PROFESSIONAL
ENGINEERING
CONSULTANTS
PROFESSIONAL ASSOCIATION

DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS

FOR
AUTUMN RIDGE 2ND ADDITION
TO WICHITA, SEDGWICK COUNTY, KANSAS

PREPARED BY
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
ENGINEERS
WICHITA, KANSAS

FEBRUARY 26, 1988

1440 EAST ENGLISH
WICHITA, KANSAS 67211
(316) 262-2691

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Project Autumn Ridge 2nd Addition

Item Drainage Plan Hydrology

I HYDROLOGY

Use Rational Formula $Q = cIA$

Determine "c"

Node	Soil Group	Land Use		C_2	C_{100}
106	B	Res	1/4 Ac.	0.44	0.61
105	B	Res	1/4 Ac.	0.44	0.61
104	B	Res	1/3 Ac	0.39	0.57
103	B	Res	1/3 Ac	0.39	0.57
102	B	Res	1/3 Ac	0.39	0.57
101	B	Res	1/3 Ac.	0.39	0.57
100	Headwall				

Determine "I"

Assume t_c = 15 minutes all nodes

∴ $I_2 = 3.83$ (all nodes)

$I_{100} = 7.37$ (all nodes)

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Determine "A"

Node	Pln. Units	40 Area SF	Area Acres
106	2269	90,760	2.08
105	1118	44,720	1.03
104	873	34,920	0.80
103	4597	183,880	4.22
102	350	14,000	0.32
101	676	27,040	0.62
100	Headwell		

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Determine "Q_2"

Node	C_2	I_2	A	Q_2
106	0.44	3.83	2.08	3.5
105	0.44	3.83	1.03	1.7
104	0.39	3.83	0.80	1.2
103	0.39	3.83	4.22	6.3
102	0.39	3.83	0.32	0.5
101	0.39	3.83	0.62	0.9
100	Headwall			

Determine "Q_{100}"

Node	C_{100}	I_{100}	A	Q_{100}
106	0.61	7.37	2.08	9.4
105	0.61	7.37	1.03	4.6
104	0.57	7.37	0.80	3.4
103	0.57	7.37	4.22	17.7
102	0.57	7.37	0.32	1.3
101	0.57	7.37	0.62	2.6
100	Headwall			

II FLOOD ROOTING / INLET SIZING - 2 YR

Node	Inlet Condition	Qapproach*	Qintercept≠	Qbypass	Qmax for 5' inlet	Qmax for 10' inlet	USE L
106	Sump	3.5	3.5	0.0	11.0	22.0	5' * (existing inlet)
105	On grade	1.7	36% = 0.6	1.1 (to 104)			5'
104	Sump	1.2 + 1.1 = 2.3	2.3	0.0	11.0	22.0	5'
103	Sump	6.3	6.3	0.0	11.0	22.0	5'
102	Sump	0.5	0.5	0.0	11.0	22.0	5' **
101	Sump	0.9	0.9	0.0	11.0	22.0	5' **

* Qapproach = Q_2 + Bypass Q_2 from other nodes

≠ Qintercept = Q input in "Storm" program.

** inlet sizes & Q's @ Nodes 102 & 101 to be modified to intecept Q_{100} (see below)

III FLOOD ROUTING / INLET SIZING - 100-YR (NODES 102 & 101)

