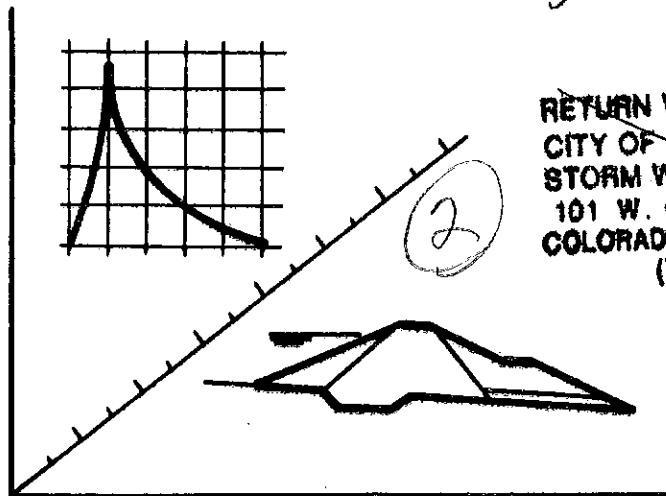


CENTRAL  
WESTERN  
ENGINEERS

# Return to Engineering



~~RETURN WITHIN 2 WEEKS TO:  
CITY OF COLORADO SPRINGS  
STORM WATER & SUBDIVISION  
101 W. COSTILLA, SUITE 113  
COLORADO SPRINGS, CO 80903,  
(719) 578-6212~~

*Spring  
Creek  
Drainage  
Basin*

*[Handwritten signature]*

*[Large handwritten signature]*

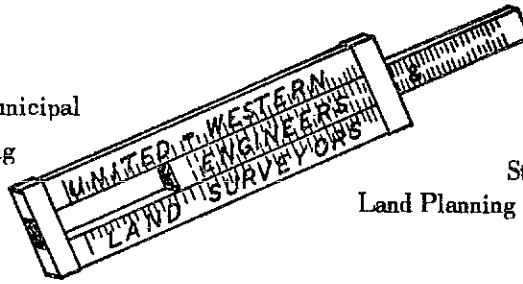
~~RETURN WITHIN 2 WEEKS TO:  
CITY OF COLORADO SPRINGS  
STORM WATER & SUBDIVISION  
101 W. COSTILLA, SUITE 113  
COLORADO SPRINGS, CO 80903  
(719) 385-6979~~

RETURN WITHIN 2 WEEKS TO:  
CITY OF COLORADO SPRINGS  
SUBDIVISION ENGINEERING  
30 SOUTH NEVADA AVE., SUITE 702  
COLORADO SPRINGS, CO 80908  
(719) 385-6979

# ENGINEERS

COLORADO SPRINGS, COLORADO

Civil & Municipal  
Engineering



Structural Design  
Land Planning and Surveying

Phone  
ME 2-9840

108 East Mill Street  
Colorado Springs, Colorado

Director of Public Works  
City of Colorado Springs  
Colorado Springs, Colorado

Dear Sir:

Enclosed herewith is the Engineering study of the Spring Creek Drainage Basin, authorized by the City Council of Colorado Springs.

The report includes a study of the rain-fall-runoff characteristics of the basin, developed hydrographs for city use, and a recommended proposal for required streets and storm sewers in the area. If desired, the study may be used as a "master drainage plan" for the area as it is developed.

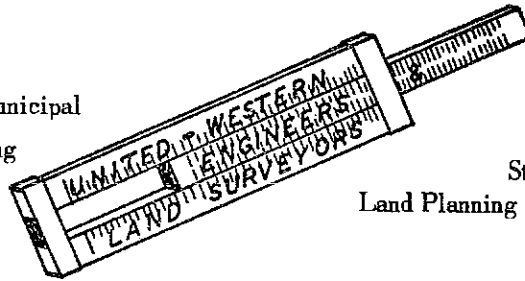
Respectfully submitted,

UNITED WESTERN ENGINEERS

A handwritten signature in cursive script, appearing to read "George D. Morris". The signature is written in dark ink and is positioned above the typed name.

George D. Morris,  
Registered Engineer  
Colorado 2051

Civil & Municipal  
Engineering



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Respectfully submitted,

UNITED WESTERN ENGINEERS

George D. Morris,  
Registered Engineer  
Colorado 2051

HYDROLOGIC ENGINEERING STUDY  
OF THE  
SPRING CREEK DRAINAGE BASIN  
FOR THE  
DEPARTMENT OF PUBLIC WORKS  
COLORADO SPRINGS, COLORADO

August, 1961

UNITED WESTERN ENGINEERS  
COLORADO SPRINGS, COLORADO

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LETTER OF TRANSMITTAL

TITLE SHEET

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REPORT (WRITTEN DISCUSSION)

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- B. FINAL OVERLAY MAP (STORM LINES, GREEN  
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- C. STORM SEWER DETAILS & MISC. CONSTRUCTION  
DETAILS (COST ESTIMATE)
- D. RAINFALL - RUNOFF DATA (TOTAL BASIN  
SHEET SHOWING ALL FIGURES & WATER-  
SHED ASSUMPTION)
- E. SYNTHETIC HYDROGRAPHS - 1  
(MAIN STREAM WITHOUT TREATMENT)
- F. SYNTHETIC HYDROGRAPHS - 2  
(MAIN STREAM WITH DAMS & CHANNELING)
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(INDIVIDUAL UNIT GRAPHS OF 42 BASINS)

SCOPE AND PURPOSE:

This report is intended to result in an overall plan for placing future storm drains in the area of Spring Creek, as subdivisions are constructed. The general development of the data required is described in the following sections.

Storm drainage is a recurring problem in the Colorado Springs area. This area is classified as semi-arid with low average annual rainfall. It is, however, subject to intense storms of several types, some of which can cause rather extreme local damage. These damaging storms have been relatively frequent during the summer of 1961, causing much damage which might have been avoided had storm drainage channels been available.

Studies of partly or wholly undeveloped drainage basins provide the basis for the design of storm drainage control structures prior to the time of subdivision development. In this manner, the storm drainage channels can be constructed as the subdivisions are developed, avoiding most of the potential storm damage.

BASIN DESCRIPTION:

The Spring Creek Basin is approximately 8 square miles in area and lies immediately East and Southeast of the City of Colorado Springs. Its northern divide is in the vicinity of the Rock Island Railroad tracks. It is bounded on the West by Knob Hill and Evergreen Cemetery, on the East by a ridge of hills separating it from Sand Creek. It empties into Fountain Creek near the City sewage disposal plant.

The Basin is drained by Spring Creek, which runs generally Southwest and nearly through the center of the Basin. At its northern end, the Creek divides into two definite streams. A small flow is present in the lower half of the stream, except in very dry years.

The Basin has a rolling topography, characterized by low hills, slightly higher along the Eastern divide than along the Western divide. The valley of Spring Creek is relatively wide in the northern 2/3 of the Basin, narrowing into a deep, narrow run in the lower 1/3 of the basin. The final 1000 feet, more or less, of the Creek runs across the flood plain of the Fountain Creek where the grade is again gentle and flat.

Three soil types are found in the basin. Along the lee side of the hills at the upper end of the Basin, large quantities

of wind blown sands and silts have been deposited. These deposits are recent, loose and very permeable. The infiltration rate from rainfall is quite high in these sands. Unfortunately, these deposits are thin and scattered.

Below this, and at the surface between Galley Road and Carlsbad Drive, the Fox Hills Formation predominates. This formation is an interbedded sand and sandy shale. Infiltration in this soil is slow for a sandy soil, and runoff is relatively high.

Southwest of the Villey Hi Country Club, the surface soil is mostly Pierre Shale with a very light cover of wind drifted sand. This soil does not allow rapid infiltration and runoff is normally quite high.



### RAINFALL PATTERNS:

As previously mentioned, average rainfall in the vicinity is low, being about 14.8" per year. The major portions of this rainfall occurs during the months of May, June, July, and August. (see graph D-1) Since the site is on the high plains area near the Front Range of the mountains, it is subject to both mountain and plains type storms.

Recorded storms generally fall into two patterns. Relatively long term storms lasting 6 hours or more, and of varying intensity comprises the first type. The second type falls in the category of intense, high local intensity storms lasting from 30 minutes to 2 hours.

The first storm type produces more water than its short term equivalent storm, but since it has a longer time interval, does not produce high flood peaks.

Several storm types were examined for runoff quantities in this report. They were:

1. 30 minute duration, 0.8" intensity, 2 year frequency storm.
2. 1 hour duration, 2.0" intensity, 50 year frequency storm.
3. 6 hour duration, 2.75" intensity, 25 year frequency storm.
4. 6 hour duration, 3.00" intensity, 50 year frequency storm.
5. 6 hour duration, 3.50" intensity, 100 year frequency storm.

Duration, as used in this report, refers to the time-length of the storm from the beginning to the end of the rainfall period.

Intensity, as used herein, refers to the amount of rainfall in inches during the storm period.

Frequency is an often misunderstood term, and refers only to the probability of occurrence of a rainfall. In other words, it is possible for two 50 year storms to fall on the area in a single year, but statistically, it is very improbable.

These storm types were applied to the Basin to determine runoff and total water produced, both in the basins existing condition and assuming all subdividable area to be developed. It was found that the storm type No. 2 (above) will produce the highest flood peaks. This storm, and its comparable 50 year, 6 hour storm (labeled #4) were then used in all computations.

The probability of occurrence was balanced against the economics of construction, and it was decided that the best balance would be obtained by designing for the 50 year frequency storm.

RUNOFF:

Unfortunately, actual measured runoff data does not exist for this Basin. The existence of such data is desirable, so that exact runoff data might be available. The availability of this exact data would allow some refinement of the figures given in this report, and would allow easier design work in the future.

Since such data was not available, some data for an adjoining basin was studied and adapted to the soil types and topography of the Spring Creek Basin.

The entire Basin was separated into 42 much smaller sub-basins. Unit hydrographs were then developed for each of these sub-basins. The method used to develop these synthetic hydrographs is that developed by the Soil Conservation Service, slightly adapted to city use.

Each unit hydrograph was developed at the collection point, or outfall, of each sub-basin. These were then adjusted for the actual runoff of the basin. The final hydrographs for each basin were then combined on a time basis to give a picture of the actual flow down Spring Creek.

For example, it takes a certain amount of time for the discharge crest to travel from point "D" on the map, to point "E". During this time, the crests of several sub-basin flows join the main flow. This time of joining can be computed, and

the final flow computed. Thus, each basin is added to the main flow at the time it enters, and the final channel flow is computed.

It must be repeated that these hydrographs are synthetic, and based on runoff data for another basin, adjusted for soil, conditions, and topography. Required future adjustment, if any, will not be large, but may be desirable.

MAIN CHANNELS - GREENBELT:

The most economical system of removing flood runoff is by a system of ditches. Ditches are invariably simpler to build, maintain and clear than are pipes. In this Basin, actual development of subdivisions has not progressed to the point where ditches would interrupt traffic flow or building. Furthermore, a drainage study committee working with City officials in 1960, recommended the adoption of a "Greenbelt" drainage system wherever feasible.

The recommendation of this study for the Spring Creek Basin is to use the "Greenbelt system in this basin.

In this case, the Greenbelts generally follow existing creek beds and will not interfere with land use for subdivision purposes. Required channel sizes and right of way widths are shown in the appendix.

The necessary Greenbelts are relatively narrow through most of the basin, although additional width may be desired. Bank side parks or playgrounds could be maintained along the belt. The belt should be grassed or planted to prevent weed growth which would tend to slow the runoff. Maintenance of this sort would allow the use of the drainage area in periods of low flow, and would allow the drainage to flow properly without expensive, lined ditches.

Crossings should be planned, and held to a minimum. Culverts, bridges and pedestrian crossings would be required at points along the stream. Care must be maintained that the flow not be impeded, however.

## RESERVOIRS:

To control every high runoff crests, two small flow through reservoirs are recommended. These reservoirs allow the water to continue on its course, and are not storage reservoirs. The main function of these is to allow water to flow through at a certain rate, only. The remaining water is stored for a short time. This greatly reduces the flood peaks downstream, allowing the construction of smaller bridges or culverts than would otherwise be required. Cost estimates indicate that the savings thus obtained on required bridges on Highway 24, Airport Road and Circle Drive alone will more than repay the cost of these reservoirs.

Both reservoirs have been located on ground not suitable for other use. Both locations are marshland during all but very dry weather. The sites are also considered excellent for preservation of existing culverts.

A major factor in the main stream drainage is found on the grounds of the Valley Hi Country Club. Several dams and reservoirs have been and are being constructed on the stream bed of Spring Creek. No information concerning these dams was made to determine their effect on flood flow.

Generally, it was found that these reservoirs will have

little effect on flood flows. Either the water will merely flow through the reservoir and over the spillway, or in a few cases, will flow over the dam and destroy it. In either case, no major change in flow pattern will be found.

To ensure the safety of several downstream bridges, it is recommended that the City inspect these structures to determine the adequacy of the spillways. Presumably, these dams have been constructed under state regulations, as required by law, but the runoff calculated at the time of design is probably not high enough. It is recommended that the State Engineer be consulted for his opinion on this subject, since reservoirs of this type are his responsibility.



### INDIVIDUAL IMPROVEMENTS:

After the main channel was designed, individual basins were studied, using the sub-basin hydrographs previously mentioned. Water flow was found at various points in each sub-basin, and compared with street capacity and distribution.

In some cases, it was found that the specification of certain street sizes or alignment will be sufficient to distribute runoff. In other cases, it was found that street capacity was not sufficient, and that storm sewers will be required. The alignment and required sewer sizes are shown in the appendix.

A cost estimate is included in the appendix.

SUMMARY AND RECOMMENDATIONS:

A study such as this should be made in basins in which residential building is planned. Even though the study may be later modified slightly with the passage of time, dangerous locations for building may be avoided.

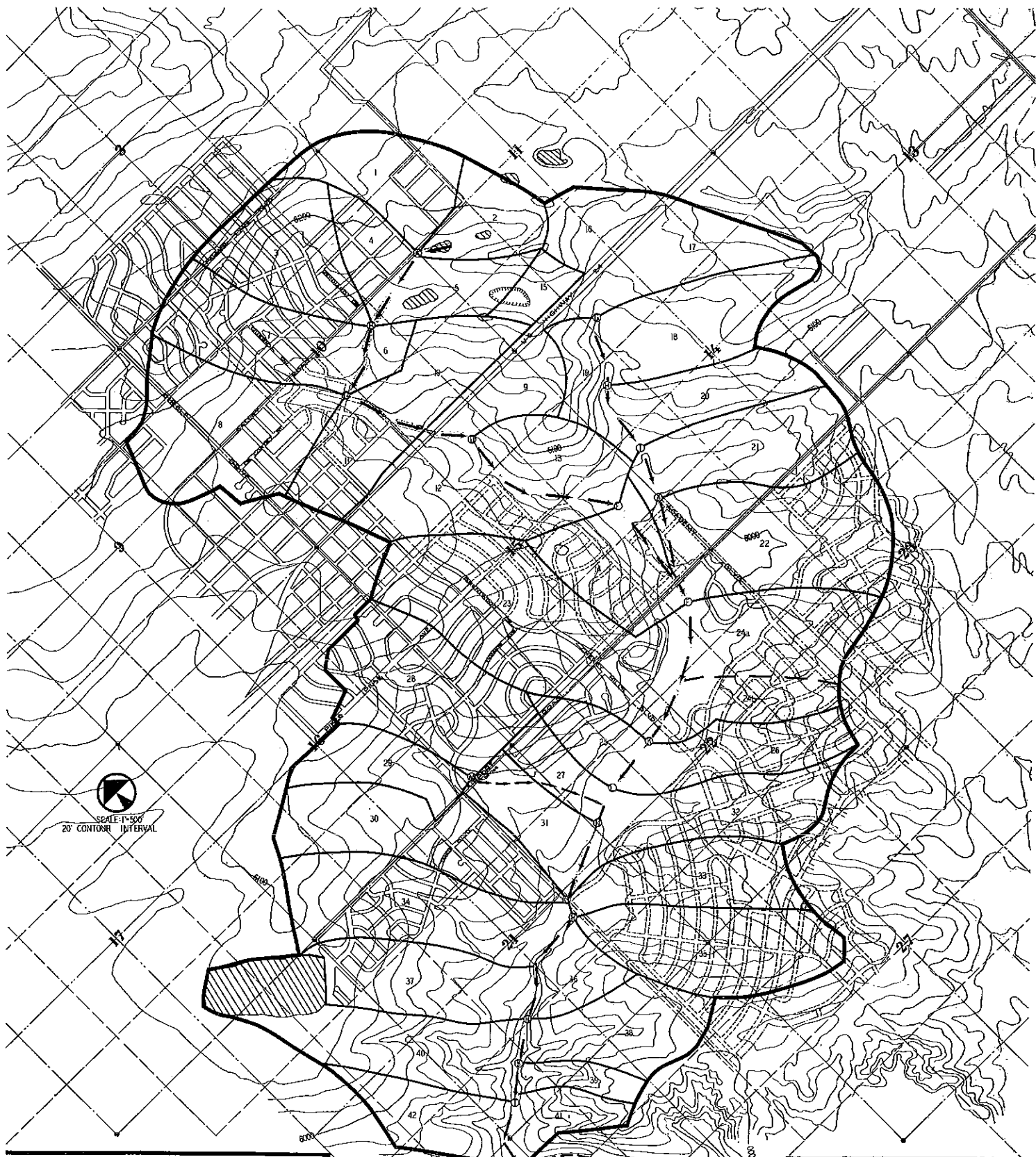
The locations and sizes of required storm sewers will be known, and may be constructed before subdivisions become so concentrated that drainage difficulties are acute. It is also more economical to construct storm drainage prior to constructing streets, etc., than after.


Experience in other parts of Colorado Springs has shown the futility of the attempt to control high runoff with street drainage only. Streets will carry considerable quantities of water under favorable conditions, but cannot possibly be designed to hold flood peaks of the types found in this area.

The recommendation of this study is that the design features shown in Appendix B and C be followed in general, and that the cost be prorated among the subdivisions involved.

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2. Lindsey, R.K.Kohler, M.A. & Paulhus, J.L.H., "Hydrology for Engineers", McGraw-Hill Book Company, 1958.
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7. Chow, V. T. - "Open Cahnnel Hydraulics" McGraw-Hill Book Company, 1959.



  
 SCALE: 1" = 500'  
 20' CONTOUR INTERVAL

# SPRING CREEK








## DRAINAGE STUDY

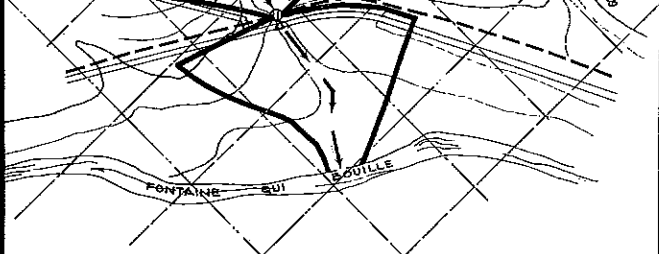
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CITY OF COLORADO SPRINGS, COLORADO

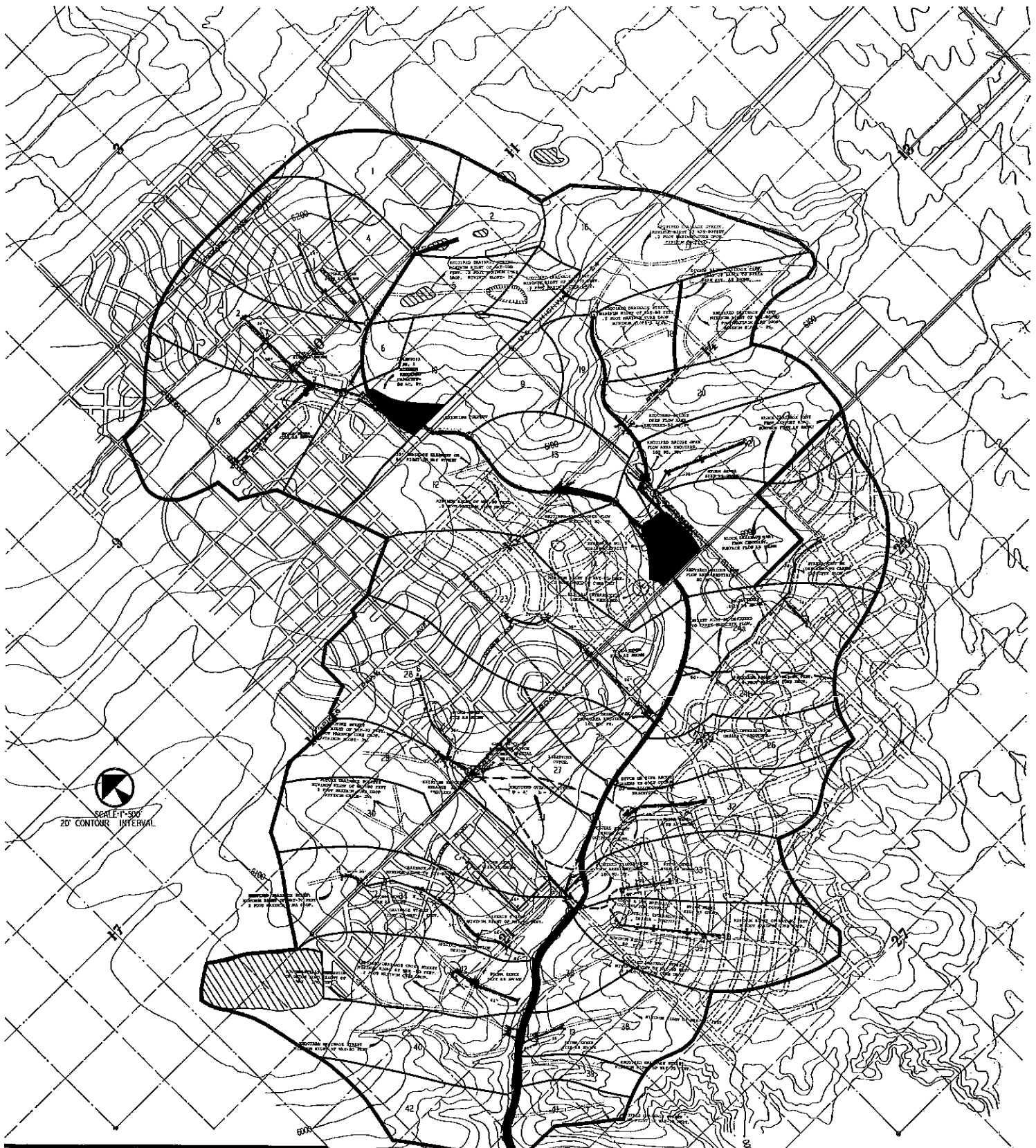
Prepared by:  
 UNITED WESTERN ENGINEERS  
 COLORADO SPRINGS, COLORADO

AUGUST 1961

### LEGEND

-  DRAINAGE BASIN BOUNDARY
-  SUB-BASIN BOUNDARY
-  MAIN DRAINAGE CHANNEL
-  EXISTING RECORDED ROADWAYS
-  PROPOSED ROADWAYS
-  SUB-BASIN COLLECTION POINTS
-  EXISTING CULVERTS
-  BRIDGES
-  PROPOSED STORM SEWERS














# SPRING CREEK DRAINAGE STUDY

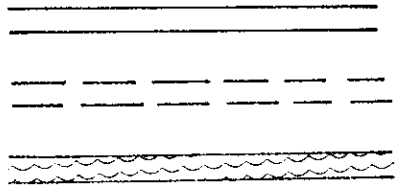
for the  
CITY OF COLORADO SPRINGS, COLORADO

Prepared by:  
UNITED WESTERN ENGINEERS  
COLORADO SPRINGS, COLORADO

AUGUST 1961

## LEGEND

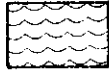
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-  SUB-BASIN BOUNDARY
-  MAIN DRAINAGE CHANNEL
-  EXISTING RECORDED ROADWAYS
-  PROPOSED ROADWAYS
-  SUB-BASIN COLLECTION POINTS
-  EXISTING CULVERTS
-  BRIDGES
-  PROPOSED STORM SEWERS



