	1.30	.35	.08	.27	0	0	.07	.01	.27	.11	.11
20	1.72	.42	.42	.08	.03	.31	.18	0	.02	.40	.16	.34
30	2.07	.35	1.30	.08	0	1.22	.73	0	.06	1.24	.50	1.23
40	2.28	.21	.21	.08	0	.13	.08	0	.01	.20	.08	.16
50	2.48	.20	.20	.08	0	.12	.07	0	.01	.19	.08	.15
60	2.65	.17	.17	.08	0	.09	.05	0	.01	.16	.06	.11
70	2.72	.07	.07	.07	0	0	0	0	0	.07	.03	.03
80	2.78	.06	.06	.06	0	0	0	0	0	.06	.02	.02
90	2.84	.06	.06	.06	0	0	0	0	0	.06	.02	.02
100	2.90	.06	.06	.06	0	0	0	0	0	.06	.02	.02
110	2.94	.04	.04	.04	0	0	0	0	0	.04	.02	.02
120	2.98	.04	.04	.04	0	0	0	0	0	.04	.02	.02
	Totals	2.98	2.98		.30	1.87	1.11	.07	.12	2.79	1.12	2.23

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COLORADO URBAN HYDROGRAPH PROCEDURE

SAMPLE CALCULATIONS - DESIGN POINT II-C UNIT HYDROGRAPH

$A = 101$ Ac

$L = 4300' = .81$ mi.

$L_{ca} = 2000' = .38$ mi.

$(L L_{ca})^{.3} = (.81 \times .38)^{.3} = .70$

RESIDENTIAL AREA ; 60 % PERVIOUS ; AVERAGE CONDITIONS

$C_t = .30$ and $C_p = .50$

$t_p = C_t (L L_{ca})^{.3} = (.30)(.70) = .21$ hrs $= 12.6$ min.

$t_u = 10$ min.

$T_p = t_p + .5 t_u = 17.6$ min. ; say 20 min.

$q_p = \frac{C_p}{t_p} = \frac{.50}{.21} = 2.38$ cfs/ac. or 1520 cfs/mi²

$Q_p = q_p A = 2.38 (101) = 240$ cfs

Width at $.75 \, Q_p = 0.16$ hrs $= 10$ min.

Width at $.50 \, Q_p = 0.28$ hrs $= 17$ min.

Unit Volume $= \frac{101}{12} = 8.4$ Ac. Ft.

Hydrograph Scale - 2.75 Ac-ft / in²

Unit Area $= \frac{8.4}{2.75} = 3.06$ in²

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