size nodes 102 & 101 for $\Sigma Q_{100} - Q_{2\ 104\text{-}101}$

= 39.0 cfs − 12.7

= 26.3 cfs

assume flow overtops crown ∴ 13.2 cfs per inlet

use 10' inlets @ Nodes 102 & 101

input 13.2 cfs @ each node for "Storm" program

```
100 j, 1339.0000  100    4    7    6
110 t,autunm ridge 2nd addition
120 t,drainage plan
130 t,storm sewer system 100 analysis
140 t,2 year storm with 100 year in pipe outfall
150 i,  106     0.44     2.08     0.00     0.00     3.50    15.00  1348.80
160 i,  105     0.44     1.03     0.00     0.00     0.60    15.00  1346.50
170 i,  104     0.39     0.80     0.00     0.00     2.30    15.00  1345.00
180 i,  103     0.39     4.26     0.00     0.00     6.30    15.00  1345.00
190 i,  102     0.39     0.32     0.00     0.00    13.20    15.00  1345.00
200 i,  101     0.39     0.62     0.00     0.00    13.20    15.00  1345.00
210 m,  100  1339.00
220 p,  106  105   160.00   18 0.013  60.00   0.00
230 p,  105  104   280.00   18 0.013  10.00   0.00
240 p,  103  104    40.00   18 0.013 100.00   0.00
250 p,  104  101   200.00   24 0.013  20.00   0.00
260 p,  102  101    40.00   18 0.013 110.00   0.00
270 p,  101  100   250.00   30 0.013  60.00   0.00
280 e
```

Date: 02-26-1988
Time: 11:38:55

Input File: ar2

autumn ridge 2nd addition
drainage plan
storm sewer system 100 analysis
2 year storm with 100 year in pipe outfall

Storm Frequency = 2-Year

* * * H Y D R O L O G Y * * *

Tributary Area									Hydrology Summation				Conduit Data				
Node to	Node	C	Area (Ac)	Slope (%)	Length (Ft)	TC(0) (Min)	I(0) (In/Hr)	Q(0) (CFS)	TC (Min)	I (In/Hr)	Q (CFS)	Sum Q (CFS)	Size	Velocity (Ft/Sec)	Length (Ft)	TT (Min)	TT+TC (Min)
106	105	0.44	2.08	0.00	0.0	15.00	4.06	3.50	15.00	4.06	3.50	3.50	18"	1.98	160.00	1.35	16.35
105	104	0.44	1.03	0.00	0.0	15.00	4.06	0.60	16.35	3.92	0.58	4.08	18"	2.31	280.00	2.02	18.37
103	104	0.39	4.26	0.00	0.0	15.00	4.06	6.30	15.00	4.06	6.30	6.30	18"	3.57	40.00	0.19	15.19
104	101	0.39	0.80	0.00	0.0	15.00	4.06	2.30	18.37	3.75	2.13	12.06	24"	3.84	200.00	0.87	19.24
102	101	0.39	0.32	0.00	0.0	15.00	4.06	13.20	15.00	4.06	13.20	13.20	18"	7.47	40.00	0.09	15.09
101	100	0.39	0.62	0.00	0.0	15.00	4.06	13.20	19.24	3.68	11.98	36.04	30"	7.34	250.00	0.57	19.80

Date: 02-26-1988
Time: 11:38:55

Input File: ar2

autumn ridge 2nd addition
drainage plan
storm sewer system 100 analysis
2 year storm with 100 year in pipe outfall

Storm Frequency = 2-Year

* * * H Y D R A U L I C S * * *

Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
106	0.00111	0.1776	0.0000	0.0000	0.0000	0.0000	0.0000	0.1776	1344.2433	1348.8000	4.56
105	0.00151	0.4225	0.0000	0.0022	0.0000	0.0187	0.0504	0.4937	1344.0657	1346.5000	2.43
104	0.00284	0.5679	0.0000	0.0031	0.0000	0.1120	0.2002	0.8832	1343.5719	1345.0000	1.43
103	0.00360	0.1439	0.0000	0.0000	0.0000	0.0000	0.0000	0.1439	1343.7159	1345.0000	1.28
102	0.01379	0.6316	0.0000	0.0000	0.0000	0.0000	0.0000	0.6316	1343.3202	1345.0000	1.68
101	0.00772	1.9303	0.0000	0.0059	0.0000	0.5511	1.2913	3.6836	1342.6886	1345.0000	2.31
100	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1339.0000	1339.0000	0.00