EXISTING STREET

PROPOSED STREET

GREENBELT



DRAINAGE RESERVOIR

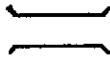


PROPOSED STORM SEWER

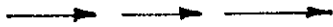
INTAKE BOX



SUB-BASIN COLLECTION POINT



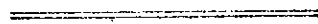
PROPOSED BRIDGE OR LARGE CULVERT



DIRECTION OF DRAINAGE FLOW



DRAINAGE BASIN BOUNDARY



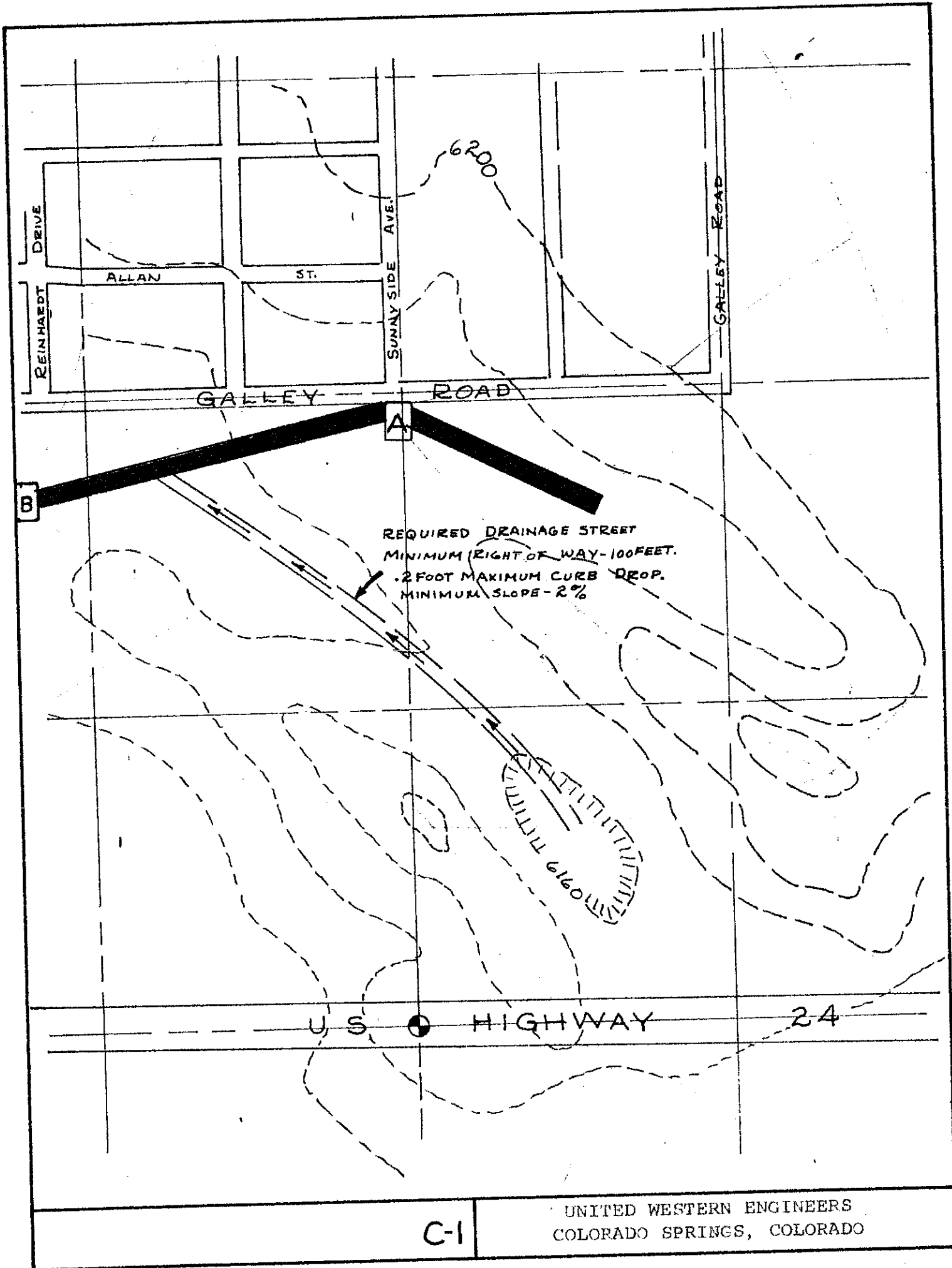
ARTIFICIAL BLOCKING OF DRAINAGE



SECTION CORNER

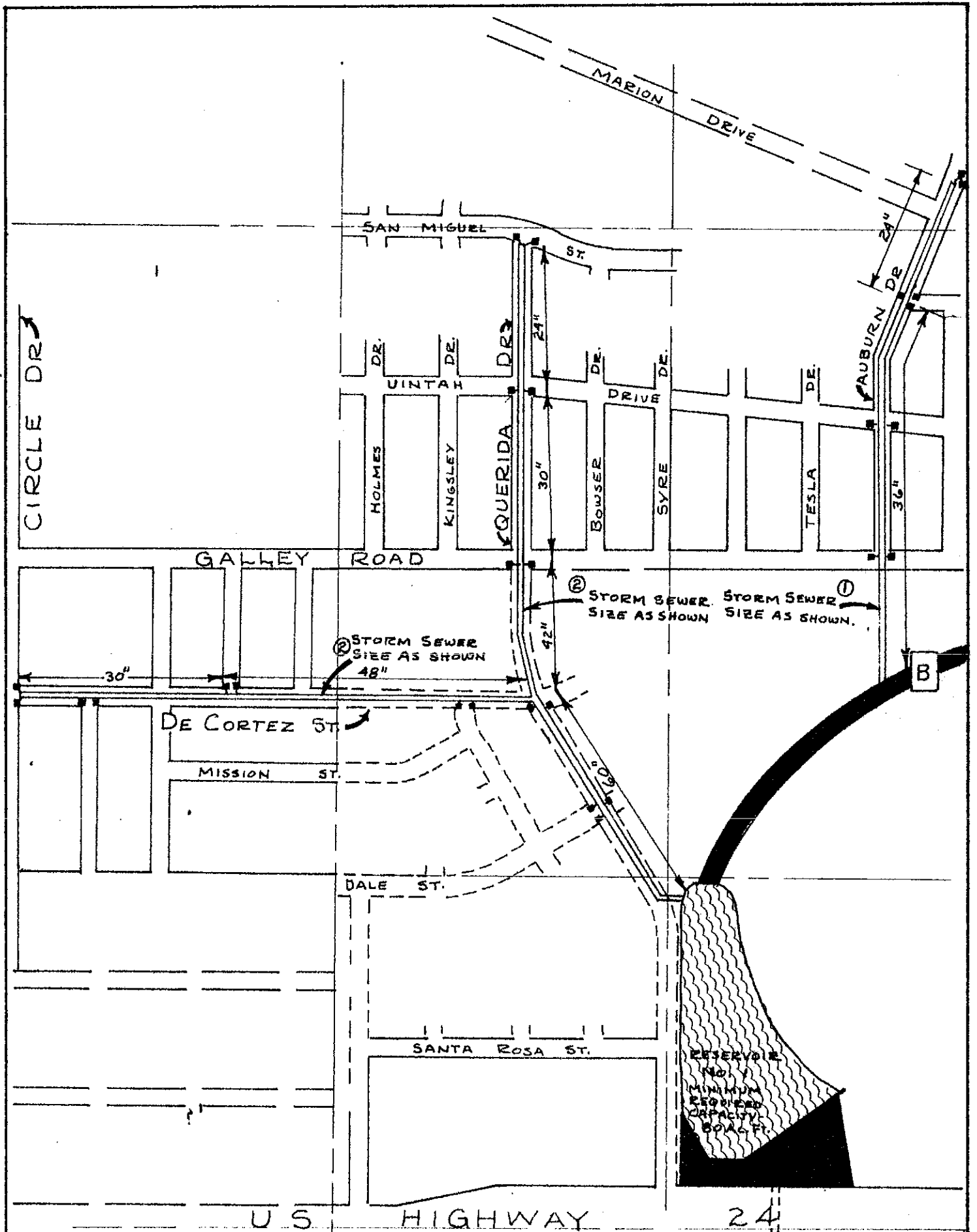


SPECIAL DESIGN PROBLEM



C-1

UNITED WESTERN ENGINEERS  
COLORADO SPRINGS, COLORADO





U S - HIGHWAY 24

REQUIRED DRAINAGE STREET.  
MINIMUM RIGHT OF WAY - 70 FEET.  
.2 FOOT MAXIMUM CURB DROP.

REQUIRED DRAINAGE STREET.  
MINIMUM RIGHT OF WAY - 80 FEET.  
.2 FOOT MAXIMUM CURB DROP.  
MINIMUM SLOPE - 2%

REQUIRED DRAINAGE STREET  
MINIMUM RIGHT OF WAY - 80 FT.  
.2 FT. MAXIMUM CURB DROP  
MINIMUM SLOPE - 1 1/2%

DIVIDE BASIN DRAINAGE HERE.  
EAST HALF OF BASIN TO PIKES  
PEAK AVE. AS SHOWN.

REQUIRED DRAINAGE STREET  
MINIMUM RIGHT OF WAY - 80 FEET.  
.2 FOOT MAXIMUM CURB DROP.  
MINIMUM SLOPE - 2%

REQUIRED BRIDGE -  
OPEN FLOW AREA,  
REQUIRED - 50 SQ. FT.

PIKES PEAK AVE. EXTENSION

EXTEND PIKES PEAK AVE  
DUE EAST.

③ STORM SEWER,  
SIZE AS SHOWN.

36"

US HIGHWAY 24

EXISTING CULVERT

30' DRAINAGE EASEMENT  
OR 80' RIGHT OF WAY STREET

MINIMUM RIGHT OF WAY-80 FEET  
.2 FOOT MAXIMUM CURB DROP.

BIJOU ST.

BLVD.

CHERRY HILLS

MINIMUM RIGHT OF WAY-80 FEET  
.2 FOOT MAXIMUM CURB DROP.

PIKES

PEAK AVE. (EXTENDED)

REQUIRED BRIDGE - OPEN FLOW  
AREA REQUIRED - 75 SQ. FT.

SEE SHEET  
C-3

REQUIRED BRIDGE  
OPEN FLOW  
AREA REQUIRED,  
100 SQ. FT.

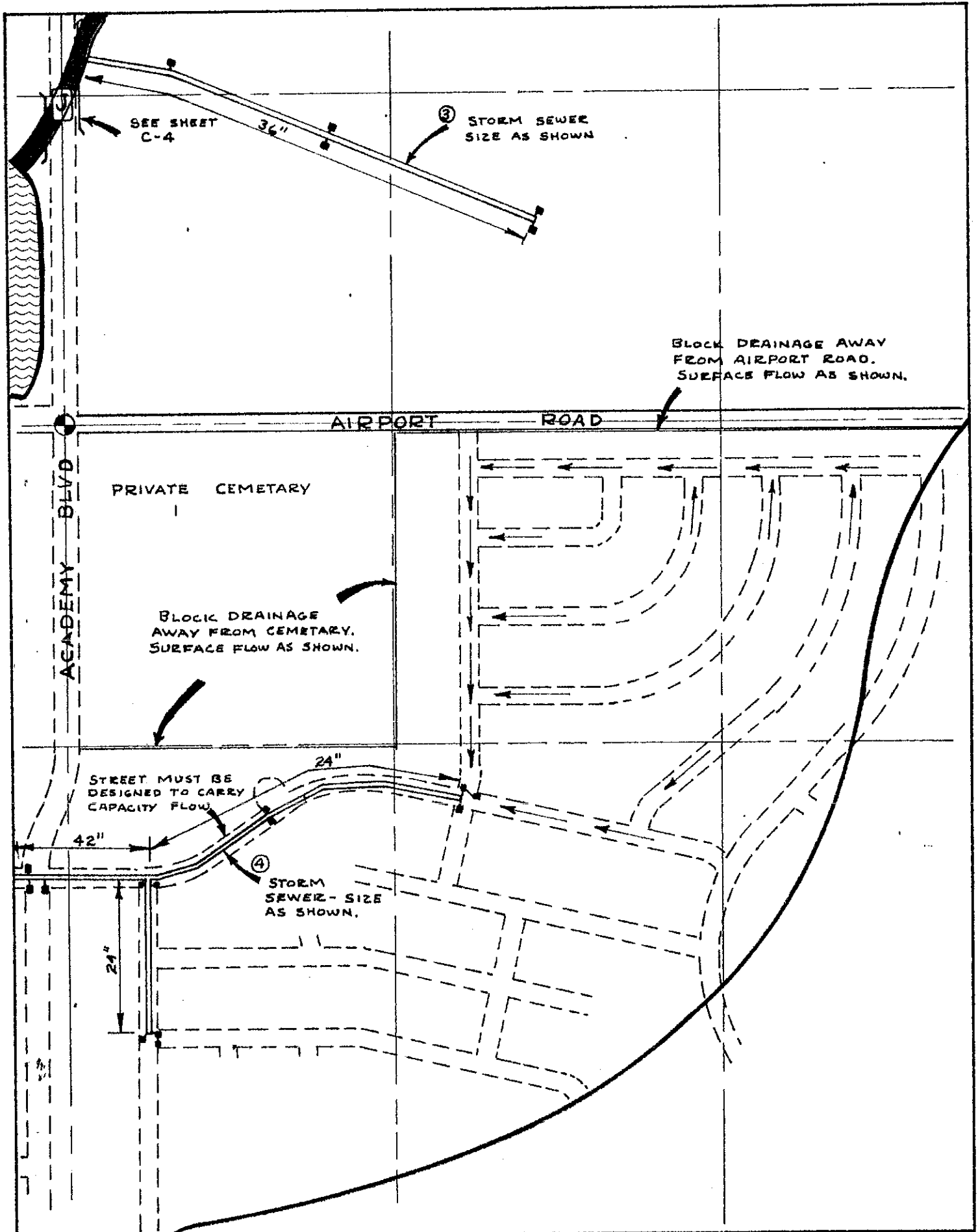
36"

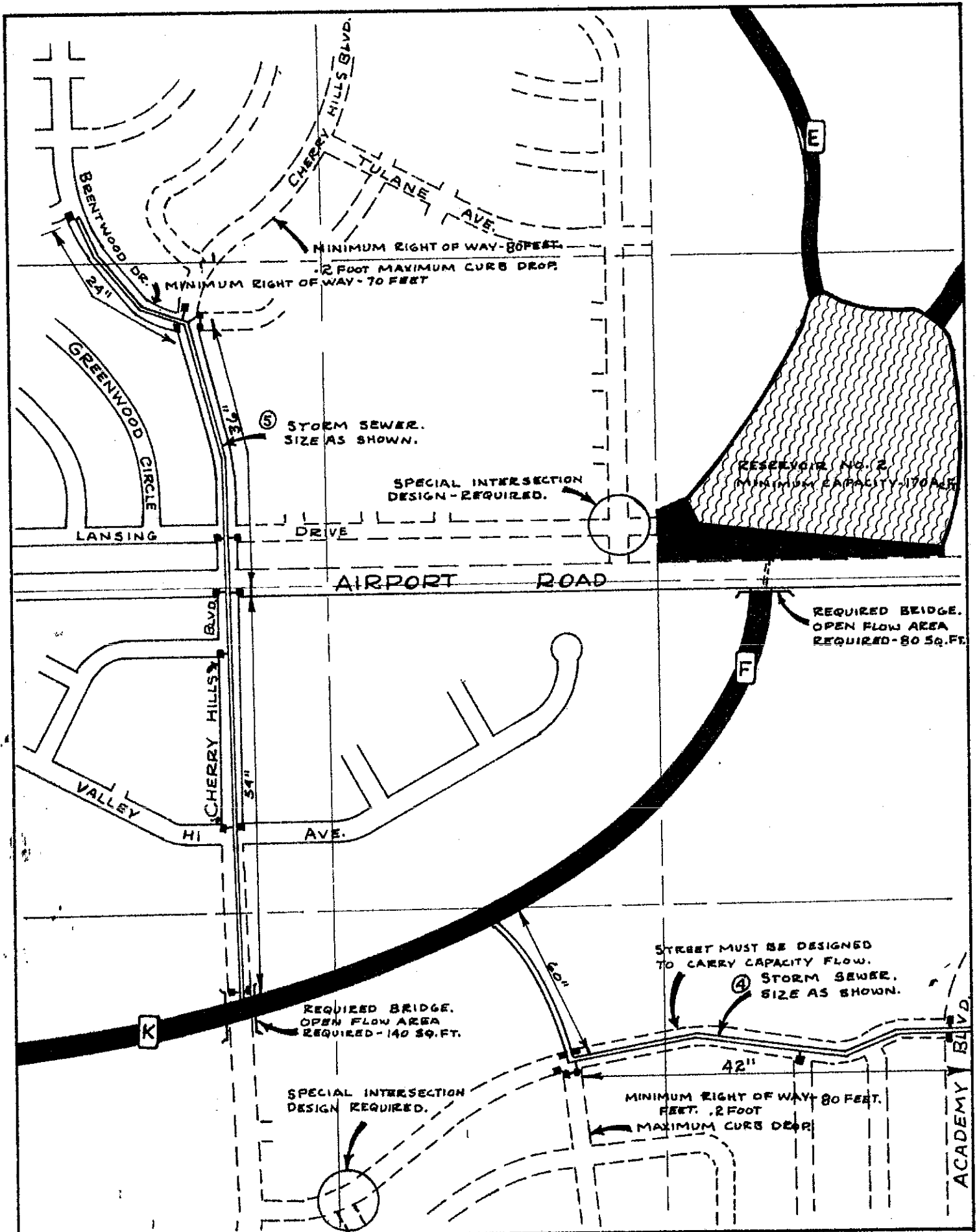
STORM SEWER.  
SIZE AS SHOWN.

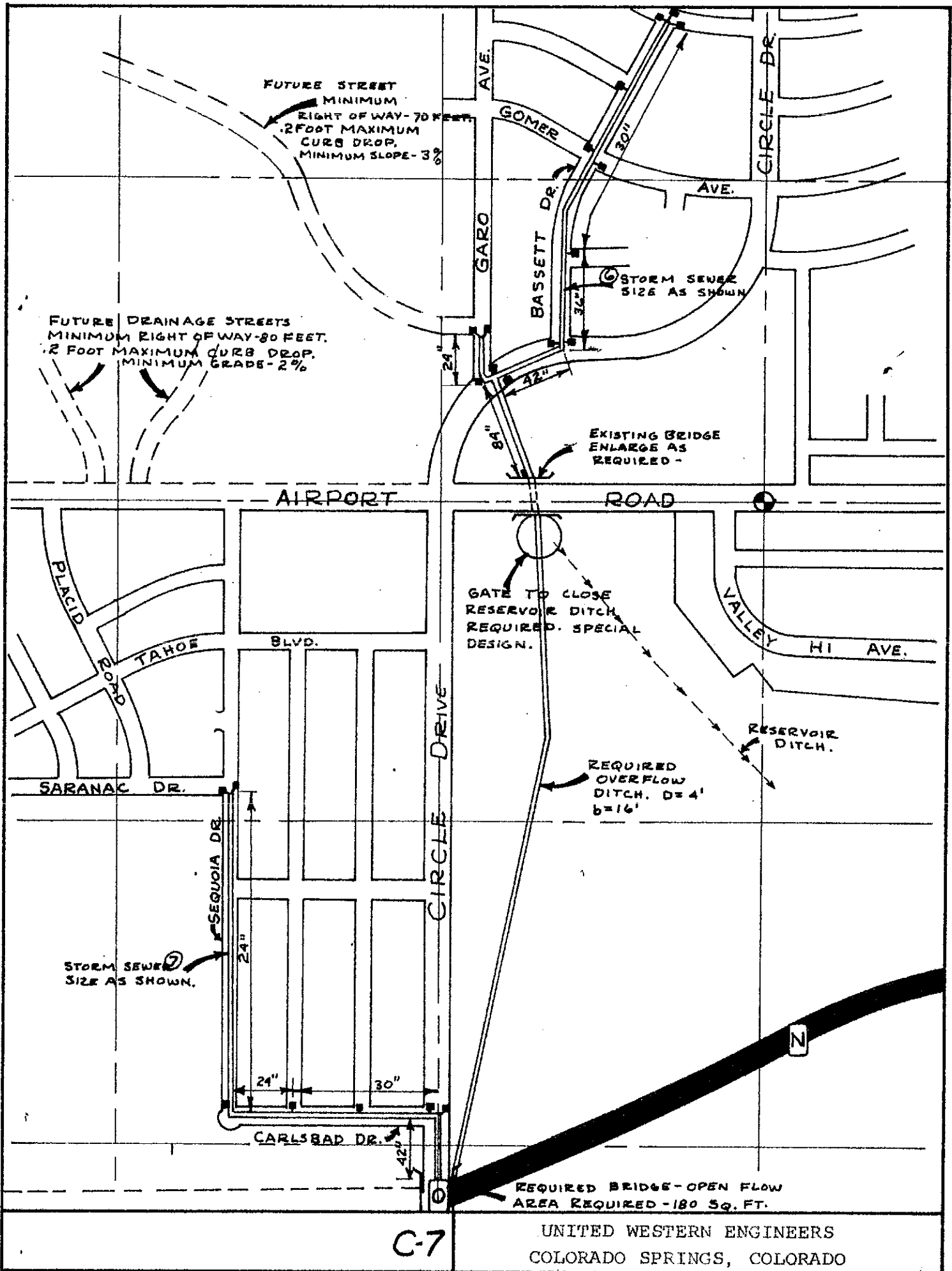
RESERVOIR  
NO. 2

C-4

UNITED WESTERN ENGINEERS  
COLORADO SPRINGS, COLORADO







FUTURE STREET  
 MINIMUM  
 RIGHT OF WAY-70 FEET.  
 2 FOOT MAXIMUM  
 CURB DROP.  
 MINIMUM SLOPE-3%

FUTURE DRAINAGE STREETS  
 MINIMUM RIGHT OF WAY-80 FEET.  
 2 FOOT MAXIMUM CURB DROP.  
 MINIMUM GRADE-2%

STORM SEWER  
 SIZE AS SHOWN

EXISTING BRIDGE  
 ENLARGE AS  
 REQUIRED -

GATE TO CLOSE  
 RESERVOIR DITCH  
 REQUIRED. SPECIAL  
 DESIGN.

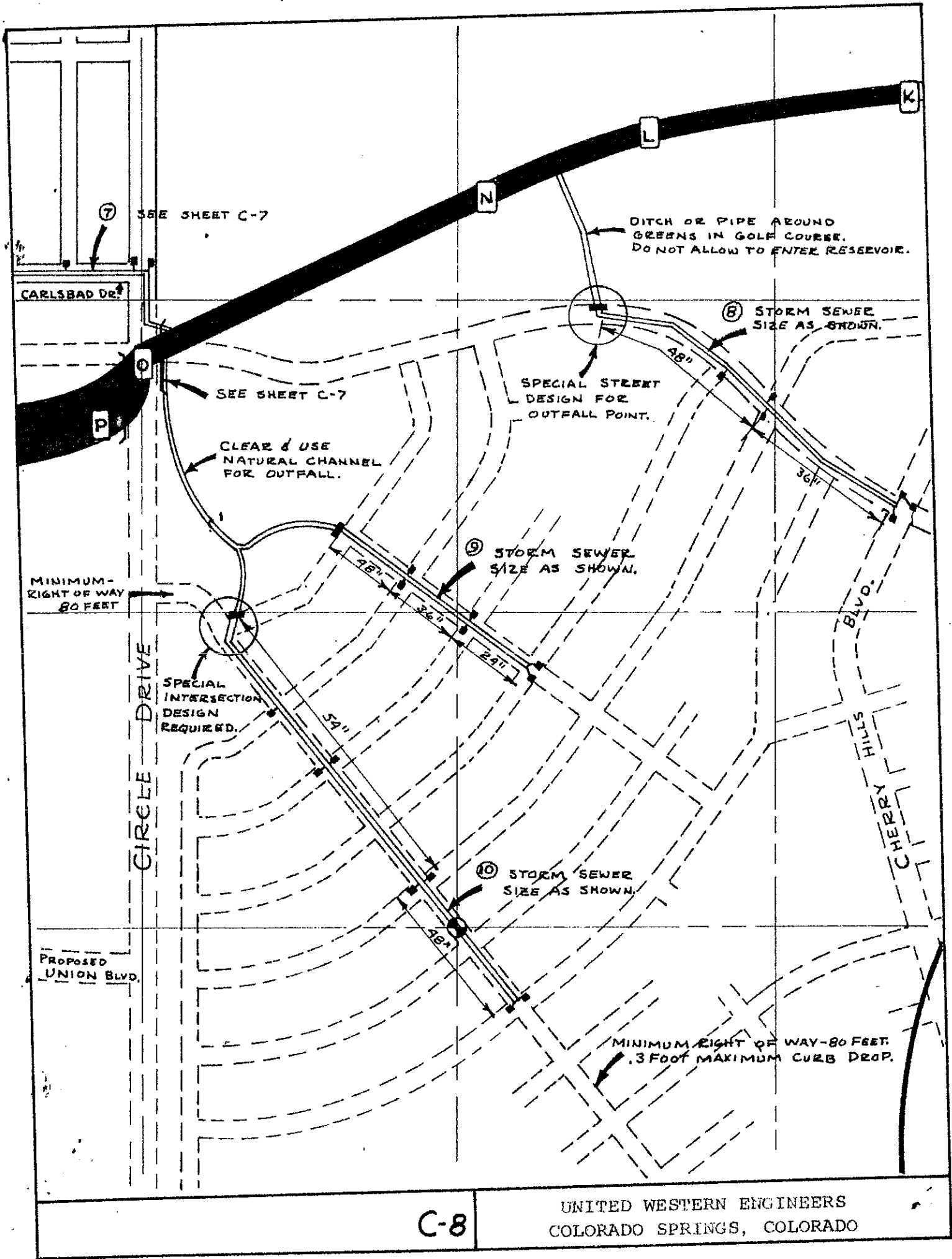
REQUIRED  
 OVERFLOW  
 DITCH. D=4'  
 b=16'

STORM SEWER  
 SIZE AS SHOWN.

REQUIRED BRIDGE-OPEN FLOW  
 AREA REQUIRED-180 Sq. FT.

C-7

UNITED WESTERN ENGINEERS  
 COLORADO SPRINGS, COLORADO



⑦ SEE SHEET C-7

CARLSBAD DR.

DITCH OR PIPE AROUND GREENS IN GOLF COURSE. DO NOT ALLOW TO ENTER RESERVOIR.

SEE SHEET C-7

⑧ STORM SEWER SIZE AS SHOWN.

CLEAR & USE NATURAL CHANNEL FOR OUTFALL.

SPECIAL STREET DESIGN FOR OUTFALL POINT.

MINIMUM-RIGHT OF WAY 80 FEET

⑨ STORM SEWER SIZE AS SHOWN.

CIRCLE DRIVE

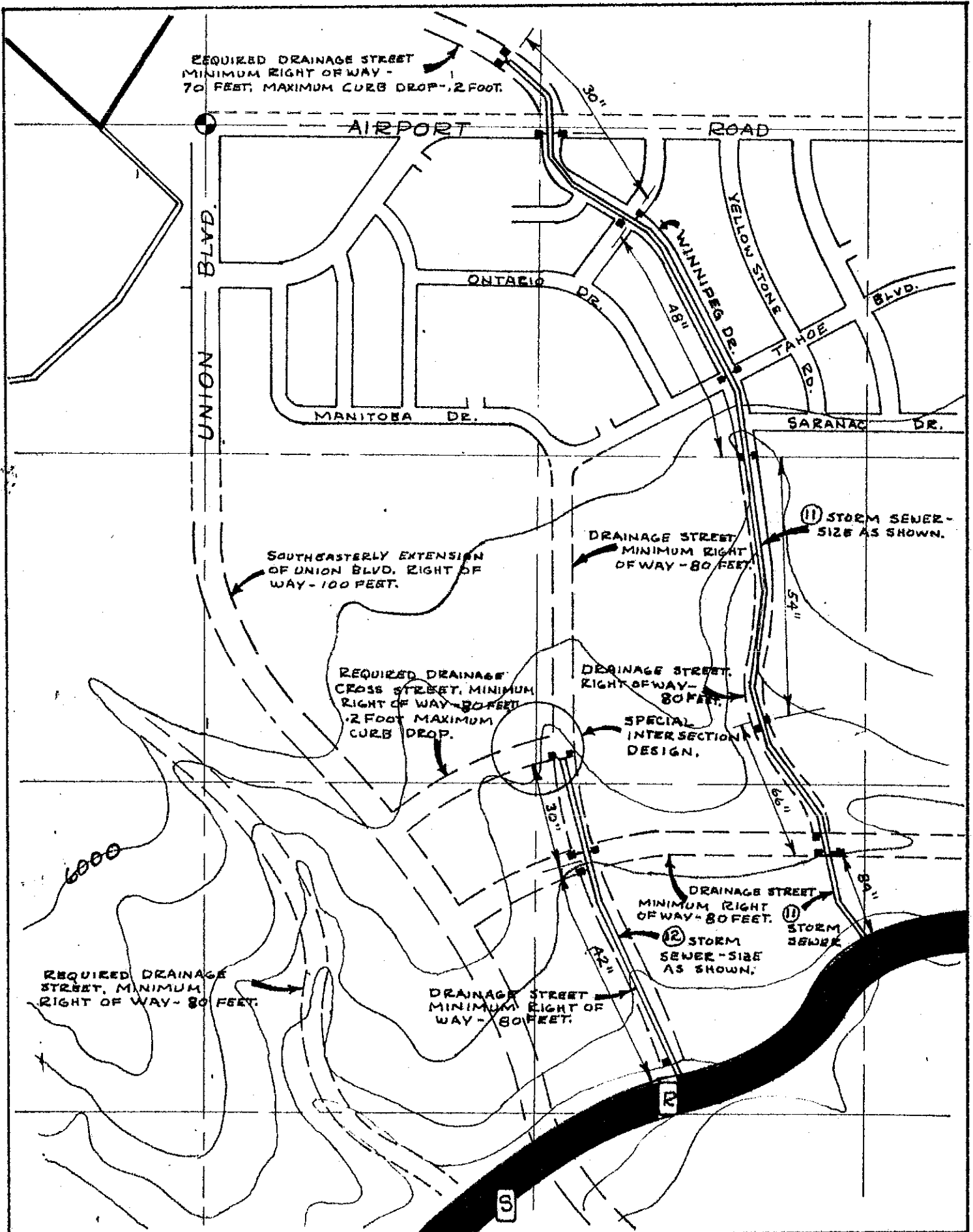
SPECIAL INTERSECTION DESIGN REQUIRED.