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Item Drainage Plan

STREET FLOW - 2YR

Node	Qapproach	Distribution	street slope	d	dmax	comment
106	3.5	50% (NE) = 1.8	1.5%	0.20'	0.55'	OK
		50% (SW) = 1.7	1.4%	0.20	0.55	OK
105	1.7	100% (E) = 1.7	1.2%	0.20	0.55	OK
104	1.2	90% 1.2 + 1.1 = 2.2 (E)	0.32%	0.28	0.55	OK
		10% 1.2 0.1 (W)	0.32%	0.09	0.55	OK
103	6.3	70% (E) = 4.4	0.32	0.38	0.55	OK
		30% (S) = 1.9	0.32	0.27	0.55	OK
102	0.5	50% (E) = 0.3	0.32	0.13	0.55	OK
		50% (W) = 0.2	0.32	0.12	0.55	OK
101	0.9	50% (E) = 0.5	0.32	0.16	0.55	OK
		50% (W) = 0.4	0.32	0.15	0.55	OK

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STREET FLOW - 100 YR

$Q_{street} = Q_{100} - Q_{pipe}$

Location	Contrib. Areas	Q_{100}	Q_{pipe}	Q_{street}	street slope	Q_{max}	Comment
Approaching Node 105 (E)	100% 106	9.4					
	100% 105	4.6					
		14.0	3.5	10.5	1.2	96.6 ✓	OK Std Cb 0.3' wkGr
Approaching Nodes 104 & 103 (E)	100% 106	9.4					
	100% 105	4.6					
	90% 104	3.1					
	70% 103	12.4					
		29.5	6.3	23.2	0.32	49.9	OK Std Cb 0.3' wkGr
Approaching Nodes 102 & 101 (E)	100% 106	9.4					
	100% 105	4.6					
	100% 104	3.4					
	100% 103	17.7					
	50% 102	0.7					
	50% 101	1.3					
		37.1	12.1	25.0	0.32	49.9	OK Std Cb 0.3' wkGr.

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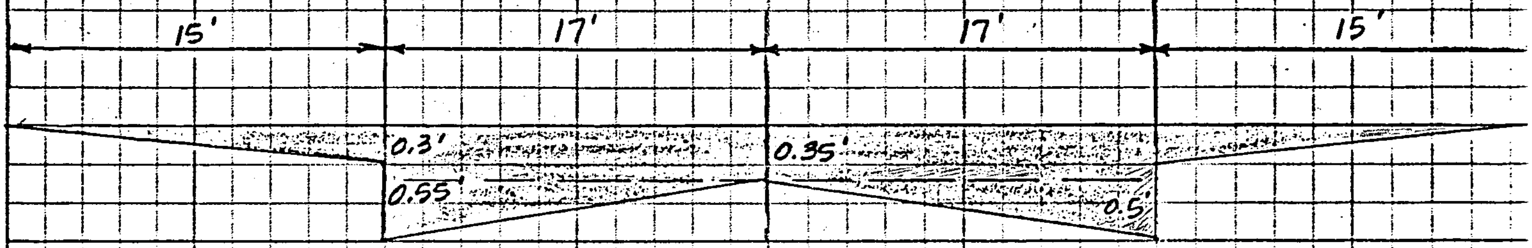
Project Autumn Ridge 2nd Addition

Item Drainage Plan -

Check Street Flow 100-YR (Walk Grade +0.3')



Determine Q_{max} in Street R-O-W

Use Mannings Eq'n $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$$n = \frac{2(14.5 \times 0.030) + 2(1.05' \times 0.013) + 2(17 \times 0.016)}{65.1}$$

$$n = 1.4413/65.1 = 0.0221$$

$$A = 2(1/2 \times 15 \times 0.3) + (34 \times 0.35) + 2(1/2 \times 0.5 \times 17)$$
$$= 24.90 \text{ SF}$$