CHERRY HILLS BLVD.

⑩ STORM SEWER SIZE AS SHOWN.

PROPOSED UNION BLVD.

MINIMUM RIGHT OF WAY-80 FEET  
.3 FOOT MAXIMUM CURB DROP.



REQUIRED DRAINAGE STREET  
MINIMUM RIGHT OF WAY -  
70 FEET, MAXIMUM CURB DROP -.2 FOOT.

AIRPORT ROAD

UNION BLVD.

ONTARIO DR.

MANITOBA DR.

WINNIPEG DR.

YELLOW STONE

TAHOE

BLVD.

SARANAC DR.

SOUTHEASTERLY EXTENSION  
OF UNION BLVD. RIGHT OF  
WAY - 100 FEET.

DRAINAGE STREET  
MINIMUM RIGHT  
OF WAY - 80 FEET.

11 STORM SEWER -  
SIZE AS SHOWN.

REQUIRED DRAINAGE  
CROSS STREET. MINIMUM  
RIGHT OF WAY 80 FEET  
.2 FOOT MAXIMUM  
CURB DROP.

DRAINAGE STREET.  
RIGHT OF WAY -  
80 FEET.

SPECIAL  
INTERSECTION  
DESIGN.

REQUIRED DRAINAGE  
STREET. MINIMUM  
RIGHT OF WAY - 80 FEET.

DRAINAGE STREET  
MINIMUM RIGHT OF  
WAY - 80 FEET.

DRAINAGE STREET  
MINIMUM RIGHT  
OF WAY - 80 FEET.

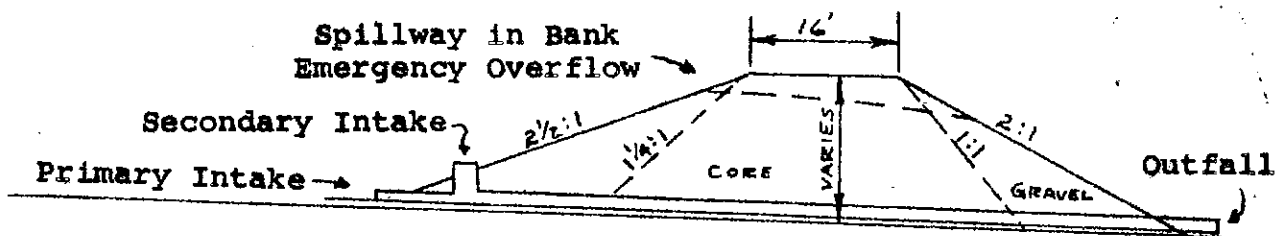
12 STORM  
SEWER - SIZE  
AS SHOWN.

11 STORM  
SEWER



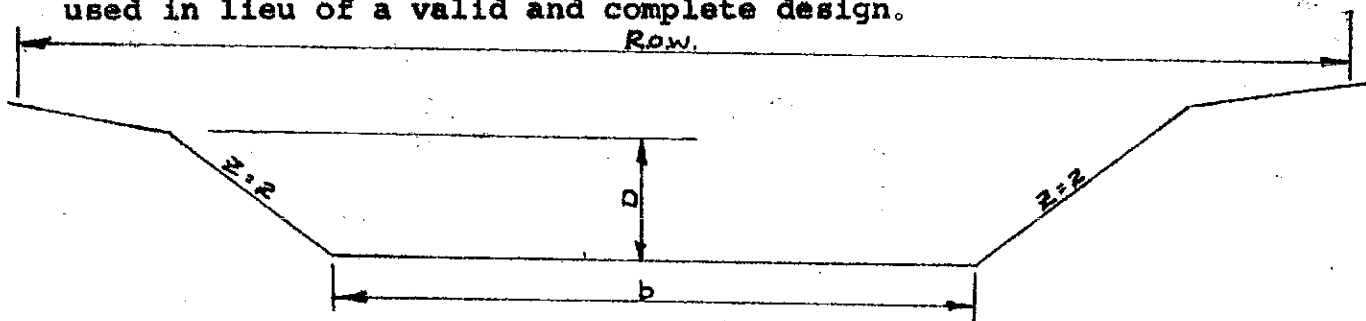


Intake Pipe to be on  
Reservoir Grade so that  
Stream does not pond.



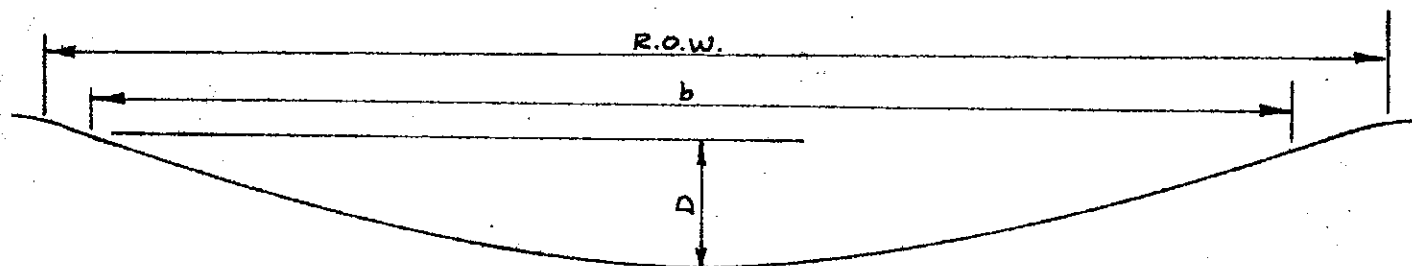
**TYPICAL SECTION - "FLOW THROUGH" DAM**

Each Dam must be individually designed and submitted to the State Engineer. The above sketch is for reference only and is not to be used in lieu of a valid and complete design.



**DITCH TYPE NO. 1**

For use as street divider or high capacity ditch.



**DITCH TYPE NO. 2**

For use as Park Strip, Playground Strip,  
or low capacity residential ditch.

See Sheet C-12 For Dimensional Values.

REQUIRED CHANNEL SIZES

LOCATION		WIDTH AT BOTTOM Feet	DEPTH OF FLOW Feet	WIDTH - GREENBELT 50'
FROM	TO			
A	B	10'	2'	
B	C	20'	3'	50'
C	D	30'	2.6'	50'

RESERVOIR NO. 1 ABOVE HIGHWAY 24 & POINT D

D	E	8'	2.2'	50'
E	F	9'	3'	50'

RESERVOIR NO. 2

G	H	9.5'	2'	50'
H	I	11.5'	2.5'	50'
I	J	11.8'	3'	50'
J	F	21.1'	3'	50'

RESERVOIR NO. 2

F	K	11.0'	2'	75')
K	L	29.4'	2.5'	75') Golf
L	N	21.5'	3'	75') Course
N	O	21.2'	3.5'	75')
O	P	26.0'	5'	150'
P	R	26.2'	5.5'	150'
R	S	26.0'	6'	150'
S	T	27.1'	6'	150'
T	U	28.0'	6'	150'

Storm Sewer 1	.....	\$ 26,484.00
Storm Sewer 2	.....	95,630.50
Storm Sewer 3	.....	28,242.00
Storm Sewer 4	.....	76,455.50
Storm Sewer 5	.....	67,576.00
Storm Sewer 6	.....	56,413.00
Storm Sewer 7	.....	28,096.00
Storm Sewer 8	.....	41,544.00
Storm Sewer 9	.....	14,220.00
Storm Sewer 10	.....	49,854.00
Storm Sewer 11	.....	107,638.00
Storm Sewer 12	.....	21,957.50
Storm Sewer 13	.....	17,505.00
Reservoir #1	.....	5,200.00 ±
Reservoir #2	.....	<u>12,550.00</u>

TOTAL BASIN ..... \$649,365.50

Cost per Acre - approx----- \$ 149.87

COST ESTIMATE INCLUDES

1. All pipe in place & Intake boxes.
2. Paving repair where required.
3. Reservoirs

COST ESTIMATE DOES NOT INCLUDE

1. Maintenance of green strips or reservoirs.
2. Cost of drainage Streets or special ditches in golf course.

APPENDIX D:

Basic Data

Soil Types:      Wind Blown Sand      - Group B  
                  Fox Hills Formation - Group B  
                  Pierre Shale            - Group D

Rainfall Types used in computation:

Duration	Intensity	Frequency
30 min.	0.8"	2 years
1 hour	2.0"	50 years
6 hour	2.75"	25 years
6 hour	3.00"	50 years
6 hour	3.50"	100 years

Soil Condition:

Average - neither dry nor saturated.  
Average infiltration characteristics prevailing.  
Infiltration Rate, high during first 1/2 hour,  
and progressively lower.

Rainfall condition assumed:

Rain of some intensity falls on basin.  
Start and end of rain same over entire basin.

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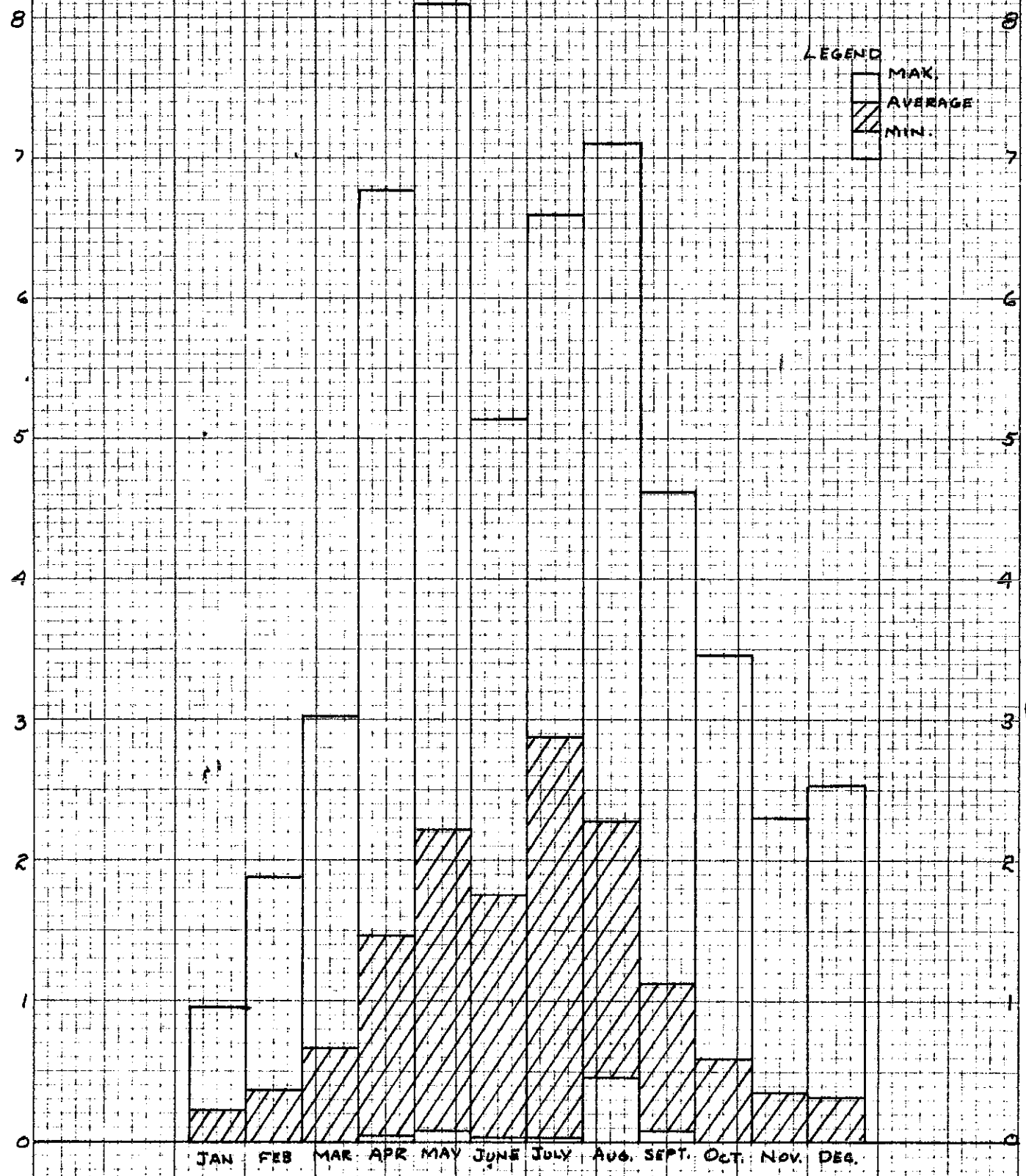


No. 100.101  
10 DIVISIONS PER INCH BOTH WAYS

# COLORADO SPRINGS, COLORADO

## MONTHLY PRECIPITATION

### MAXIMUM-MINIMUM-AVERAGE



PERIOD OF RECORD, 1872 to 1938

Compiled from U.S. Weather Bureau Records.

FIGURE 15 D-1

INFILTRATION CURVES  
ESTIMATED FROM RAINMAKER TESTS  
BY SCS PROJECTS, 1936

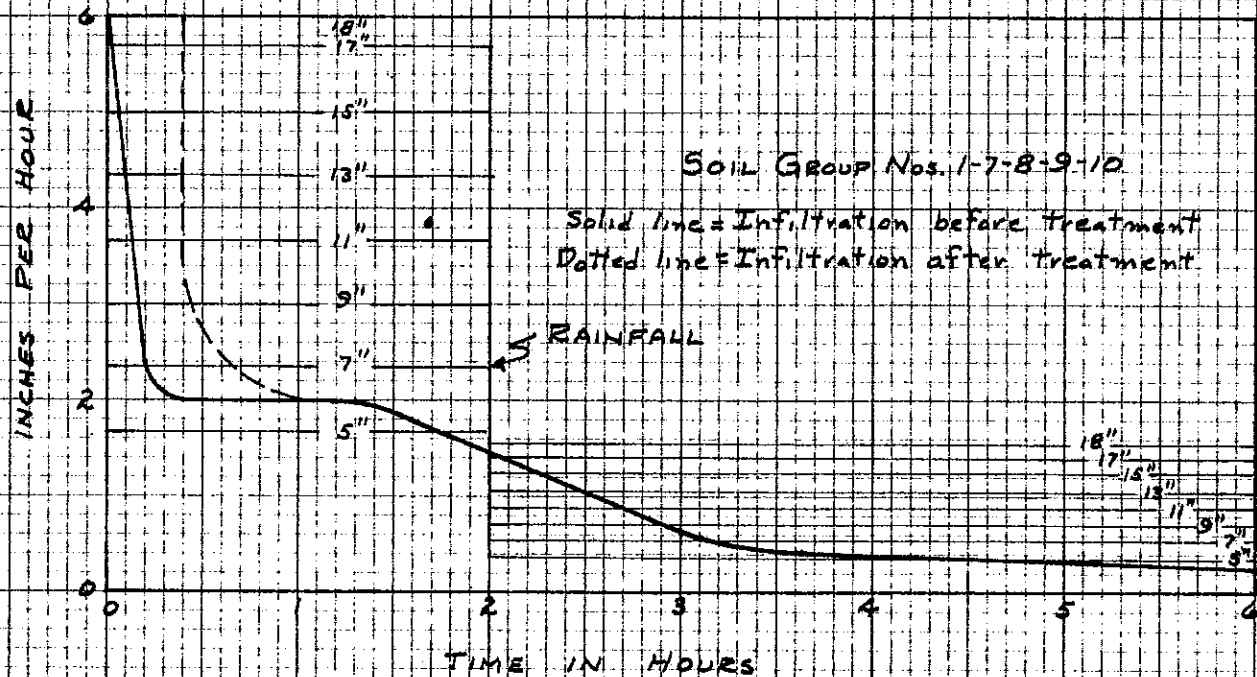
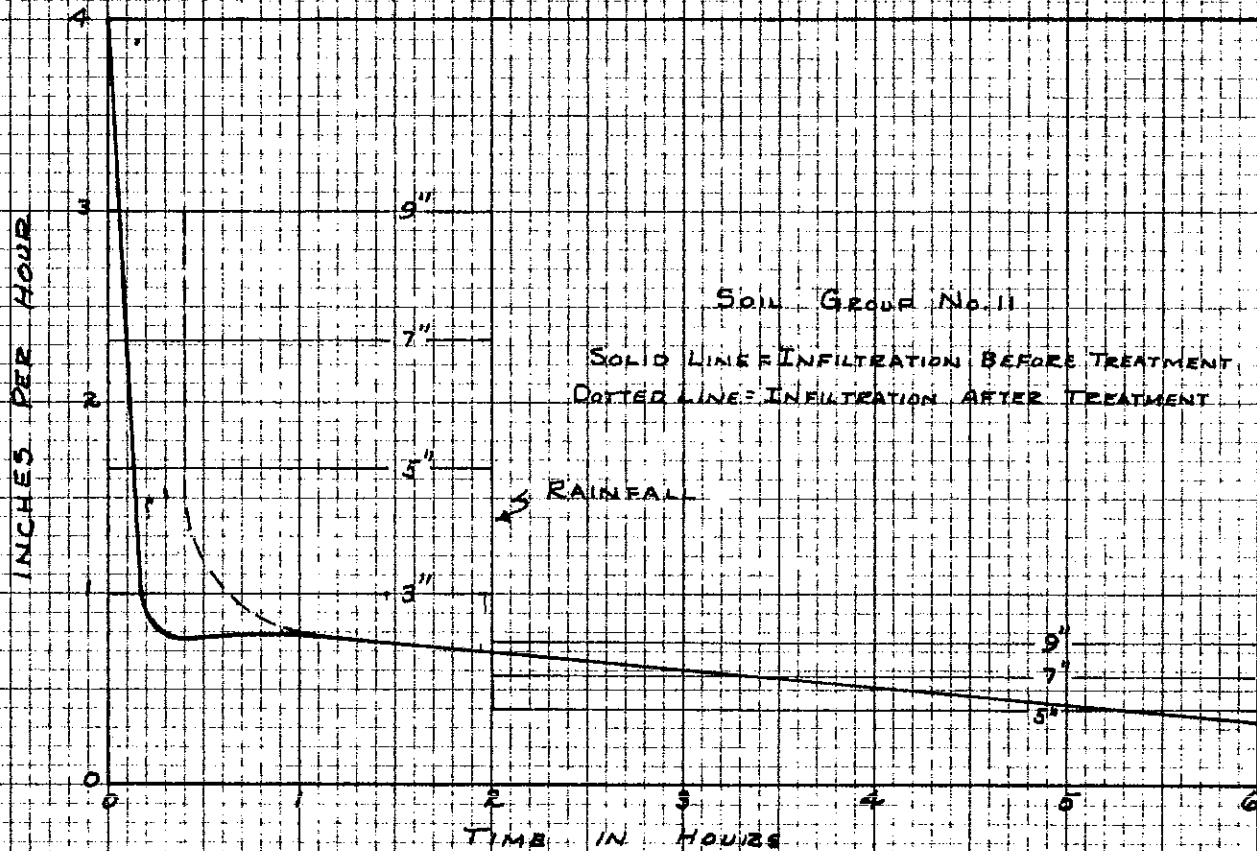


FIGURE 26

EXISTING GROUNDSUBDIVIDED GROUND

RUNOFF BASIN	AREA	25 YEAR RUNOFF	50 YEAR RUNOFF	25 YEAR RUNOFF	50 YEAR RUNOFF	100 YEAR RUNOFF	1 HOUR 50 YEAR RUNOFF
1	96.4	1.92	2.40	16.89	18.60	22.30	11.22
2	73.5	1.84	2.45	12.86	14.20	17.00	8.57
3	122.1	2.44	3.05	21.40	23.60	28.36	14.26
4	54.2	1.26	1.54	9.48	10.50	12.56	6.33
5	55.4	1.02	1.30	9.68	10.70	12.80	6.46
6	25.7	0.47	0.60	4.50	4.96	5.96	3.00
7	113.9	5.88	7.60	19.90	22.00	26.38	13.28
8	146.0	7.55	9.74	25.60	28.20	33.80	17.02
9	59.7	1.19	1.50	10.44	11.52	13.80	6.97
10	90.0	1.65	2.10	15.74	17.40	20.82	10.50
11	93.7	2.34	3.28	16.40	18.10	21.70	10.92
12	108.4	1.90	2.17	15.52	18.10	22.40	9.90
13	57.9	1.11	1.64	10.26	11.20	13.40	6.76
14	79.9	3.06	4.00	11.46	13.30	16.52	9.32
Sub-Total Runoff	1183.8	33.63	43.37	200.12	222.38	268.80	134.51
15	44.1	0.80	1.10	6.32	7.35	9.12	4.04
16	62.4	1.51	1.87	10.92	12.06	14.46	7.12
17	97.3	1.78	2.27	17.00	18.80	22.50	11.34
18	123.0	2.26	2.87	21.52	23.80	28.50	14.34
19	58.8	1.18	1.47	10.60	11.38	13.62	6.87
20	80.8	1.48	1.89	14.15	15.60	18.70	9.42
21	141.4	2.59	3.30	24.76	27.38	32.80	16.50
22	197.4	3.46	3.95	33.88	37.50	44.70	21.70
Sub- Total Runoff	810.2	15.06	18.72	139.15	153.87	184.40	91.33
23	289.3	7.22	9.64	40.90	45.70	55.90	24.58
24	179.1	3.28	4.18	31.38	34.62	41.50	20.90
25	51.4	0.77	0.86	6.52	7.54	9.34	3.94
26	91.8	2.22	2.76	15.70	17.45	20.80	10.10
27	48.7	0.56	0.62	4.65	5.21	6.52	3.58
28	149.7	2.99	3.74	26.20	28.90	34.70	17.45
29	100.1	1.84	2.34	17.56	19.40	23.20	11.68
30	165.3	7.16	8.95	28.90	32.00	38.30	19.30
31	56.0	0.47	0.56	6.52	7.46	9.52	3.50
32	136.8	2.51	3.19	23.90	26.40	31.70	15.95
Sub- Total Runoff	1275.2	29.02	36.84	202.23	224.68	271.48	130.98

EXISTING GROUNDSUBDIVIDED GROUND

RUNOFF BASIN	AREA	25 YEAR RUNOFF	50 YEAR RUNOFF	25 YEAR RUNOFF	50 YEAR RUNOFF	100 YEAR RUNOFF	1 HOUR 50 YEAR RUNOFF
33	104.7	1.92	2.44	20.10	22.30	26.00	14.30
34	184.6	6.15	8.00	35.50	39.40	45.80	25.22
35	135.9	2.49	3.16	26.10	29.00	33.70	18.56
36	48.7	0.98	1.22	9.37	10.40	12.10	6.66
37	191.9	6.70	8.95	36.90	40.90	47.60	26.20
38	114.8	2.10	2.68	22.10	24.48	28.46	15.70
39	30.3	0.56	0.71	5.82	6.45	7.51	4.14
40	126.7	3.16	4.21	20.20	22.60	27.40	13.08
41	44.1	0.81	1.03	8.10	9.42	10.95	5.44
42	78.1	1.43	1.82	11.20	13.04	16.14	7.16
Sub- Total Runoff	1064.3	26.30	34.22	195.39	217.99	255.66	136.46
Total S.C. Runoff	4333+	104.01	133.15	736.89	818.92	980.34	493.28



## APPENDIX E:

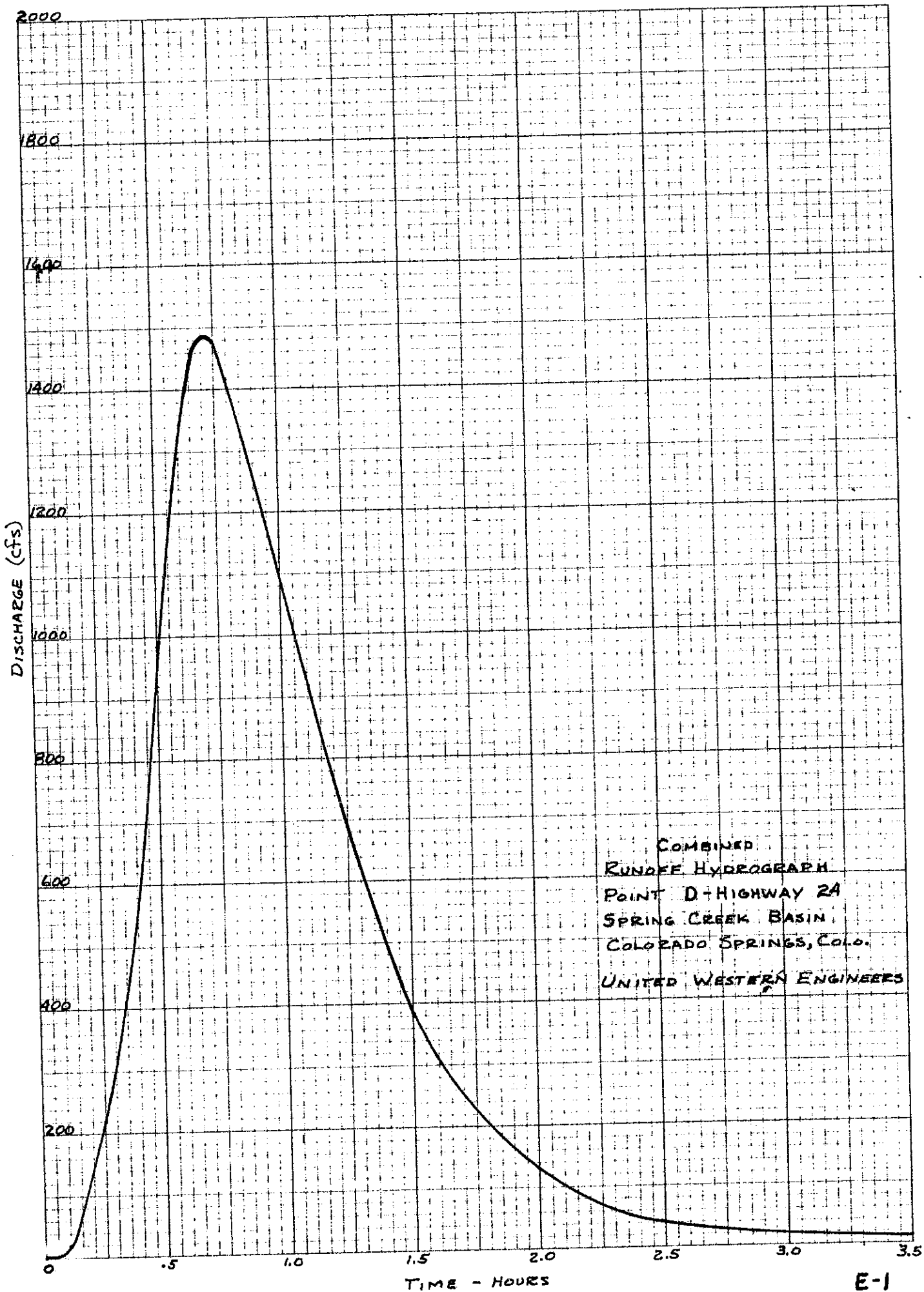
### Hydrograph:

A hydrograph is a graphic "picture of runoff. The area of the graph equals the total amount of runoff in Acre Feet. The peak and entire upper limit of the hydrograph represents the amount of runoff at any given instant of time. In the case of all the following hydrographs, the 0 point on the time scale represents the beginning of rainfall.

To be plotted and calculated, a point in the subject basin must be arbitrarily selected, and the hydrograph constructed in relation to that point.

In the cases in Appendix E, Five lettered key points were selected along Spring Creek for these computations.

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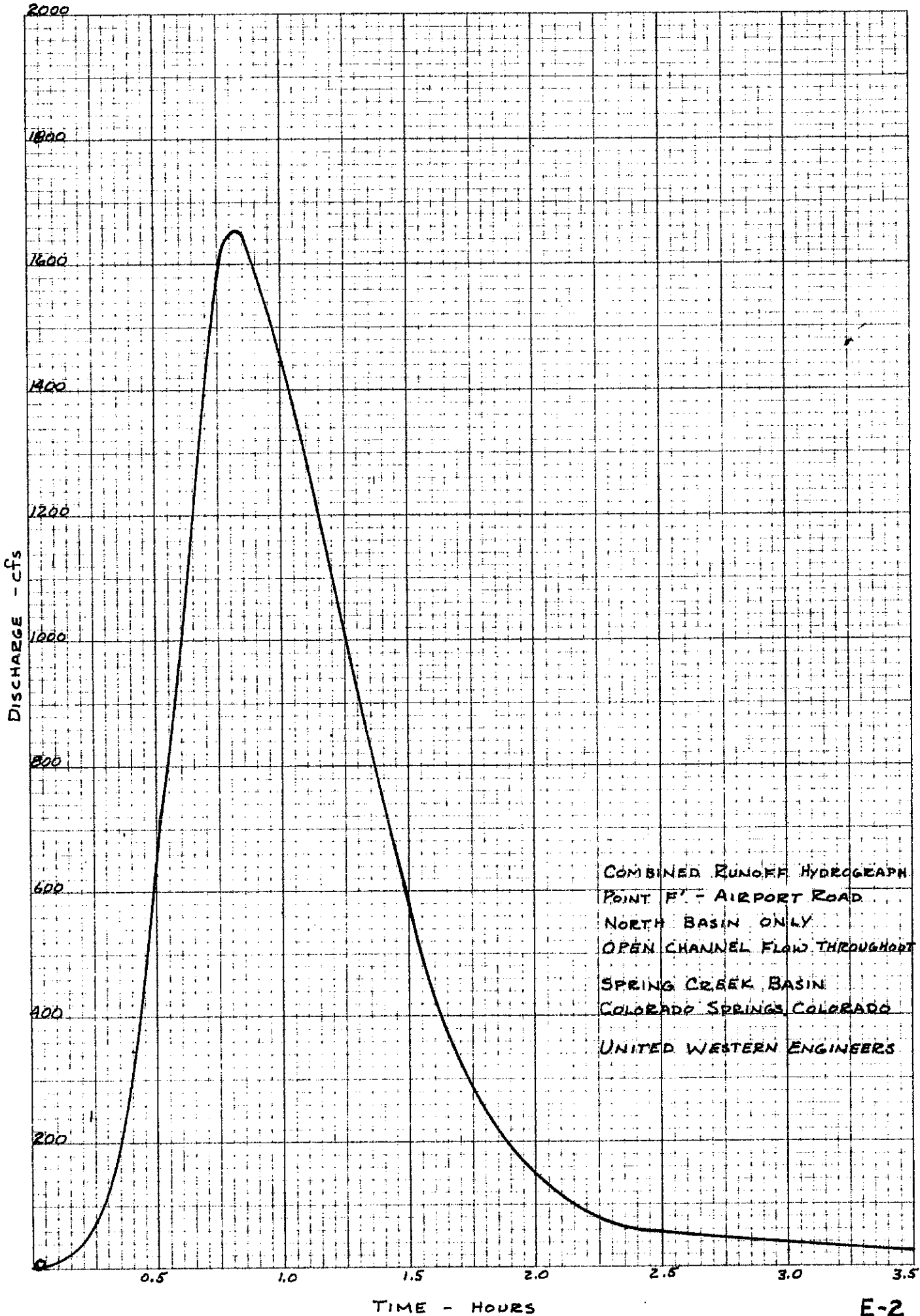


COMBINED  
RUNOFF HYDROGRAPH  
POINT D-HIGHWAY 2A  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

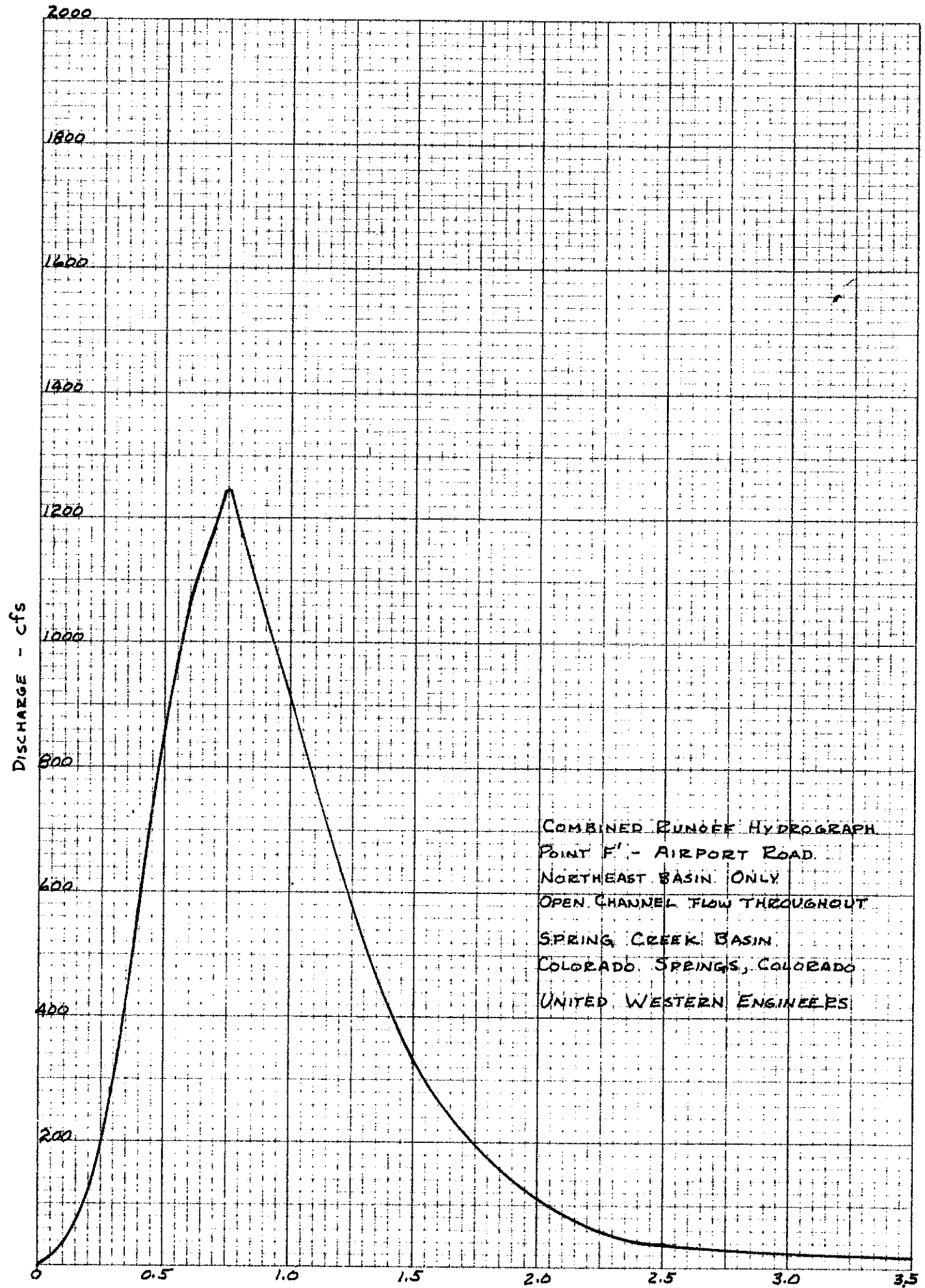
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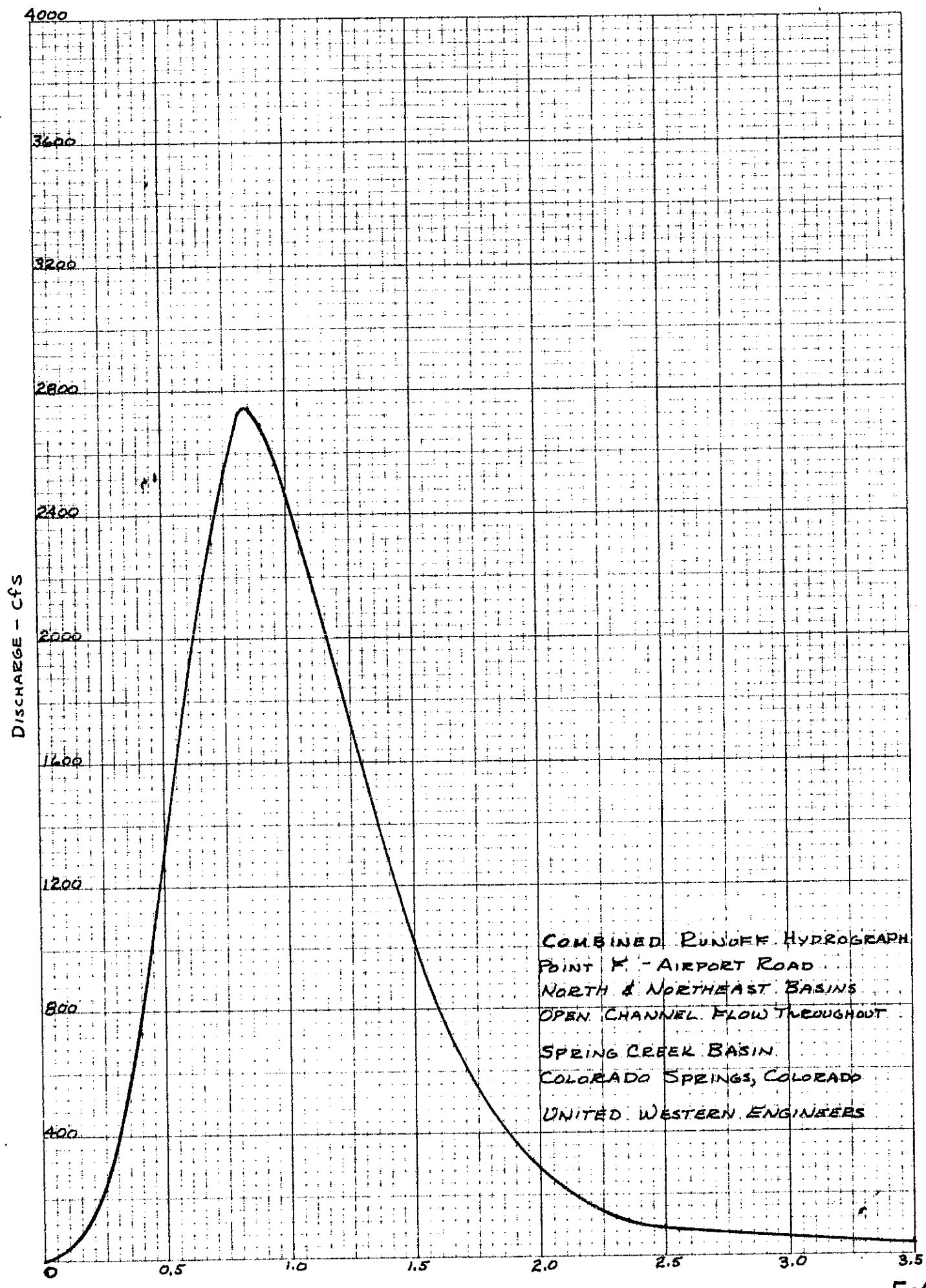


COMBINED RUNOFF HYDROGRAPH  
POINT F' - AIRPORT ROAD  
NORTH BASIN ONLY  
OPEN CHANNEL FLOW THROUGHOUT  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
UNITED WESTERN ENGINEERS

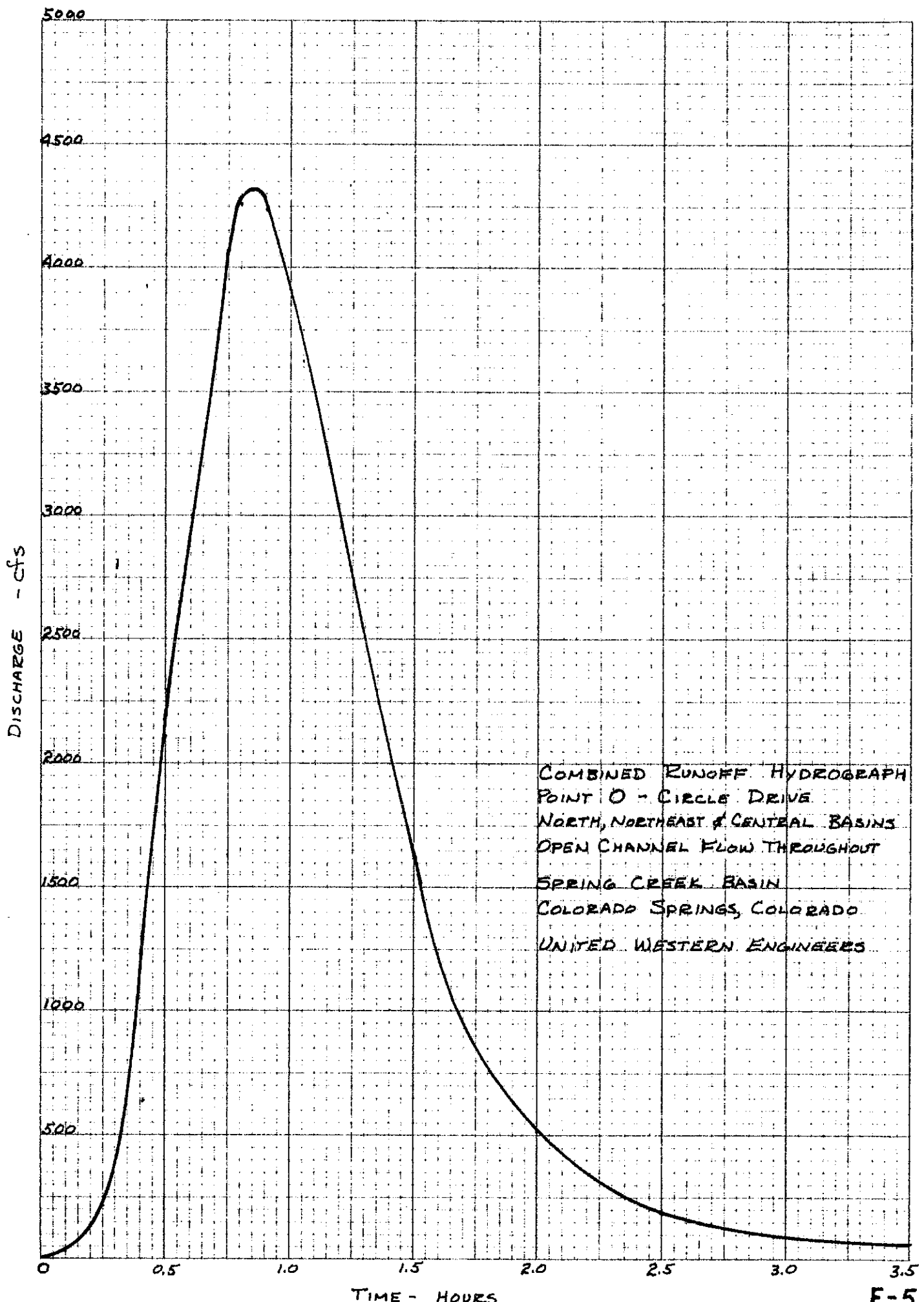


COMBINED RUNOFF HYDROGRAPH  
POINT F' - AIRPORT ROAD  
NORTHEAST BASIN ONLY  
OPEN CHANNEL FLOW THROUGHOUT  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
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REPRODUCED FROM THE ORIGINAL RECORDS OF THE UNITED STATES GEOLOGICAL SURVEY  
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COMBINED RUNOFF HYDROGRAPH  
POINT K - AIRPORT ROAD  
NORTH & NORTHEAST BASINS  
OPEN CHANNEL FLOW THROUGHOUT  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
UNITED WESTERN ENGINEERS

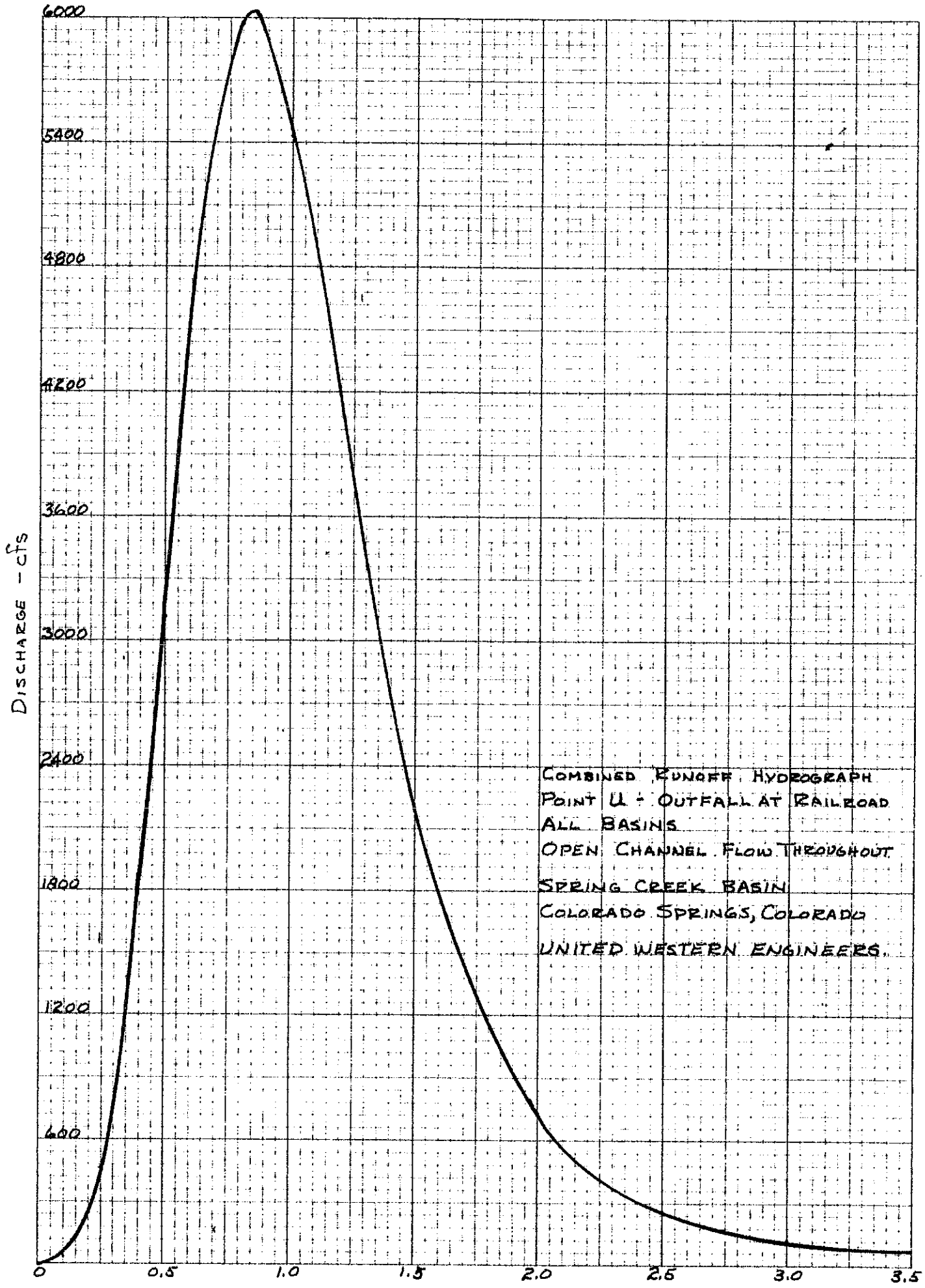


COMBINED RUNOFF HYDROGRAPH  
 POINT O - CIRCLE DRIVE  
 NORTH, NORTHEAST & CENTRAL BASINS  
 OPEN CHANNEL FLOW THROUGHOUT  
 SPRING CREEK BASIN  
 COLORADO SPRINGS, COLORADO  
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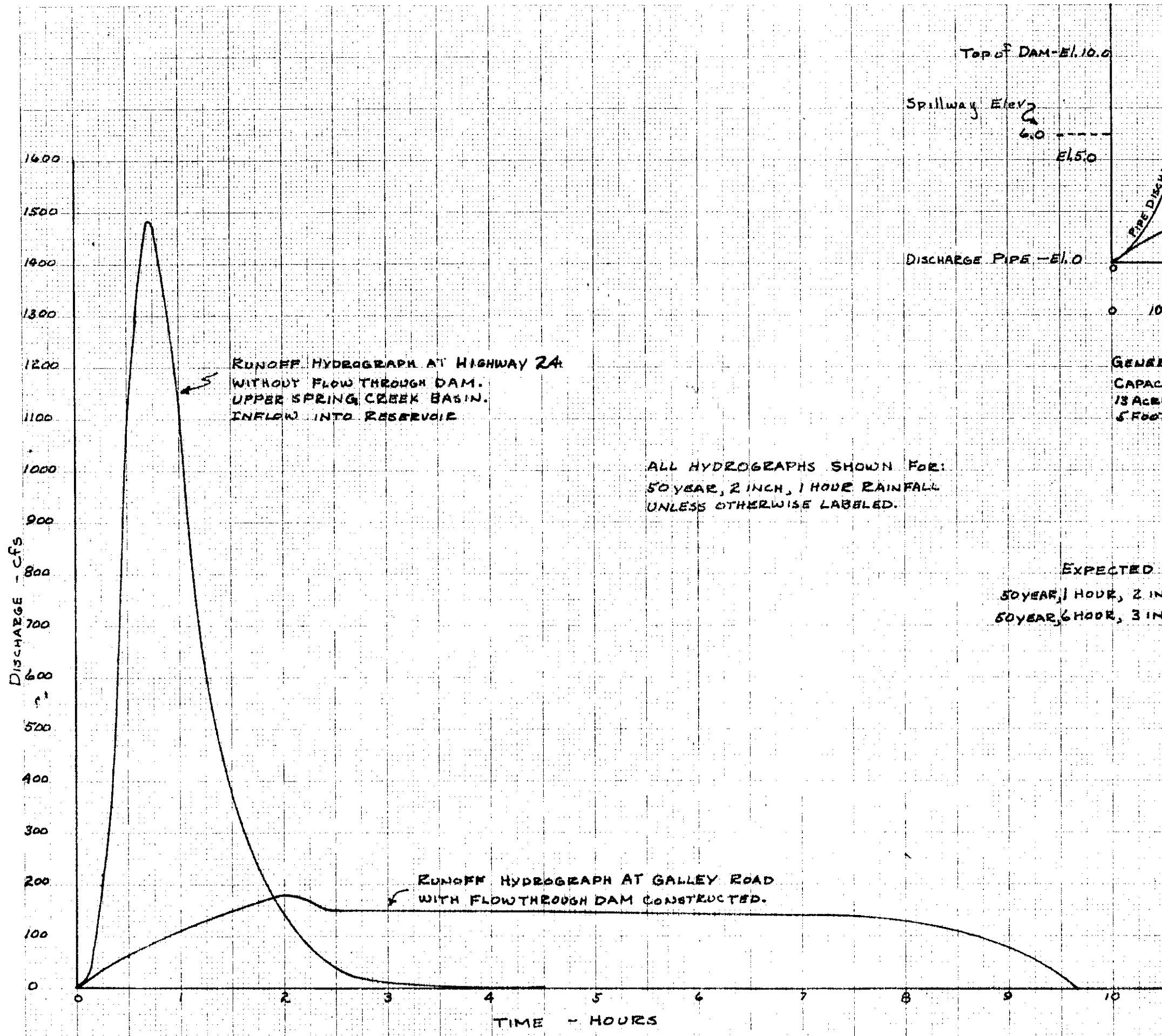


COMBINED RUNOFF HYDROGRAPH  
POINT U - OUTFALL AT RAILROAD  
ALL BASINS  
OPEN CHANNEL FLOW THROUGHOUT  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
UNITED WESTERN ENGINEERS.

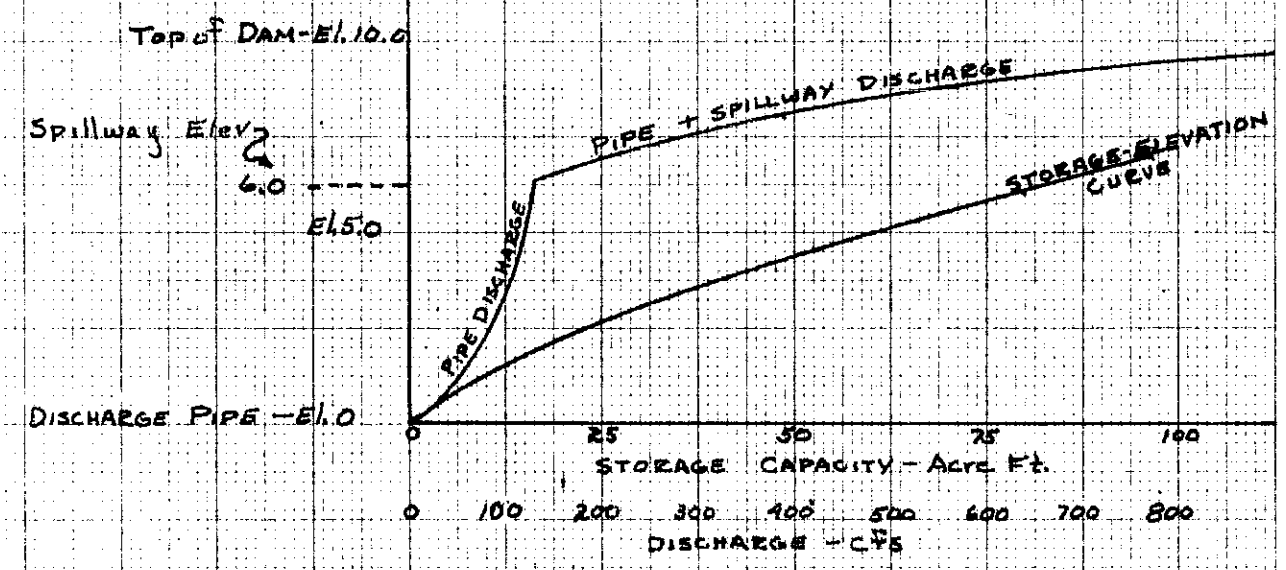
## APPENDIX F:

The hydrographs shown here are based on the same data as those in Appendix E. These, however, reflect the treatment of the Spring Creek Channel by proper channeling and the construction of low, "flow through", dams. The dams have the effect of reducing peak flows and lengthening flow periods.