$$P = (2 \times 15) + (2 \times 17) + (2 \times 0.55)$$
$$= 65.1'$$

$$R = A/P = 24.9/65.1 = 0.38249$$

$$R^{2/3} = 0.527$$

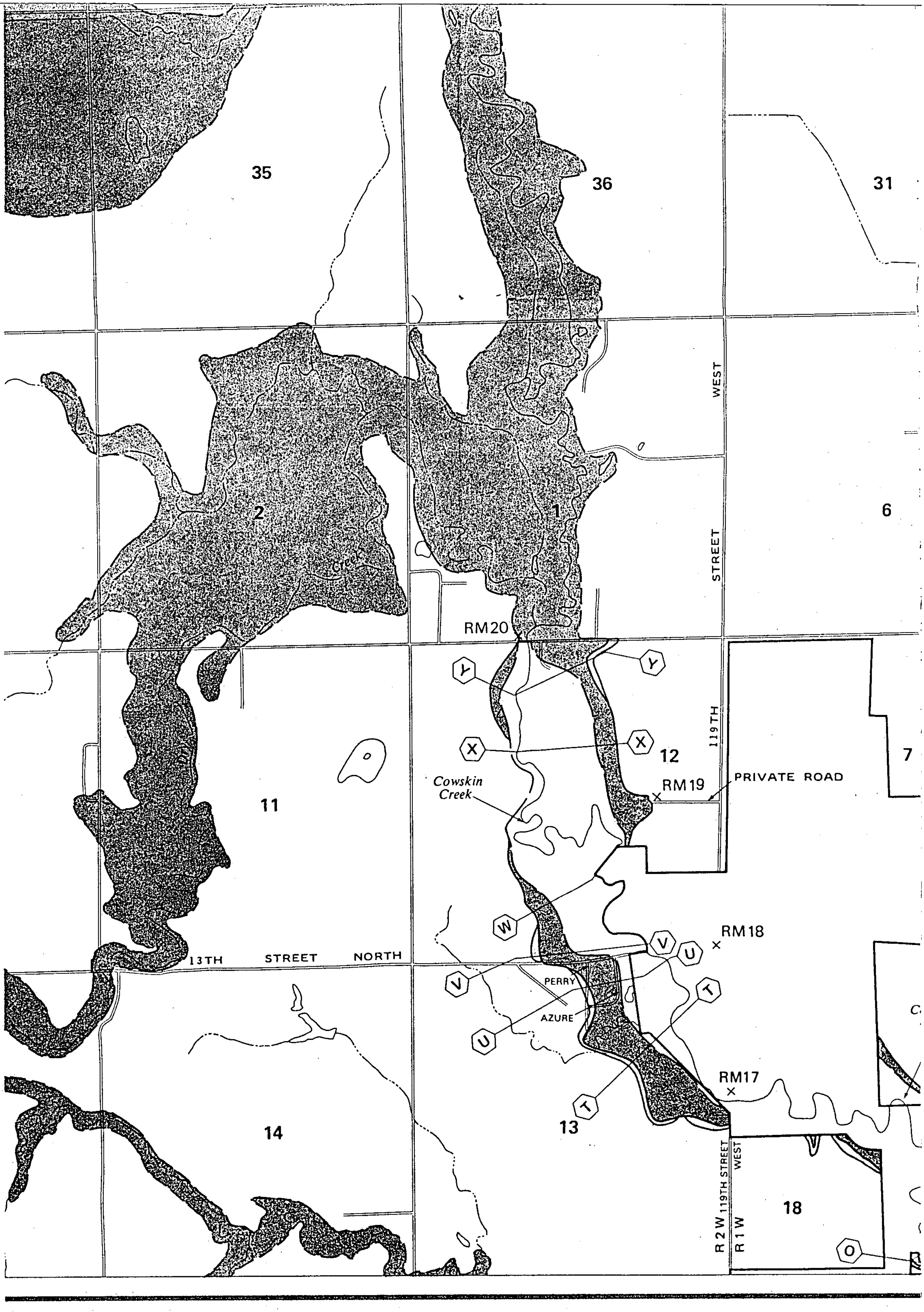
$$Q = \frac{1.486}{0.0221} \times 24.90 \times 0.527 \times S^{1/2}$$