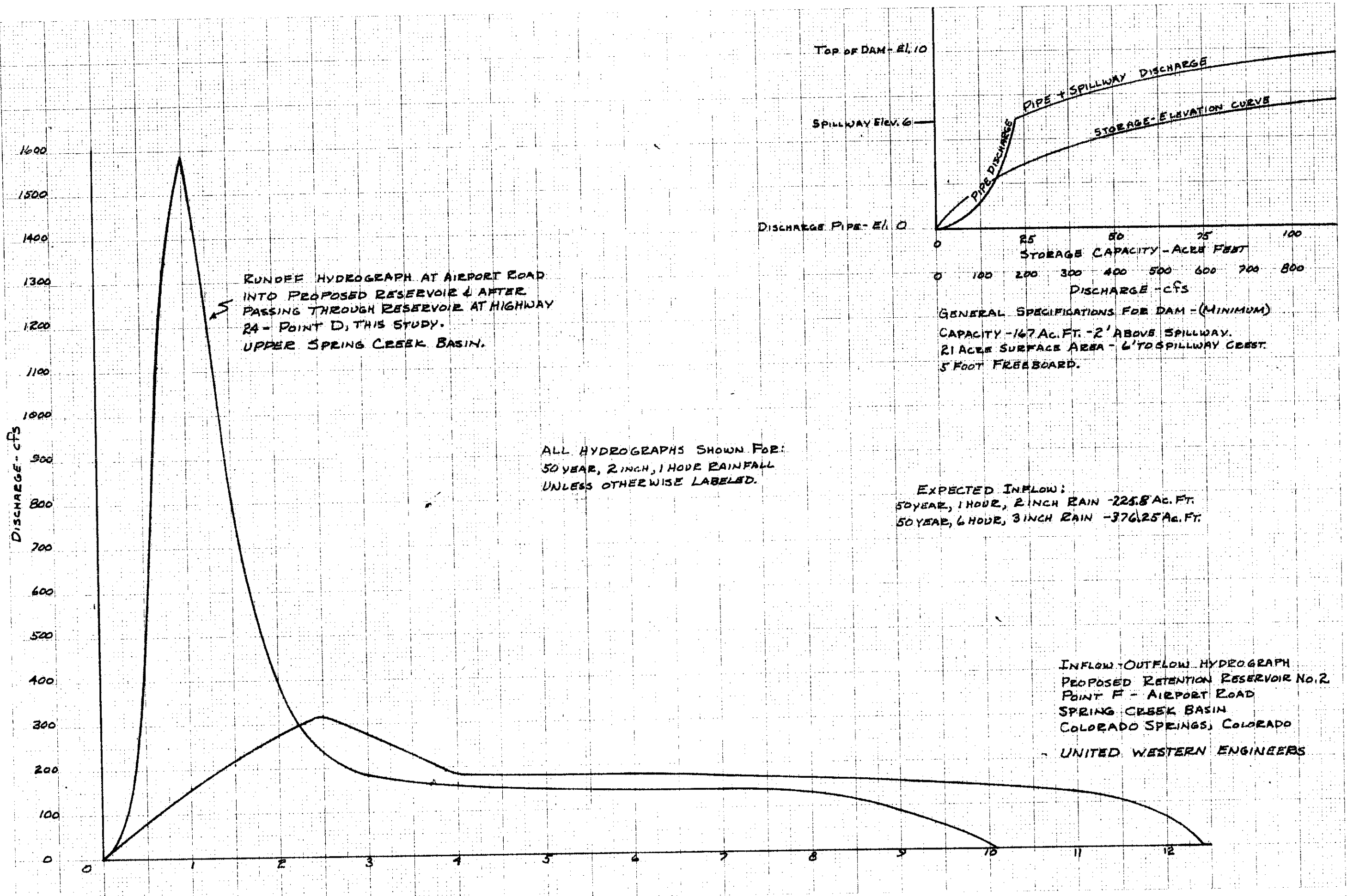
ALL HYDROGRAPHS SHOWN FOR:  
50 YEAR, 2 INCH, 1 HOUR RAINFALL  
UNLESS OTHERWISE LABELED.



GENERAL SPECIFICATIONS FOR DAM - (MINIMUM)  
CAPACITY - 78 AC. FEET BELOW SPILLWAY  
13 ACRE SURFACE AREA - 6' TO SPILLWAY CREST,  
5 FOOT REEBBOARD.

EXPECTED INFLOW:  
50 YEAR, 1 HOUR, 2 INCH RAIN - 134.5 AC. FT.  
50 YEAR, 6 HOUR, 3 INCH RAIN - 179.8 AC. FT.

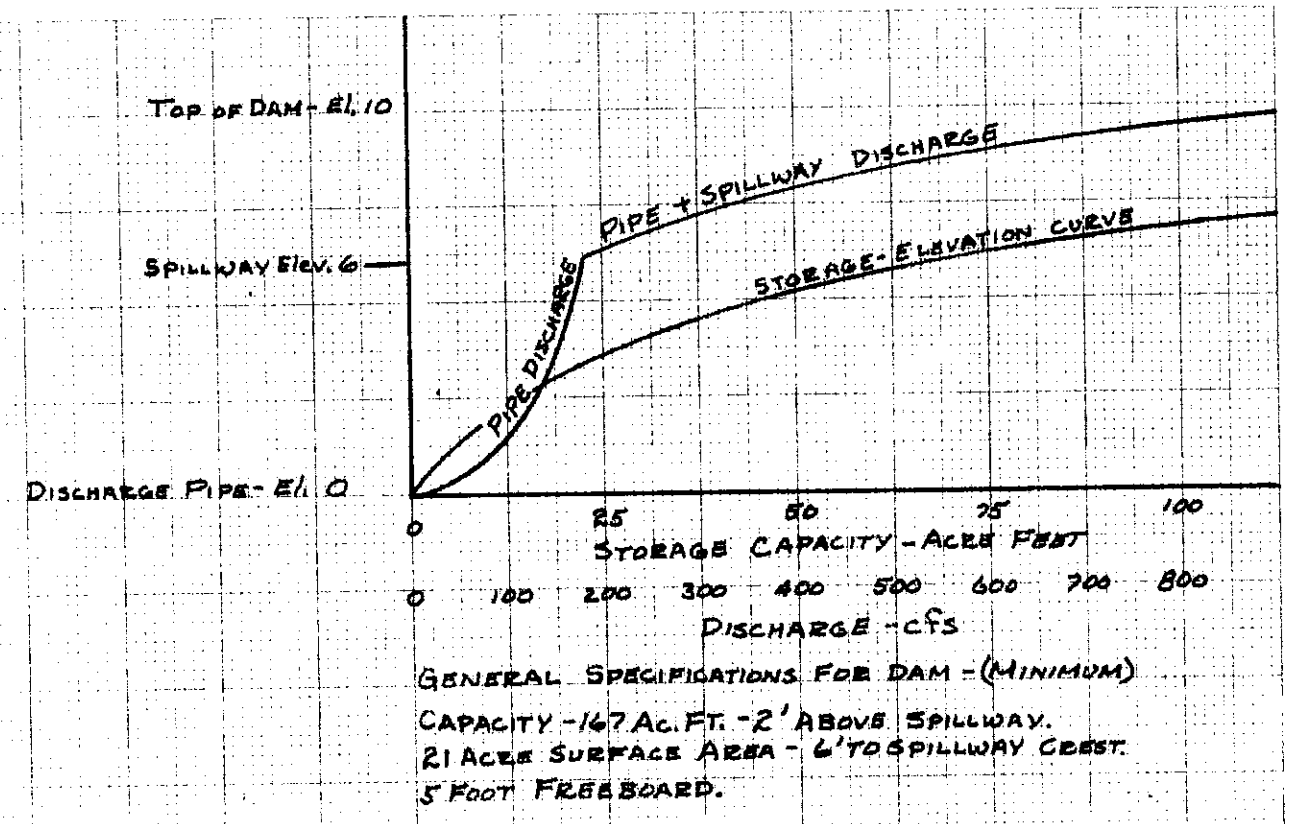
INFLOW-OUTFLOW HYDROGRAPH  
PROPOSED RETENTION RESERVOIR No. 1  
POINT D - HIGHWAY 24  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
UNITED WESTERN ENGINEERS



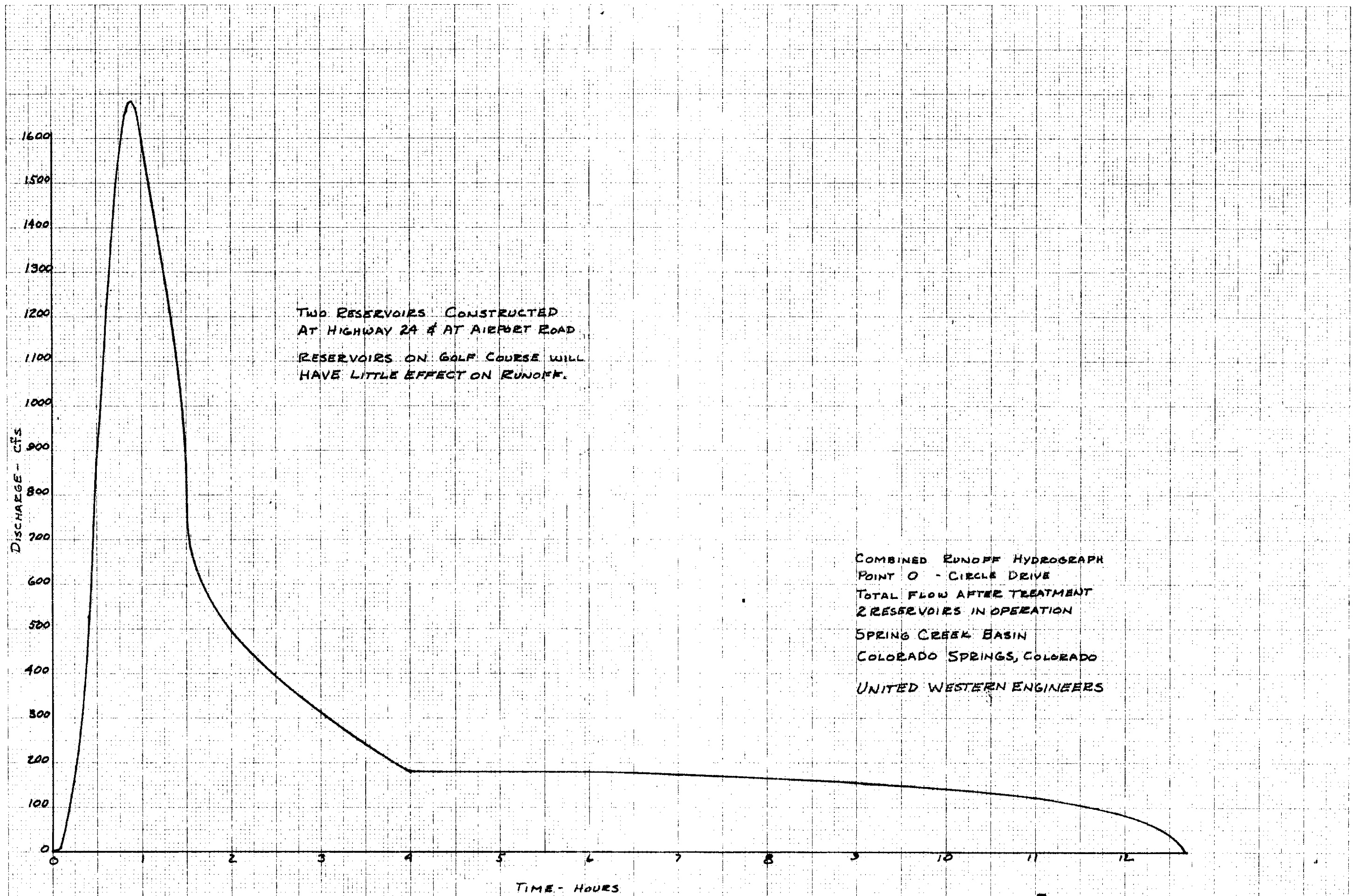
RUNOFF HYDROGRAPH AT AIRPORT ROAD INTO PROPOSED RESERVOIR & AFTER PASSING THROUGH RESERVOIR AT HIGHWAY 24 - POINT D, THIS STUDY. UPPER SPRING CREEK BASIN.

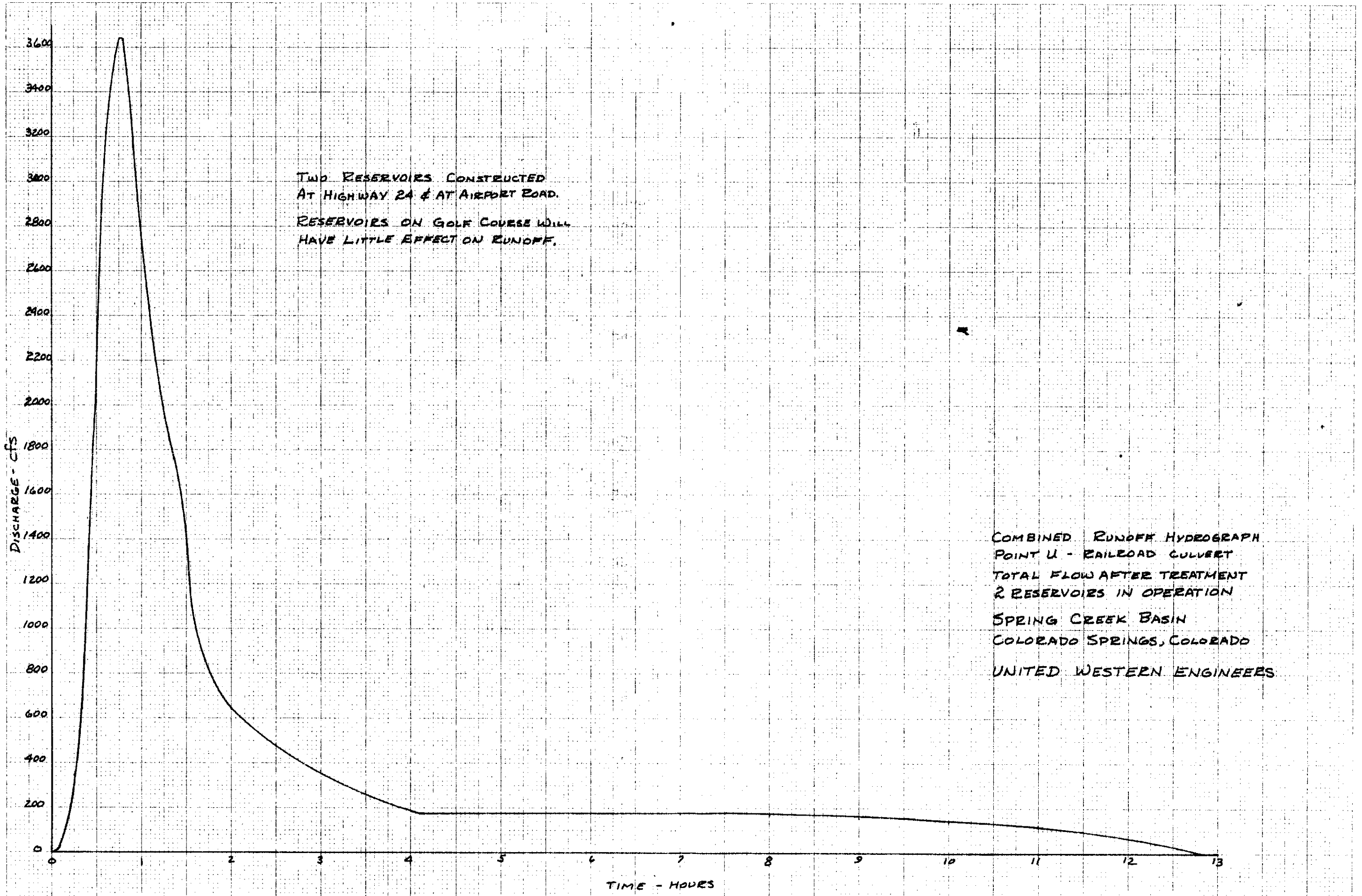
ALL HYDROGRAPHS SHOWN FOR: 50 YEAR, 2 INCH, 1 HOUR RAINFALL UNLESS OTHERWISE LABELED.

INFLOW-OUTFLOW HYDROGRAPH PROPOSED RETENTION RESERVOIR NO. 2 POINT F - AIRPORT ROAD SPRING CREEK BASIN COLORADO SPRINGS, COLORADO  
- UNITED WESTERN ENGINEERS



EXPECTED INFLOW:  
50 YEAR, 1 HOUR, 2 INCH RAIN - 225.8 AC. FT.  
50 YEAR, 6 HOUR, 3 INCH RAIN - 376.25 AC. FT.





TWO RESERVOIRS CONSTRUCTED  
AT HIGHWAY 24 & AT AIRPORT ROAD.  
RESERVOIRS ON GOLF COURSE WILL  
HAVE LITTLE EFFECT ON RUNOFF.

COMBINED RUNOFF HYDROGRAPH  
POINT U - RAILROAD CULVERT  
TOTAL FLOW AFTER TREATMENT  
& RESERVOIRS IN OPERATION  
SPRING CREEK BASIN  
COLORADO SPRINGS, COLORADO  
UNITED WESTERN ENGINEERS

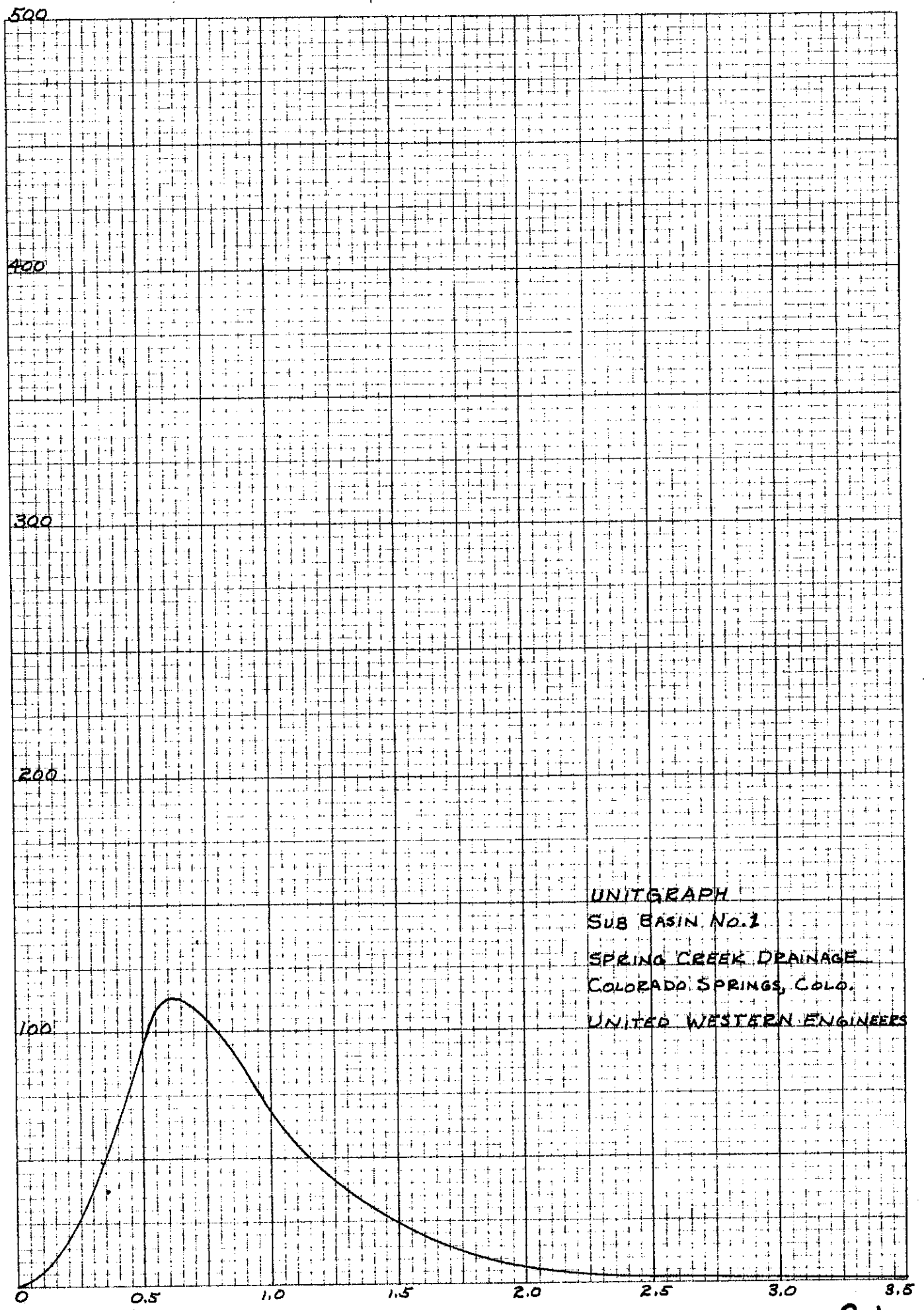
## APPENDIX G:

The following hydrographs are for the individual sub-basins contained within the Spring Creek Basin. They have been computed for the outfall point of each sub-basin.

These are "unit hydrographs". In other words, they represent the runoff of 1 inch from each basin. For use in design, they must be multiplied by the actual runoff to obtain actual peak flow.

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RUNOFF - cfs



UNITGRAPH  
SUB BASIN No. 2  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

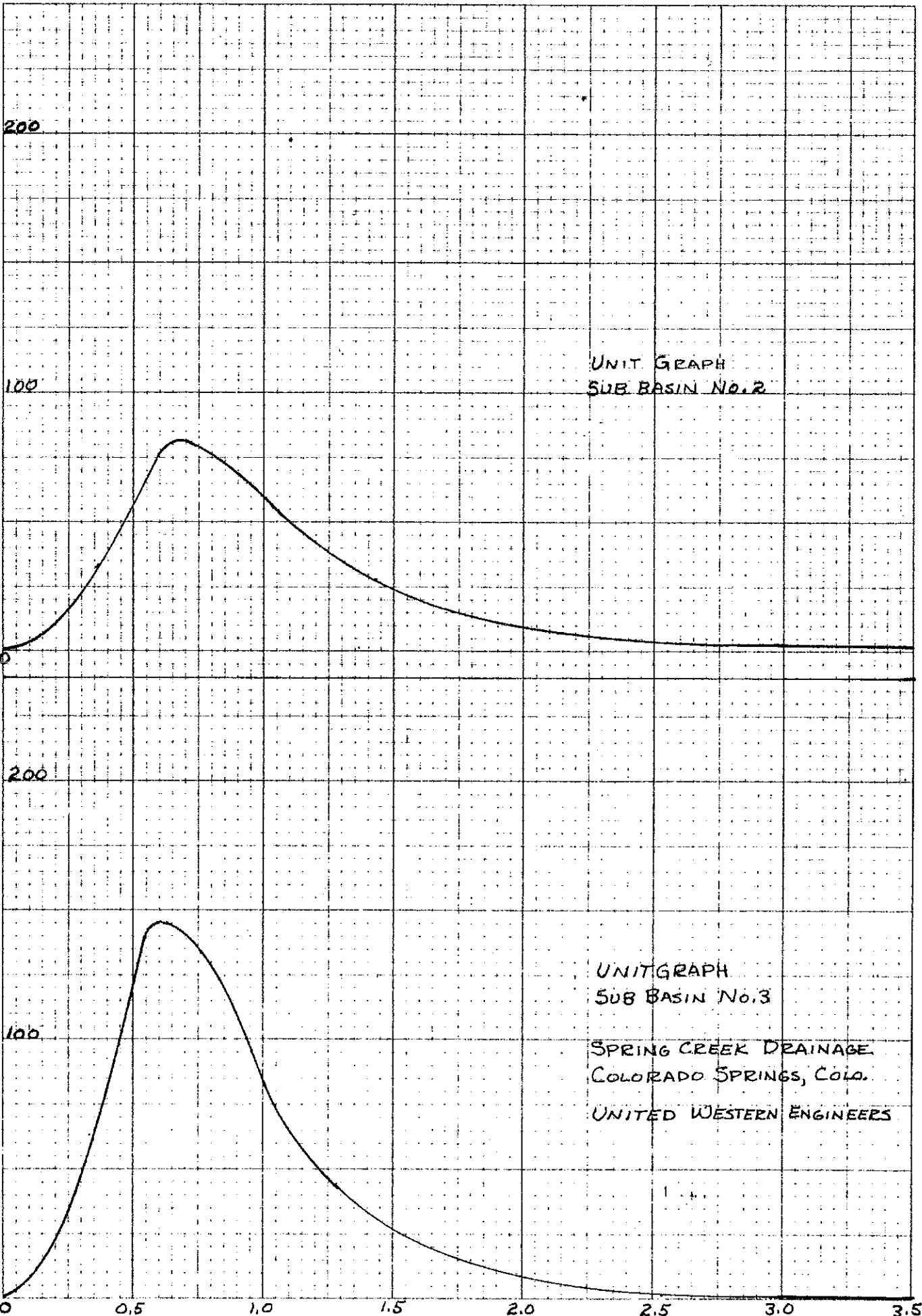
TIME - HOURS

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CLEARPRINT CHARTS

RUNOFF - cfs



UNIT GRAPH  
SUB BASIN No. 2

UNIT GRAPH  
SUB BASIN No. 3

SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

TIME - HOURS

RUNOFF - cfs

200

100

200

100

UNIT GRAPH  
SUBBASIN No. 4

UNIT GRAPH  
SUB BASIN No. 5

SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.

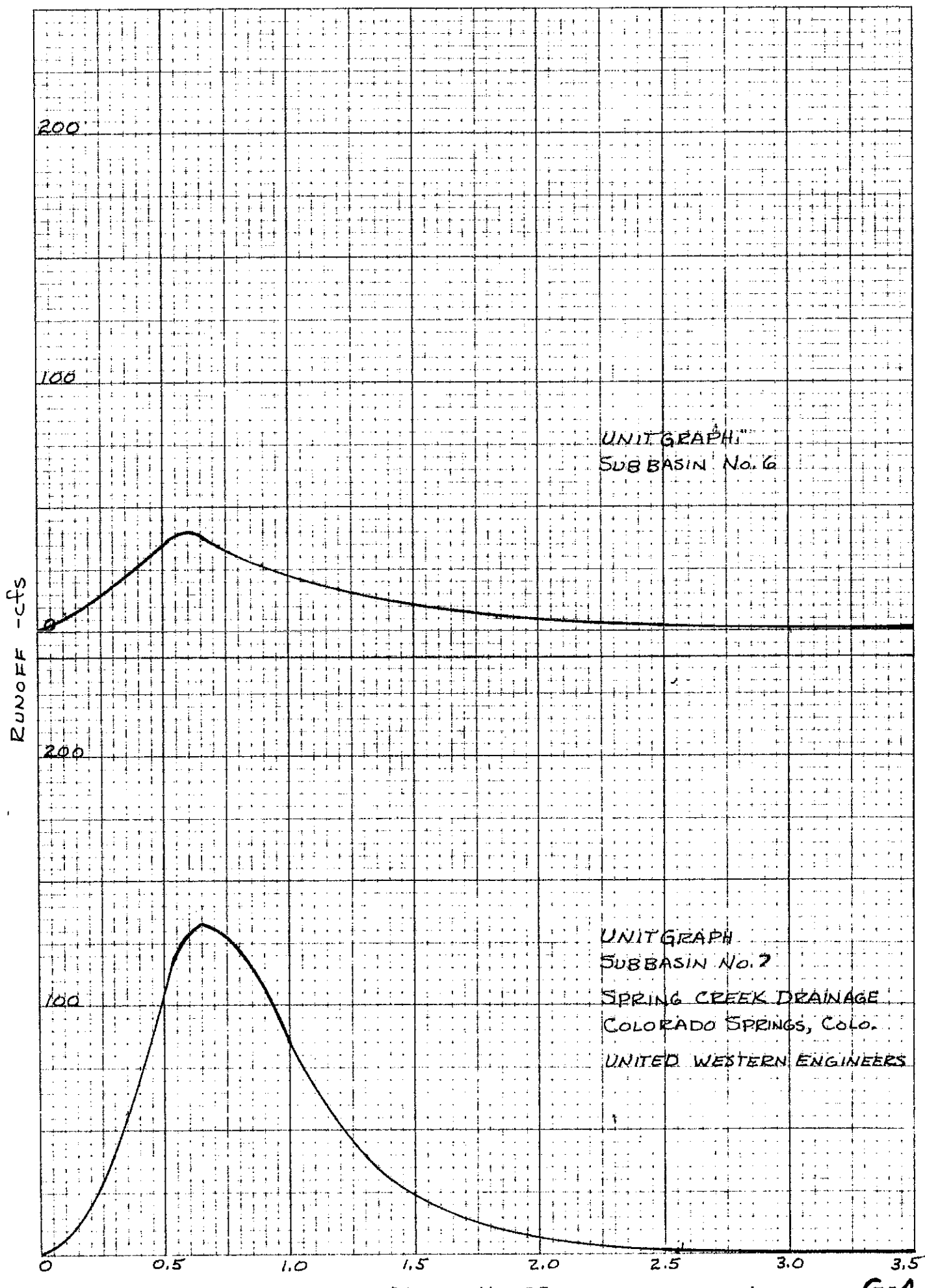
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0 0.5 1.0 1.5 2.0 2.5 3.0 3.5

TIME - HOURS

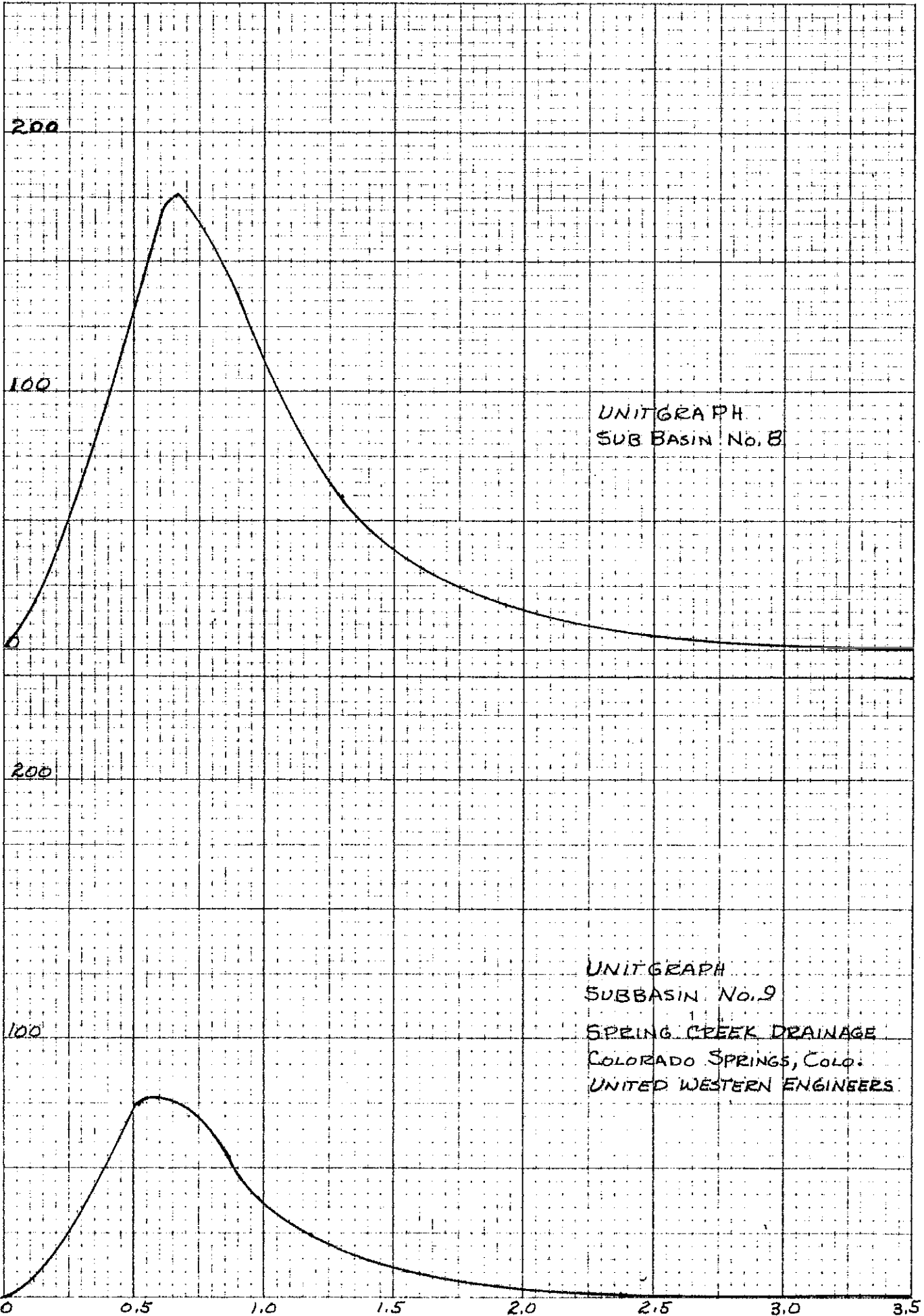


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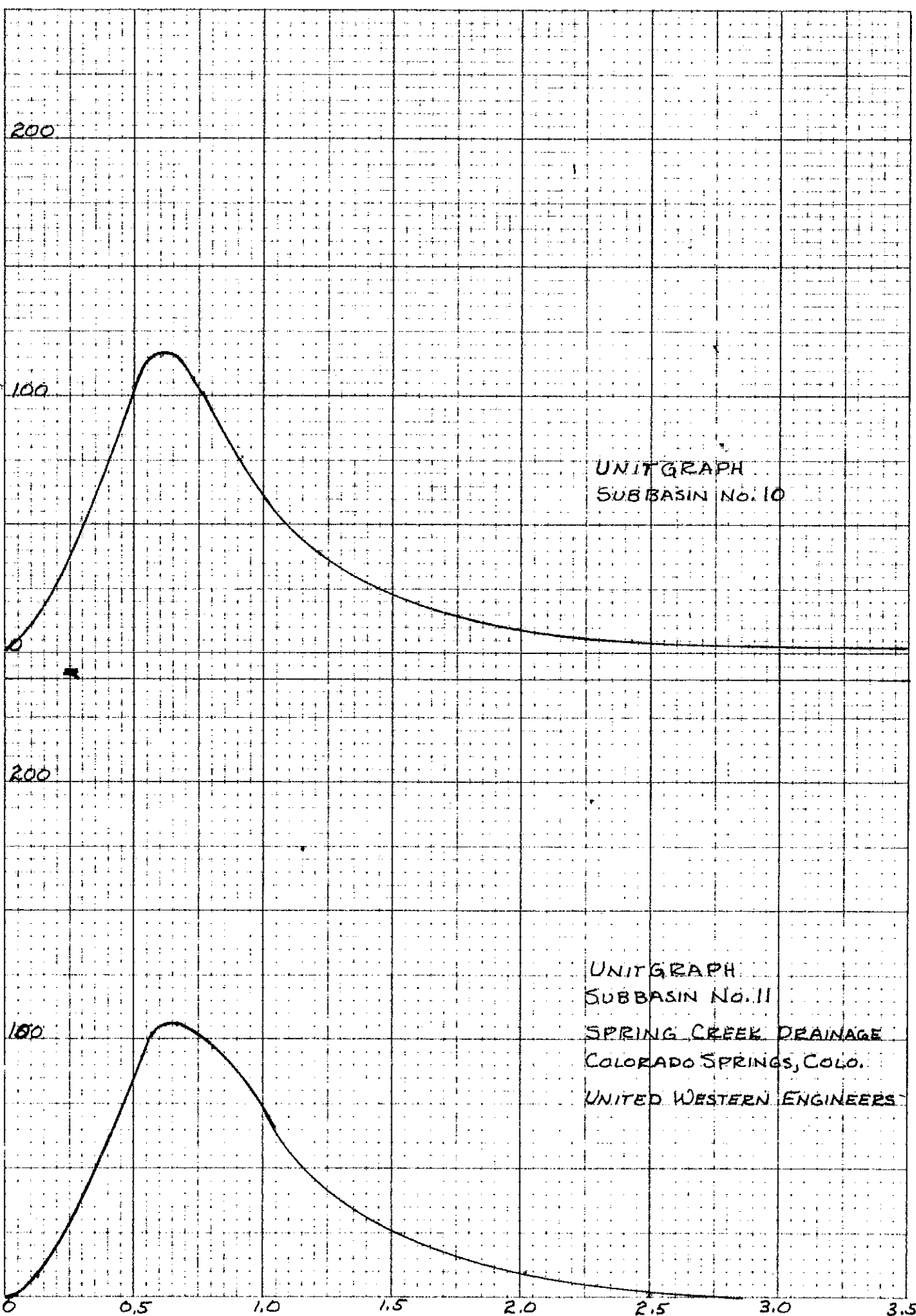
RUNOFF - cfs



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RUNOFF - cfs

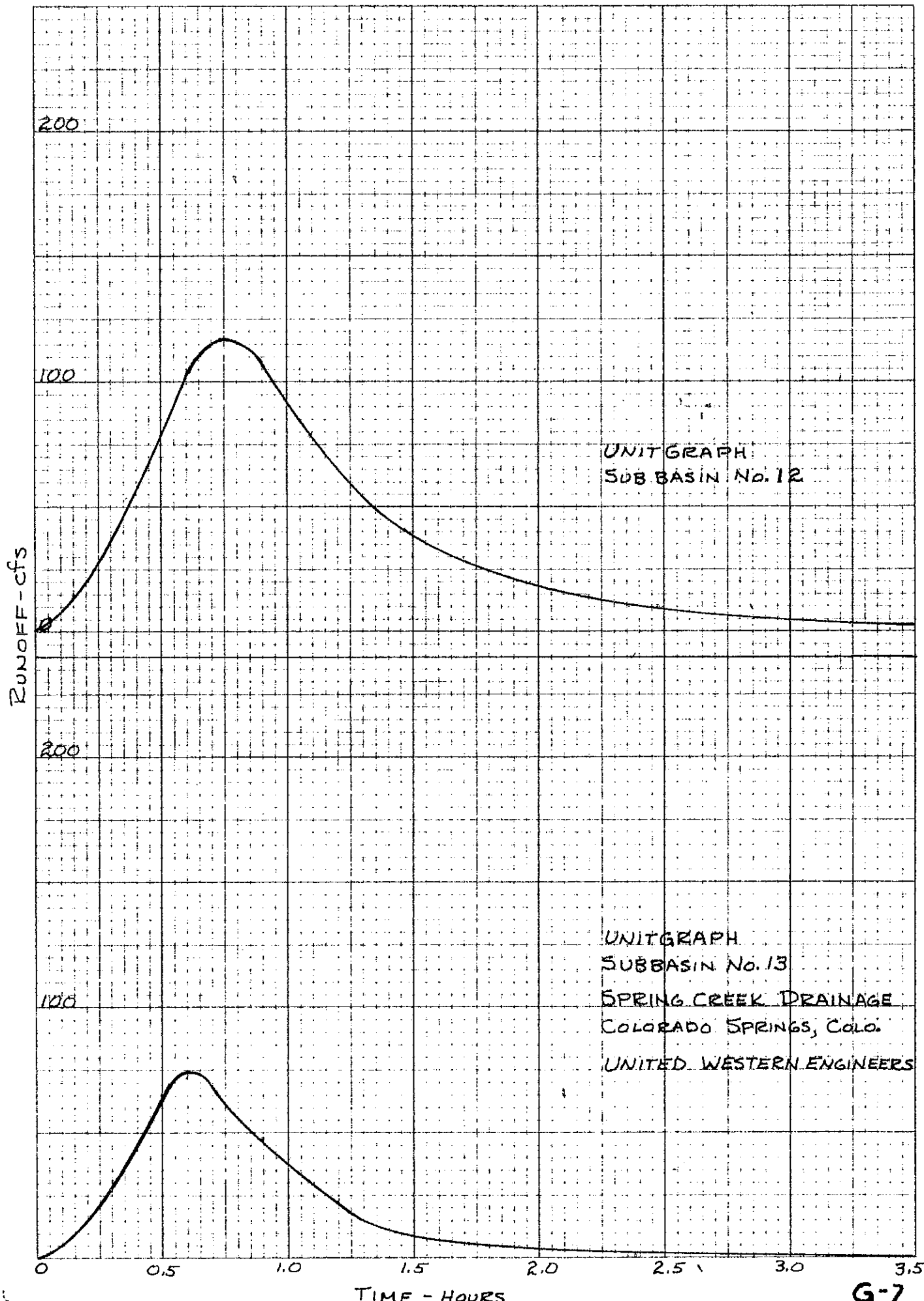


UNIT GRAPH  
SUBBASIN No. 10

UNIT GRAPH  
SUBBASIN No. 11  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

TIME - HOURS

6/6



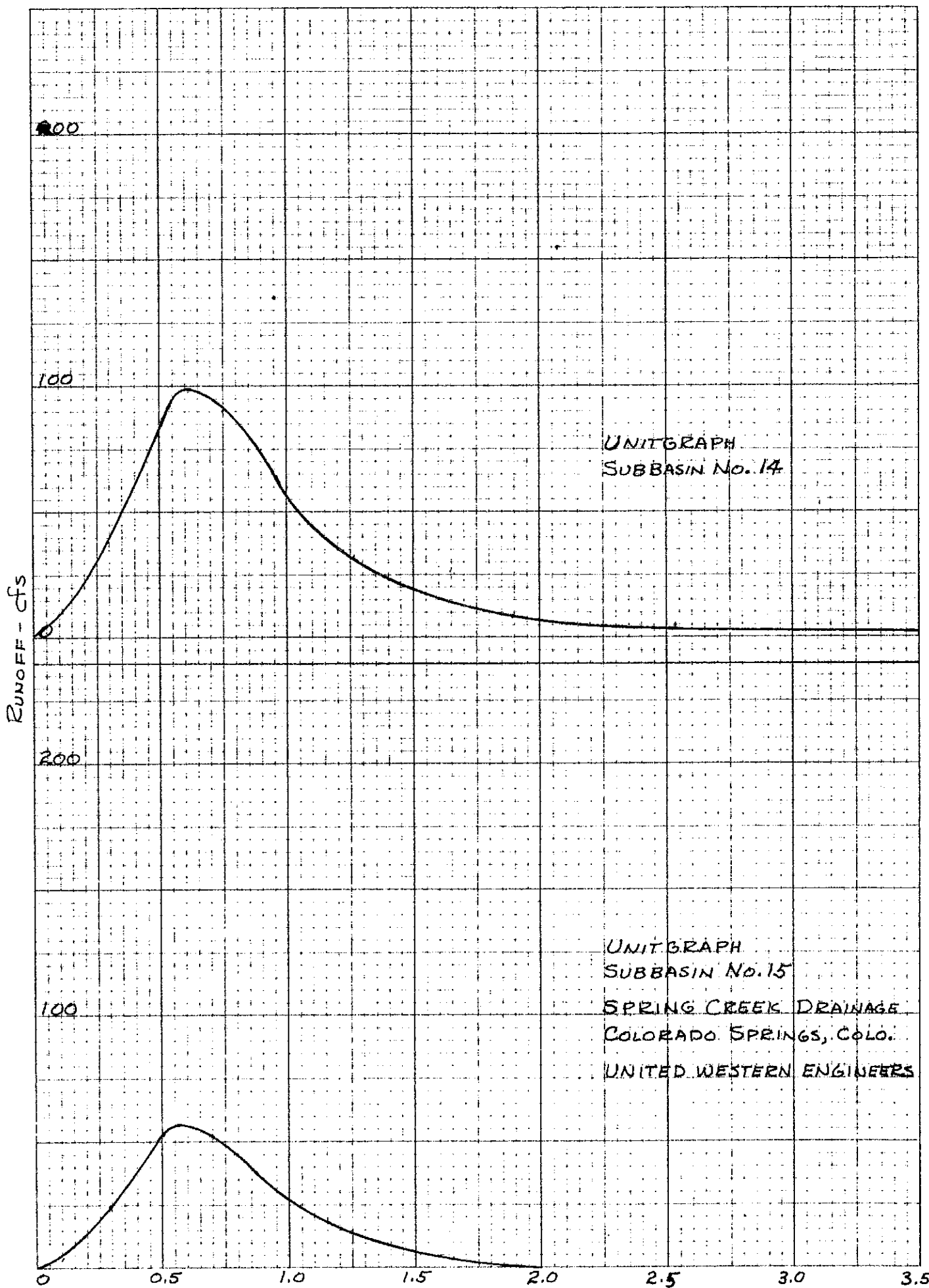
UNIT GRAPH  
SUBBASIN No. 12

UNIT GRAPH  
SUBBASIN No. 13  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

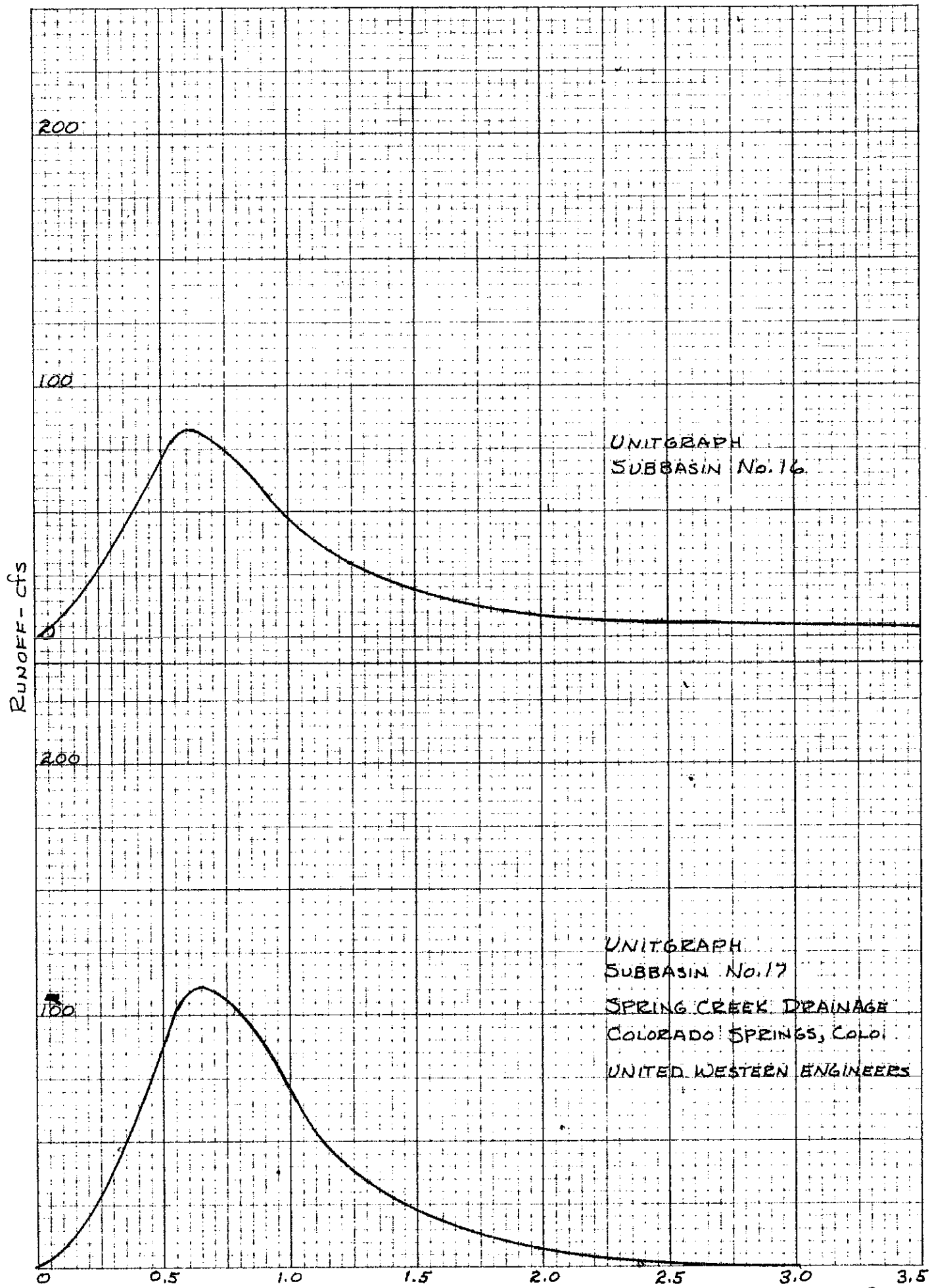
TIME - HOURS

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UNIT GRAPH SUBBASIN No. 14  
UNIT GRAPH SUBBASIN No. 15  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS



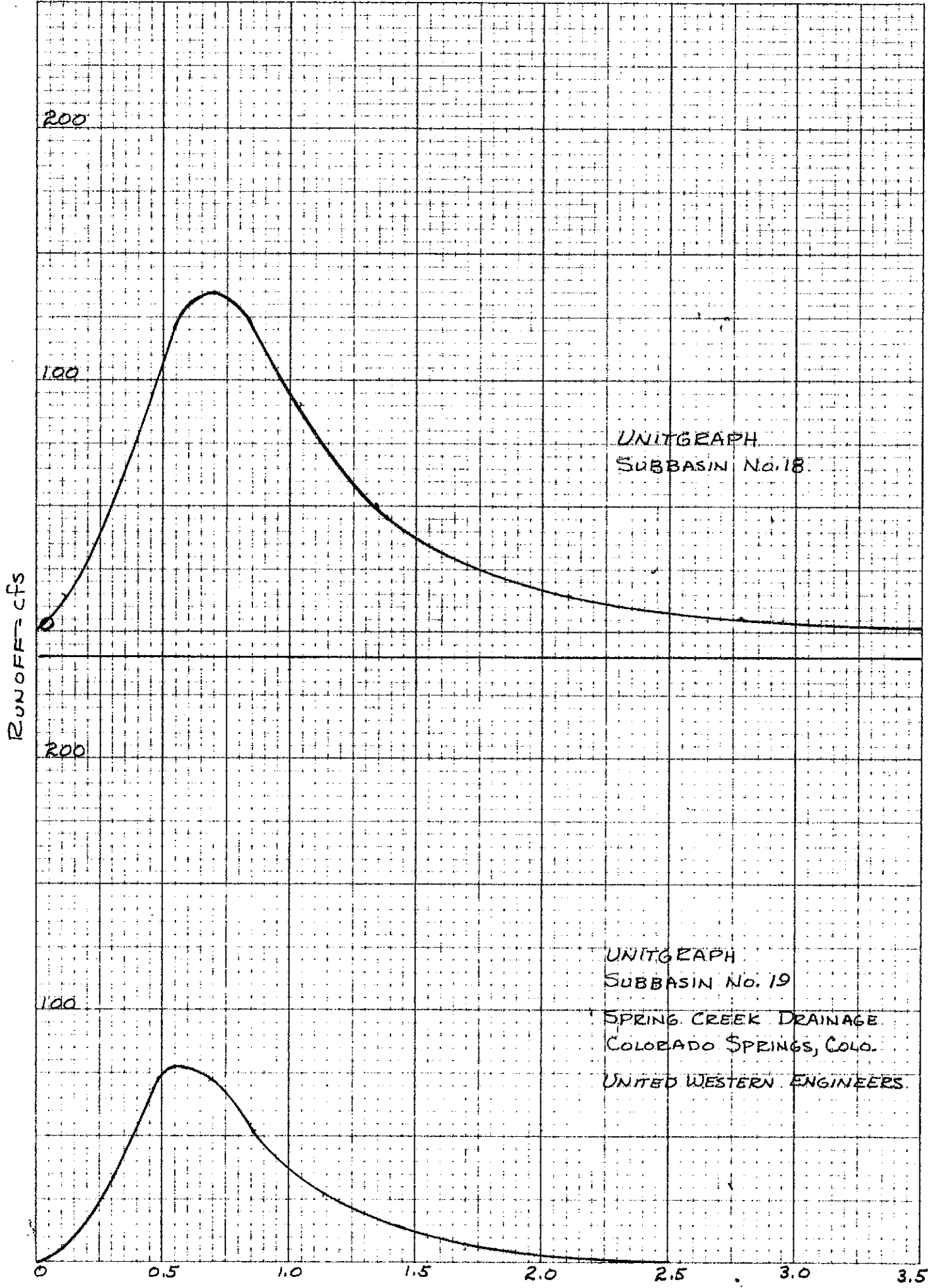
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UNITGRAPH  
SUBBASIN No. 16

UNITGRAPH  
SUBBASIN No. 17  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

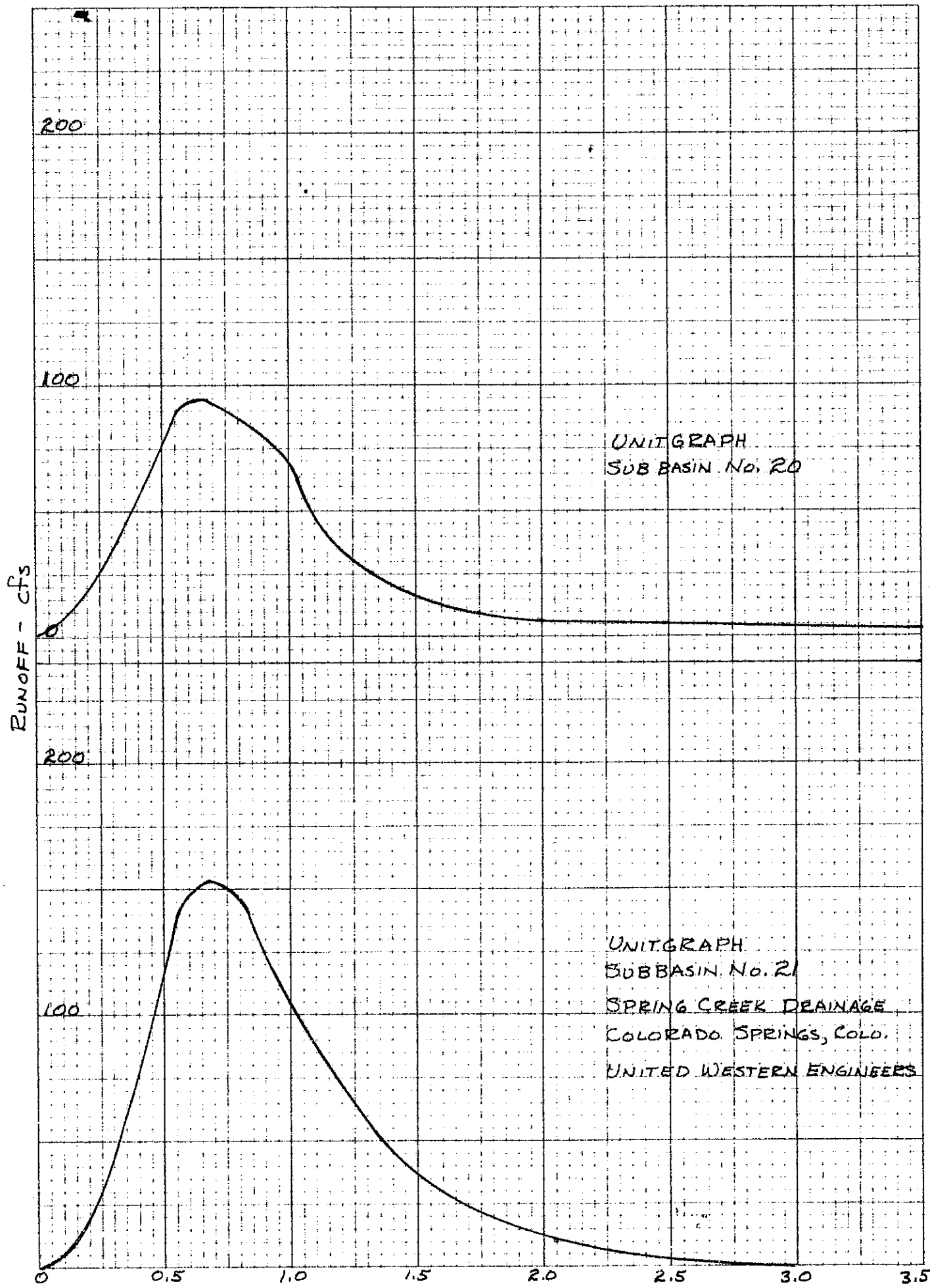
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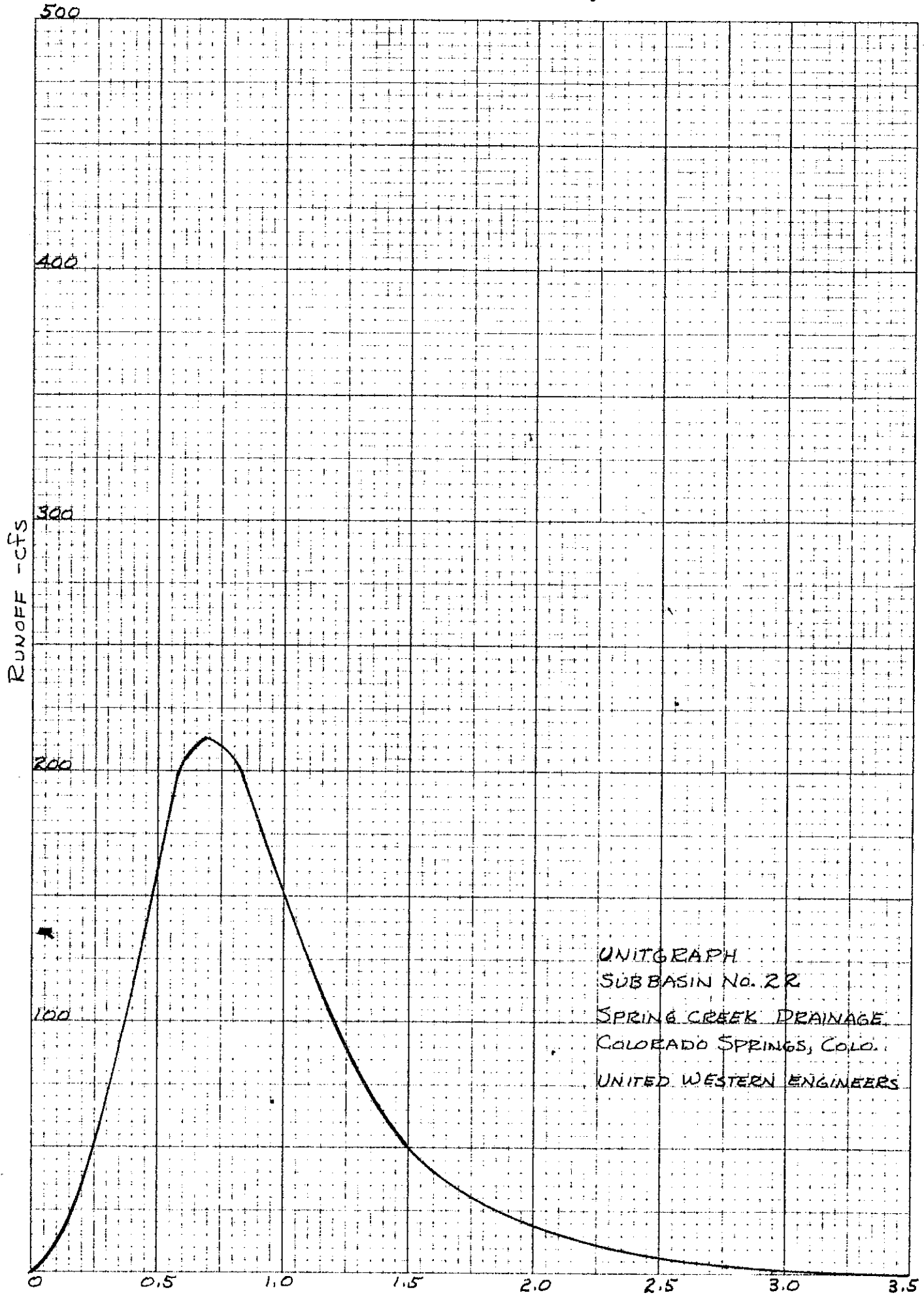
UNITGRAPH  
SUBBASIN No. 18

UNITGRAPH  
SUBBASIN No. 19  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

UNIT GRAPH  
SUB BASIN No. 20  
UNIT GRAPH  
SUB BASIN No. 21  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

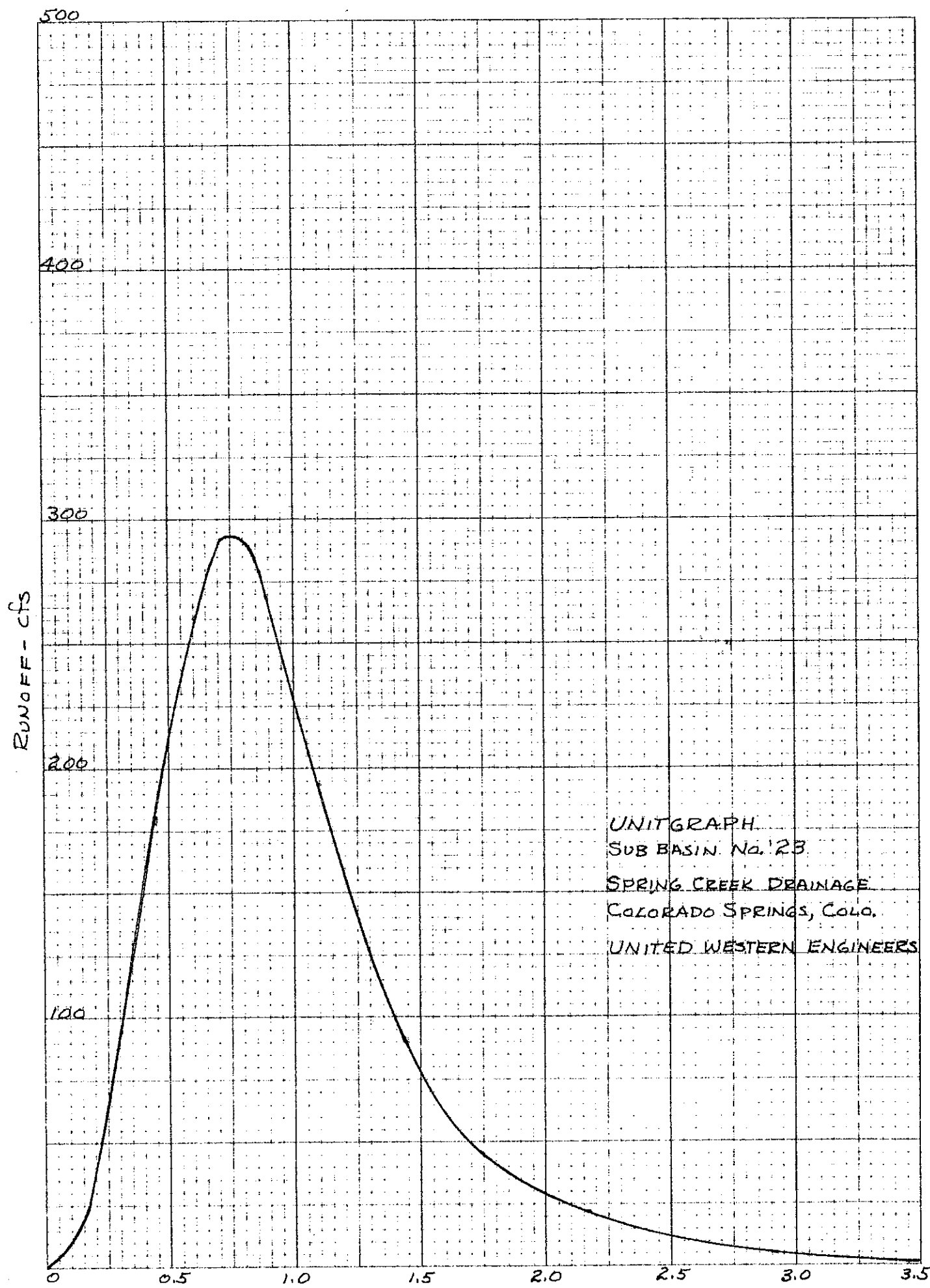






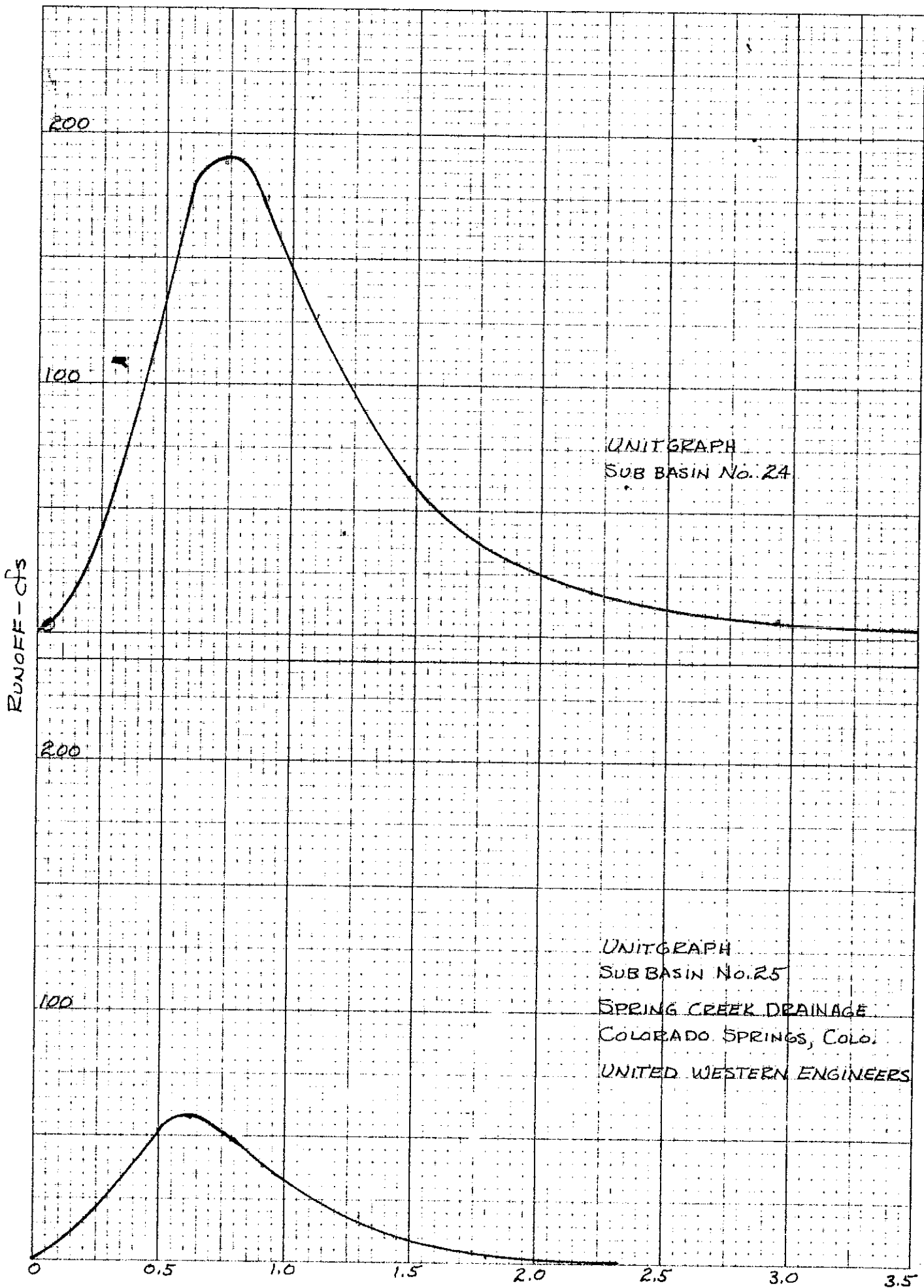
UNIT GRAPH  
SUBBASIN No. 22  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
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UNITGRAPH  
SUB BASIN No. 123  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
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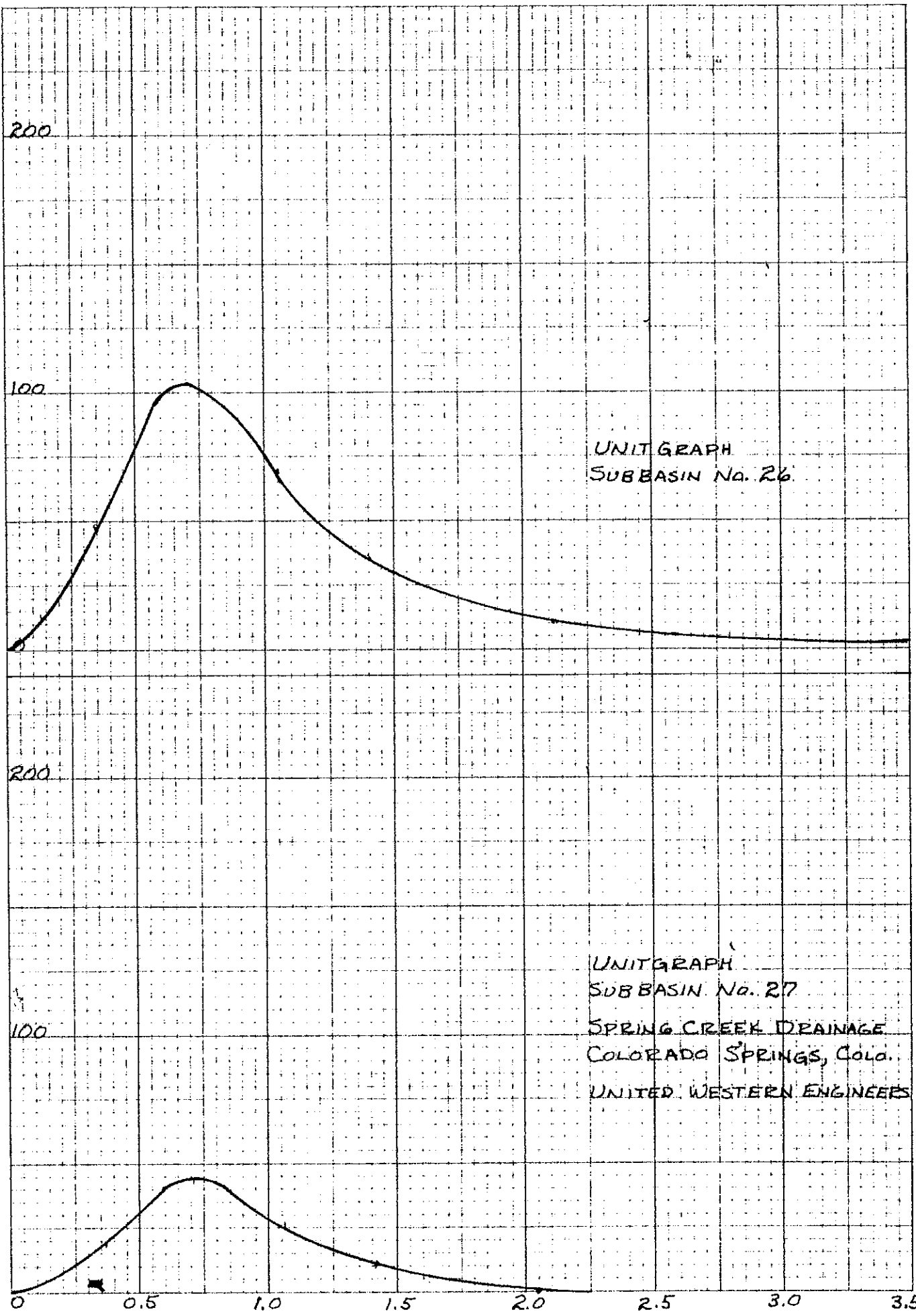


UNIT GRAPH  
SUB BASIN No. 24

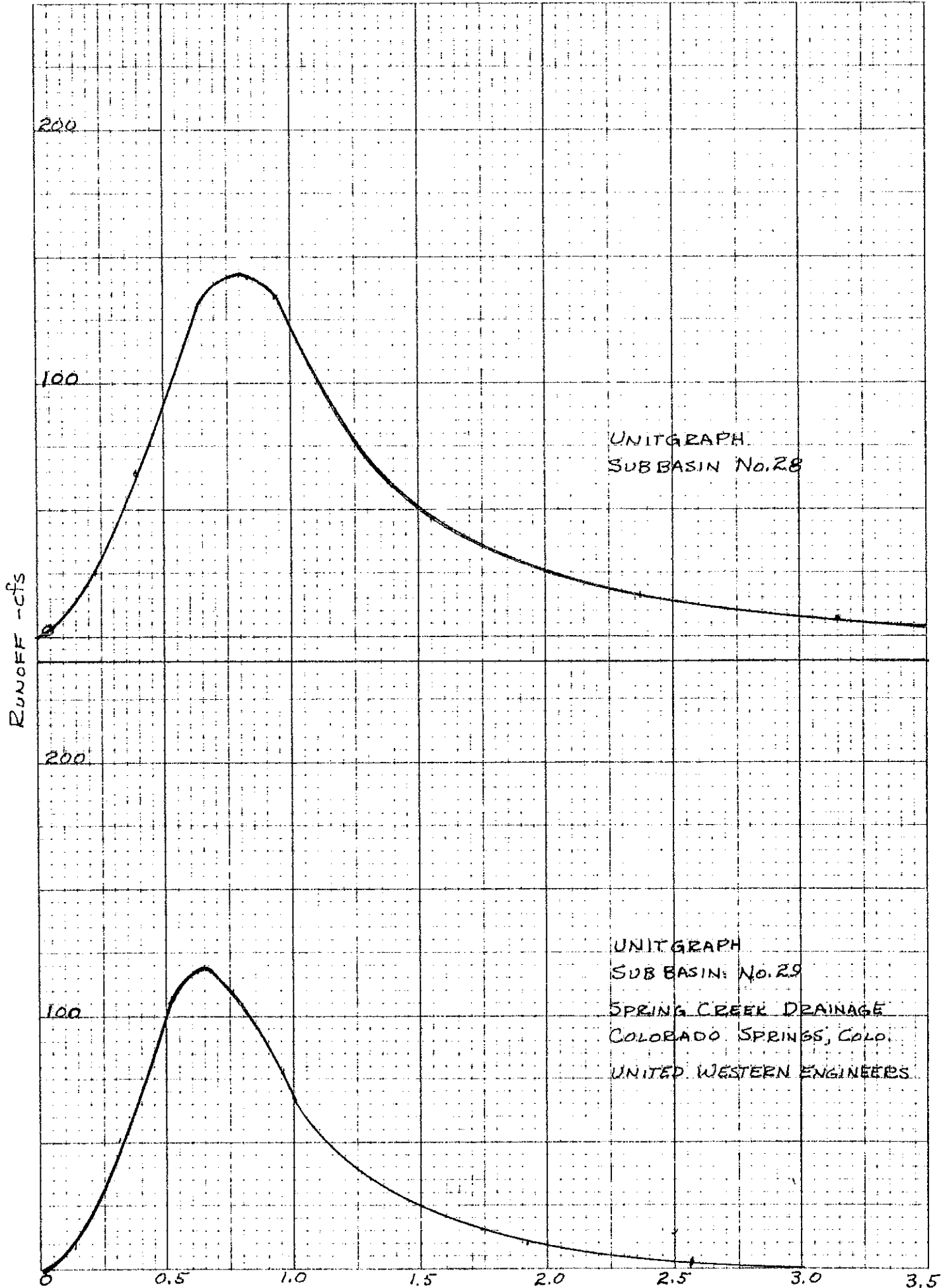
UNIT GRAPH  
SUB BASIN No. 25  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

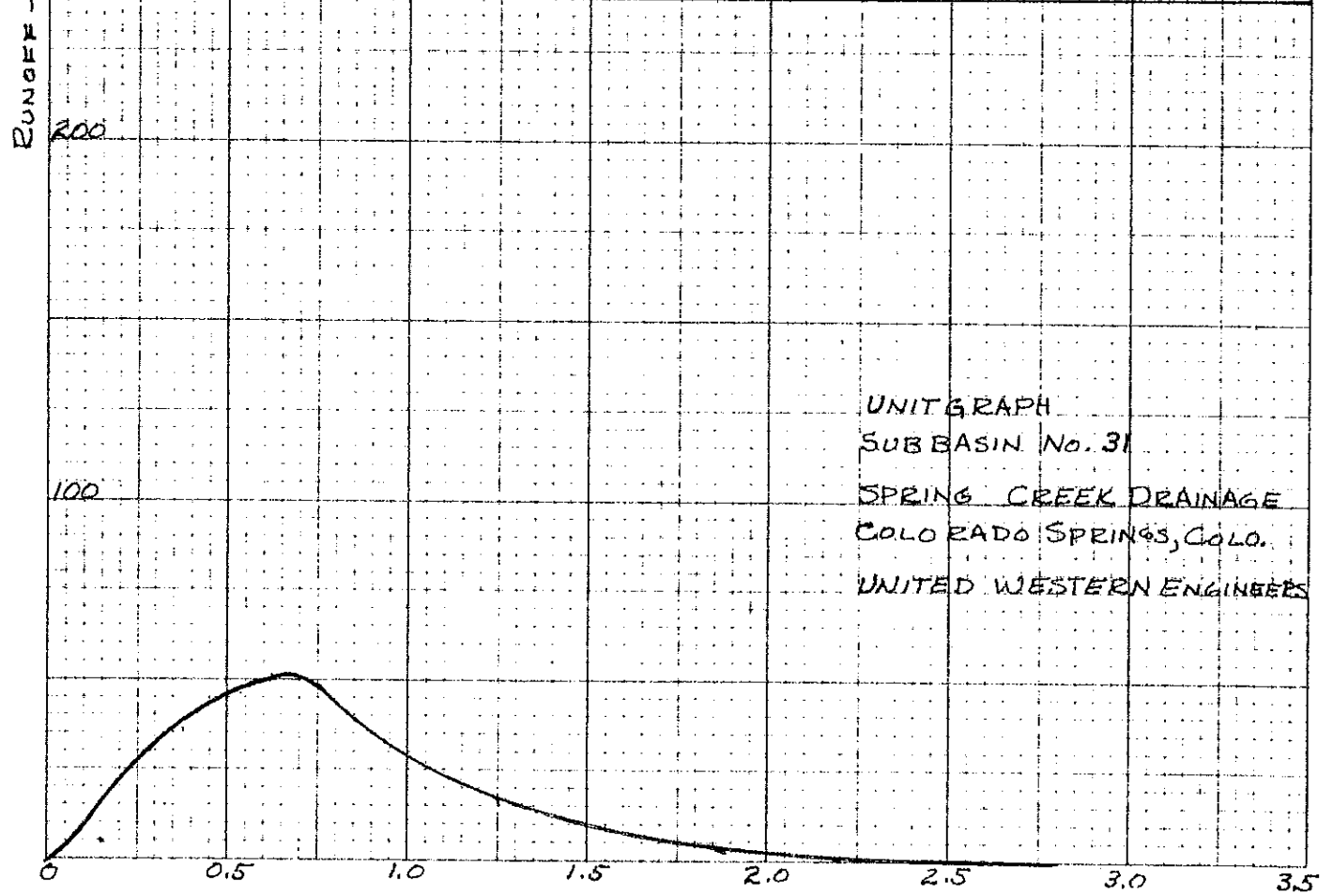
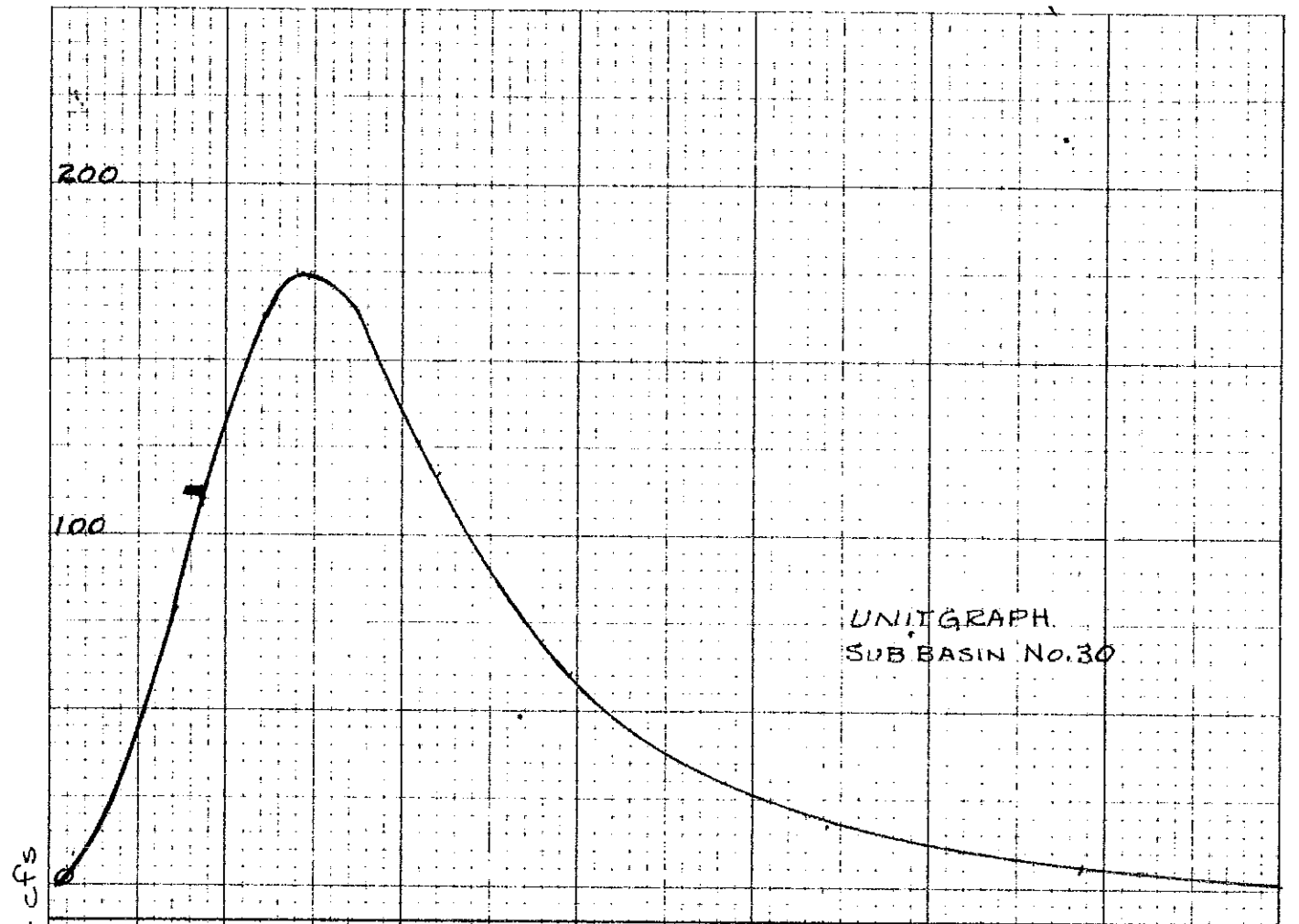
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RUNOFF - CFS



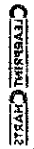
UNIT GRAPH  
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UNIT GRAPH  
SUBBASIN No. 29  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS



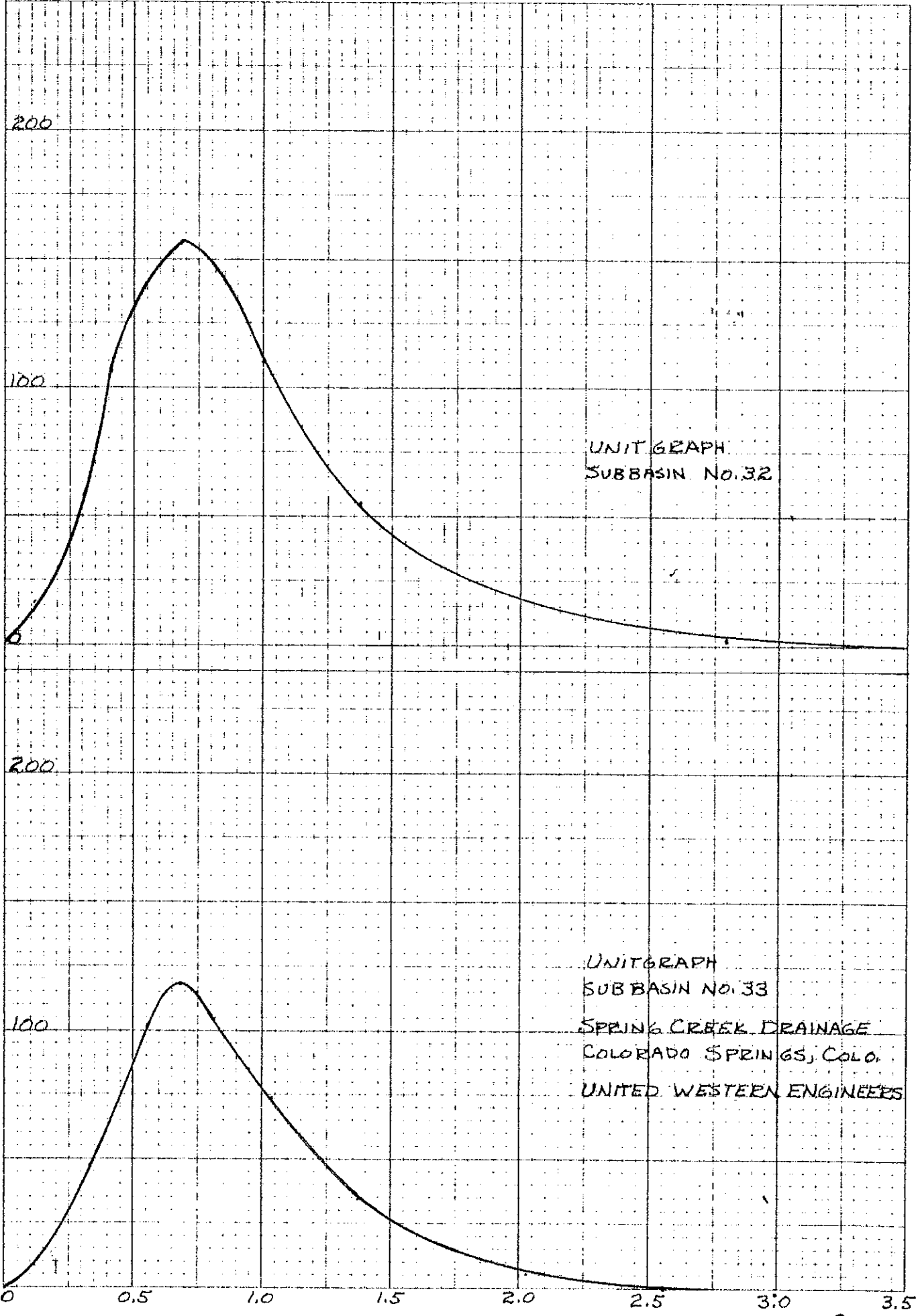


TIME - HOURS

CIVIL ENGINEERING DEPARTMENT UNIVERSITY OF COLORADO

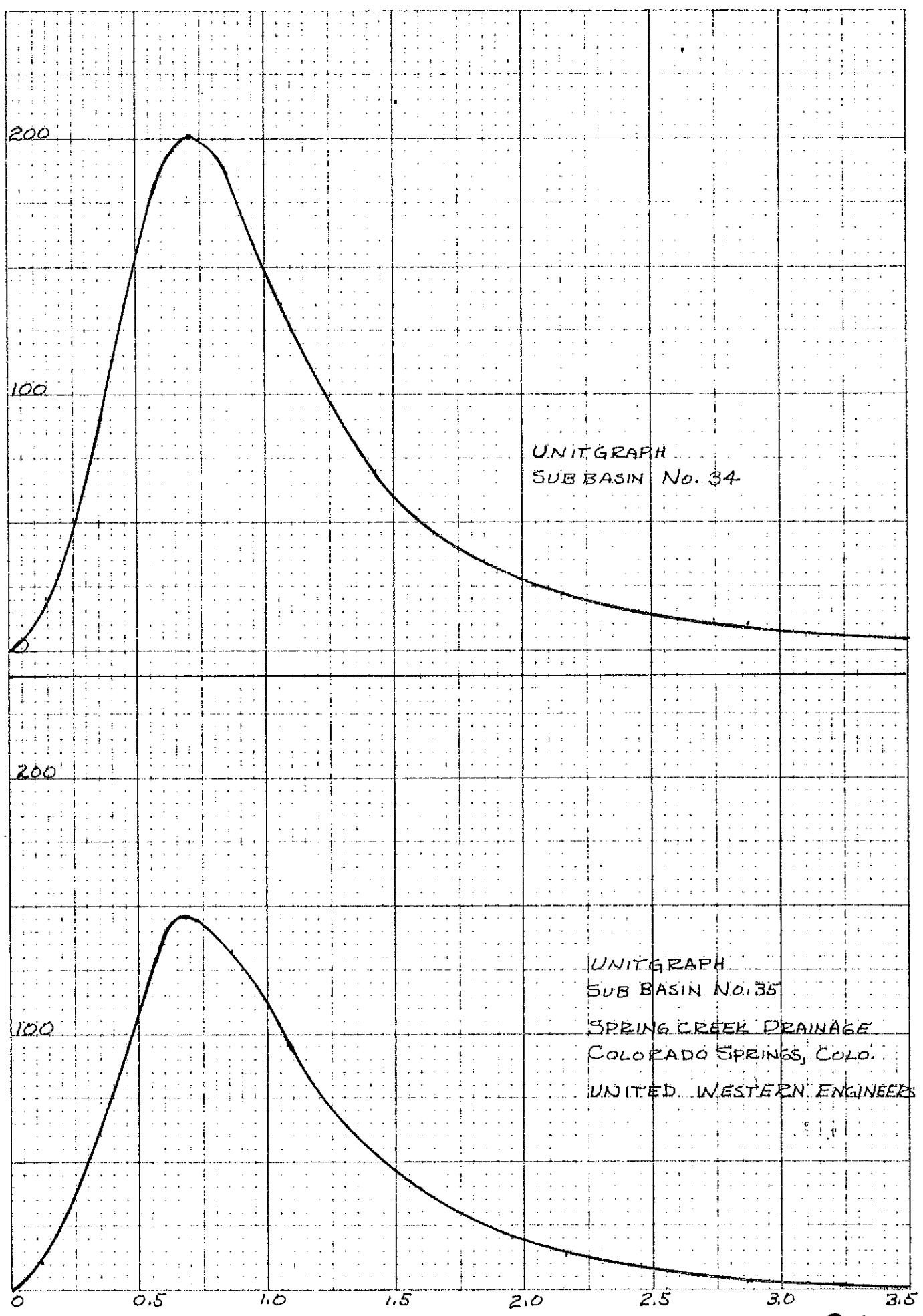


RUNOFF - cfs



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RUNOFF - CFS

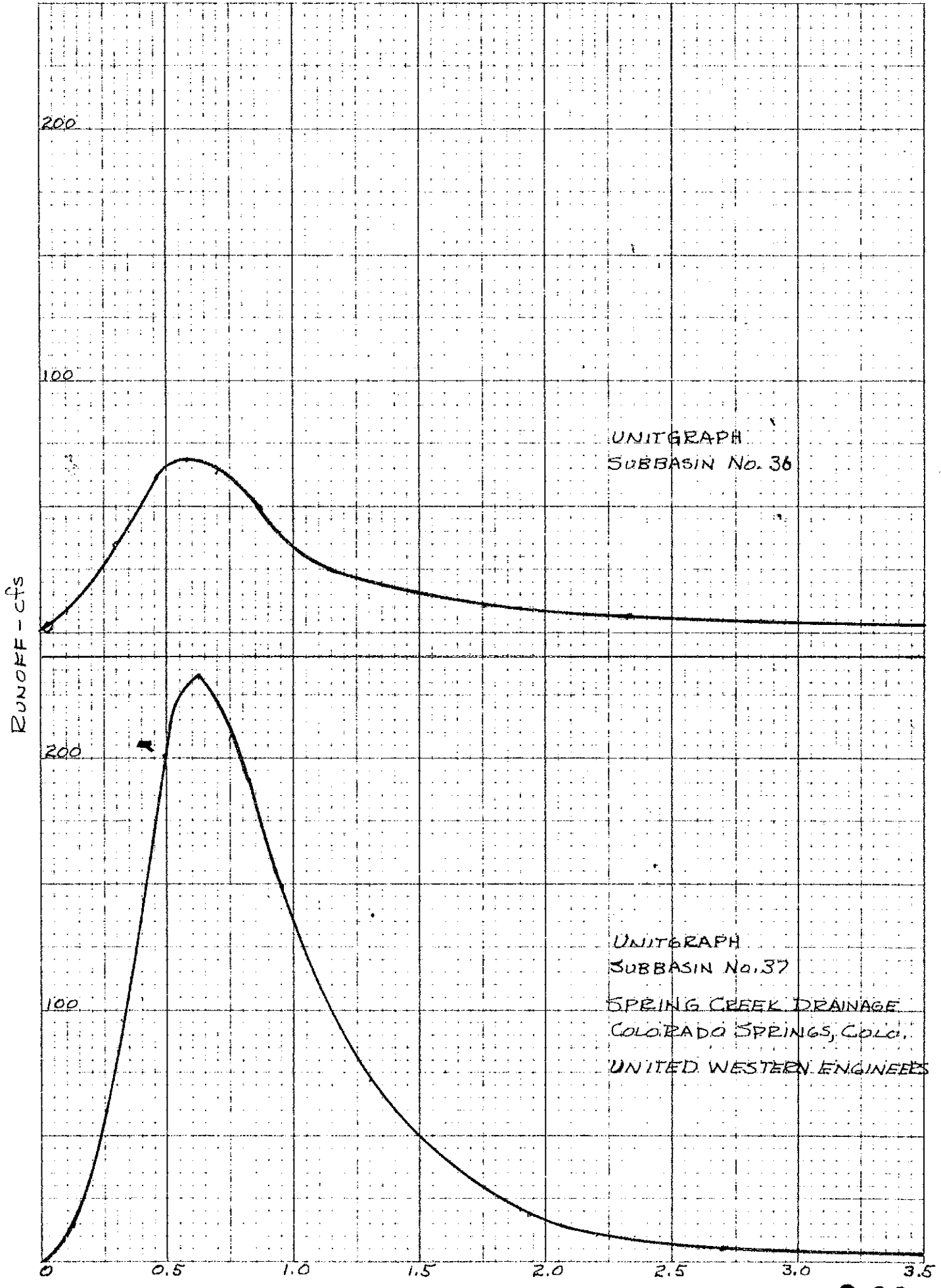


UNIT GRAPH  
SUB BASIN No. 34

UNIT GRAPH  
SUB BASIN No. 35  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

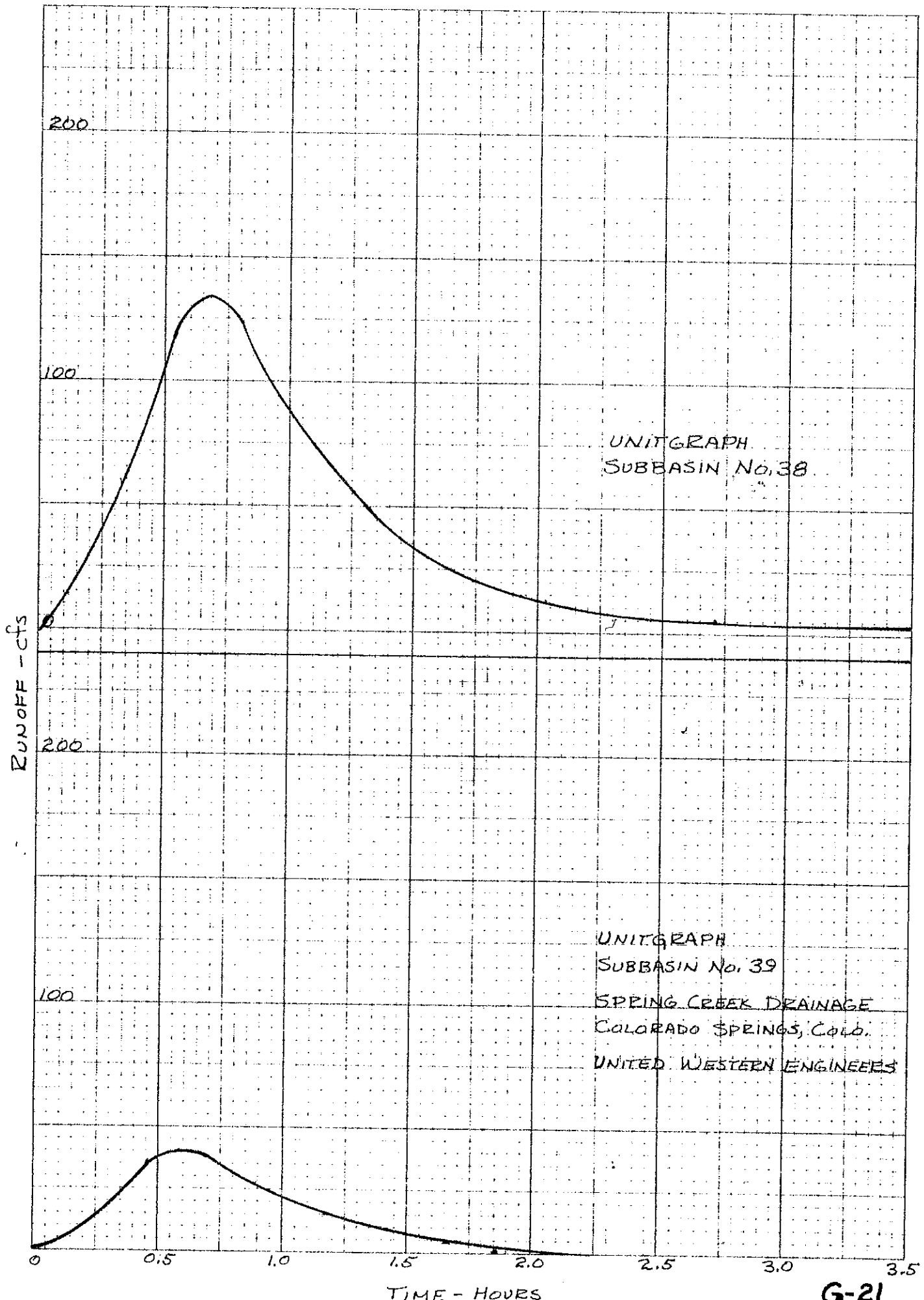


UNITGRAPH COMPANY  
2101 W. 10TH AVENUE  
DENVER, COLORADO



UNITGRAPH  
SUBBASIN No. 36

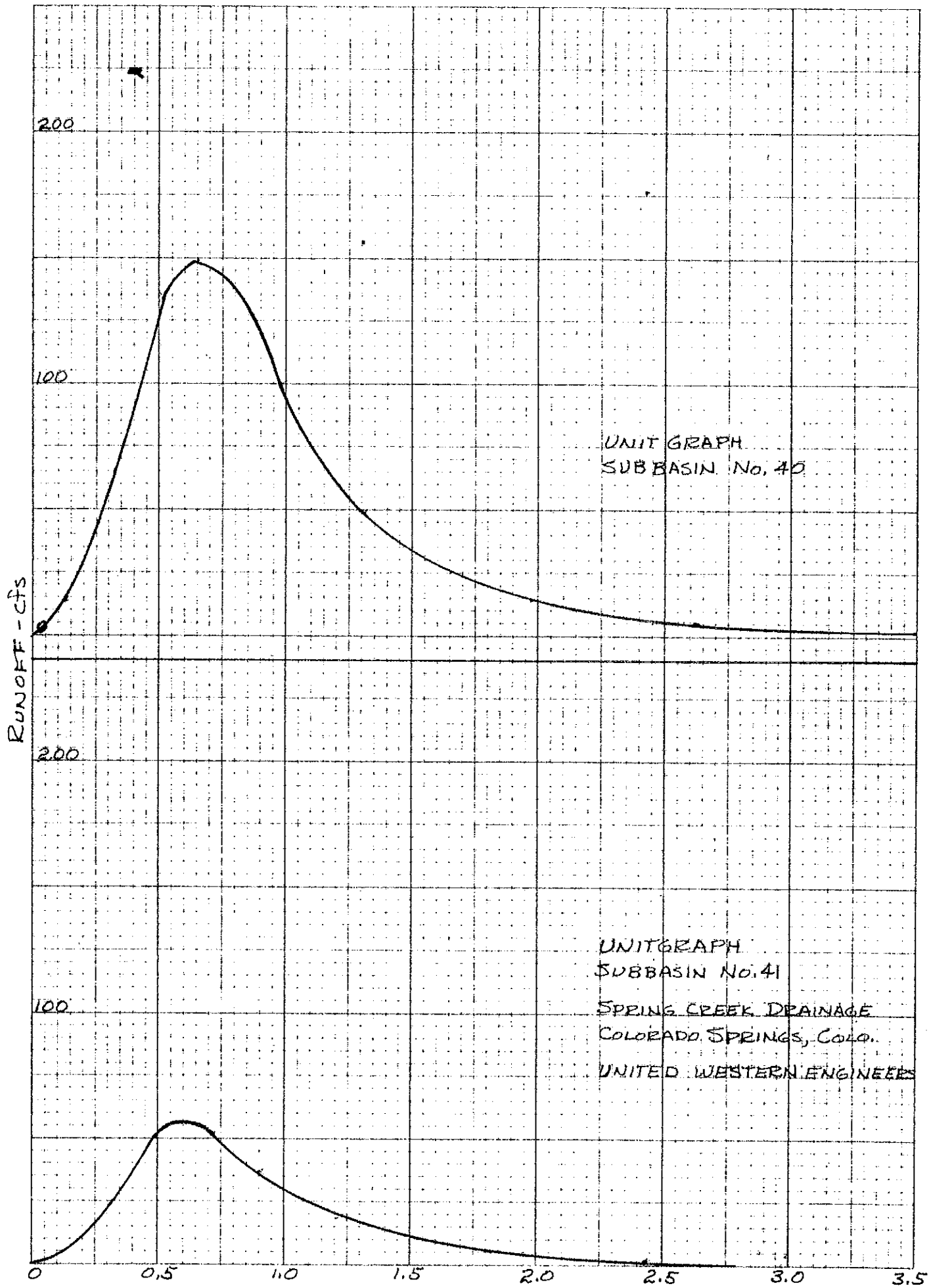
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SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

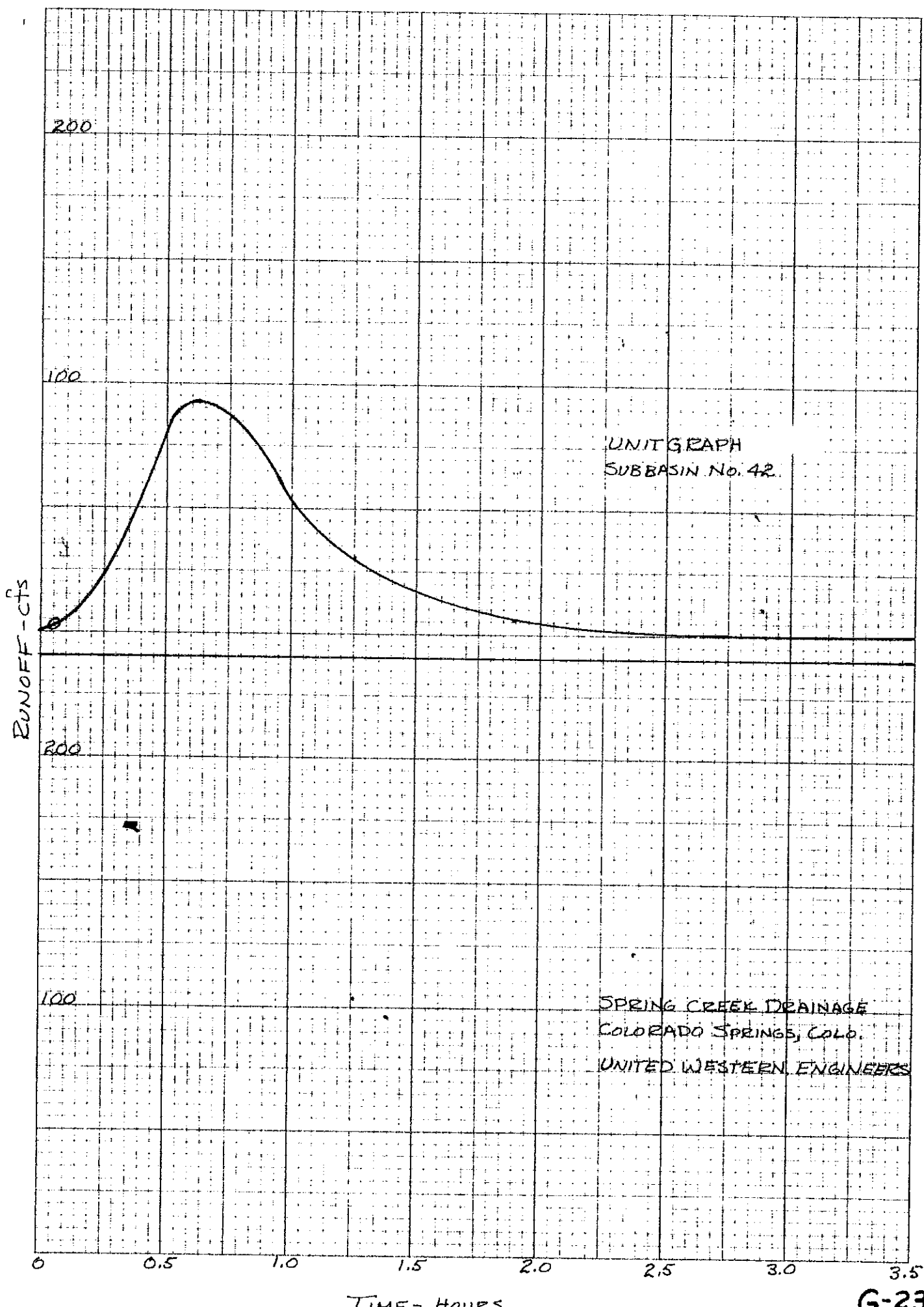


UNITGRAPH  
SUBBASIN No. 38

UNITGRAPH  
SUBBASIN No. 39  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS

UNIT GRAPH  
SUBBASIN No. 45  
UNIT GRAPH  
SUBBASIN No. 41  
SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS





UNIT GRAPH  
SUBBASIN No. 42.

SPRING CREEK DRAINAGE  
COLORADO SPRINGS, COLO.  
UNITED WESTERN ENGINEERS