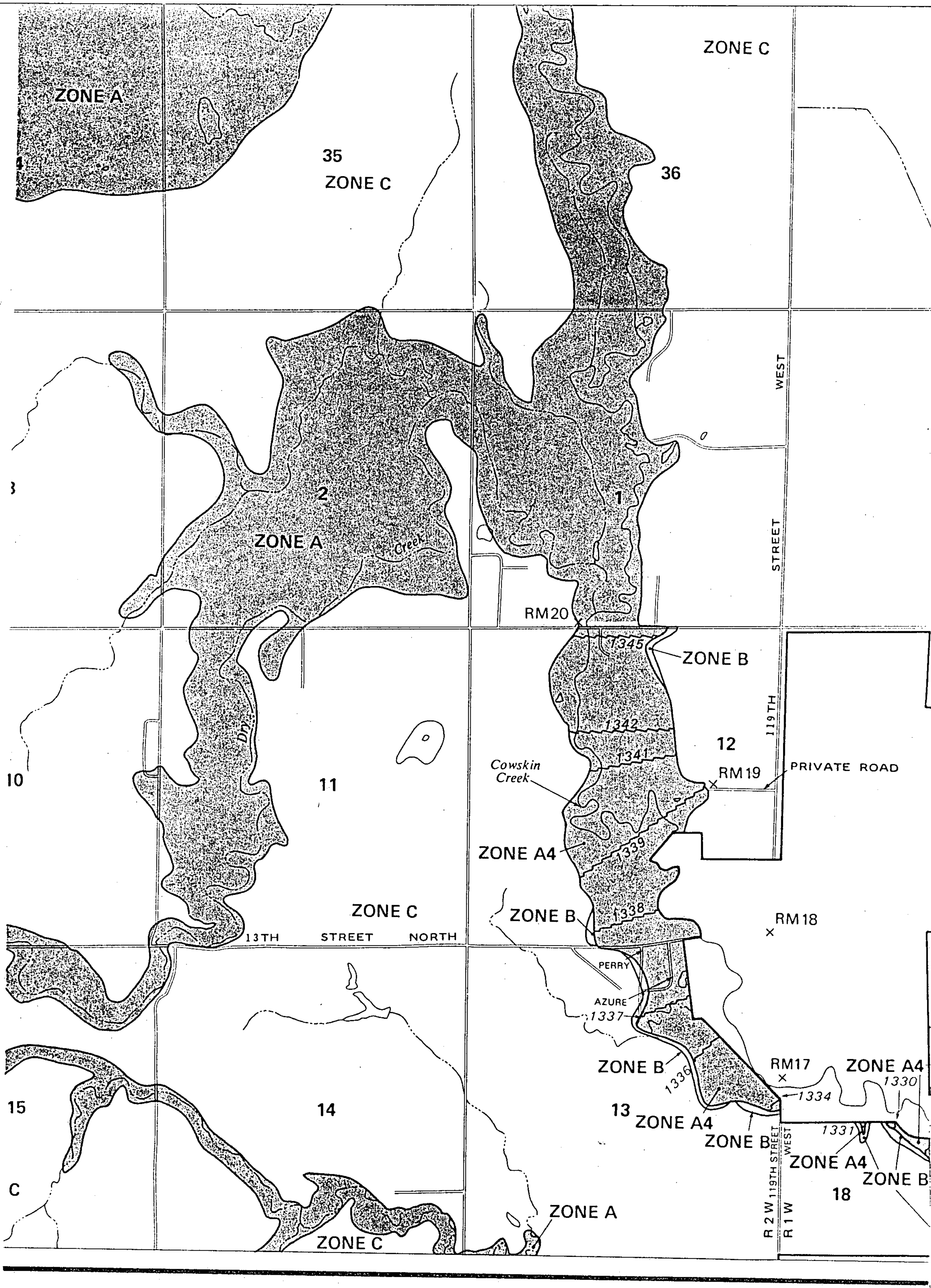
$$Q = 882.3 \times S^{1/2}$$

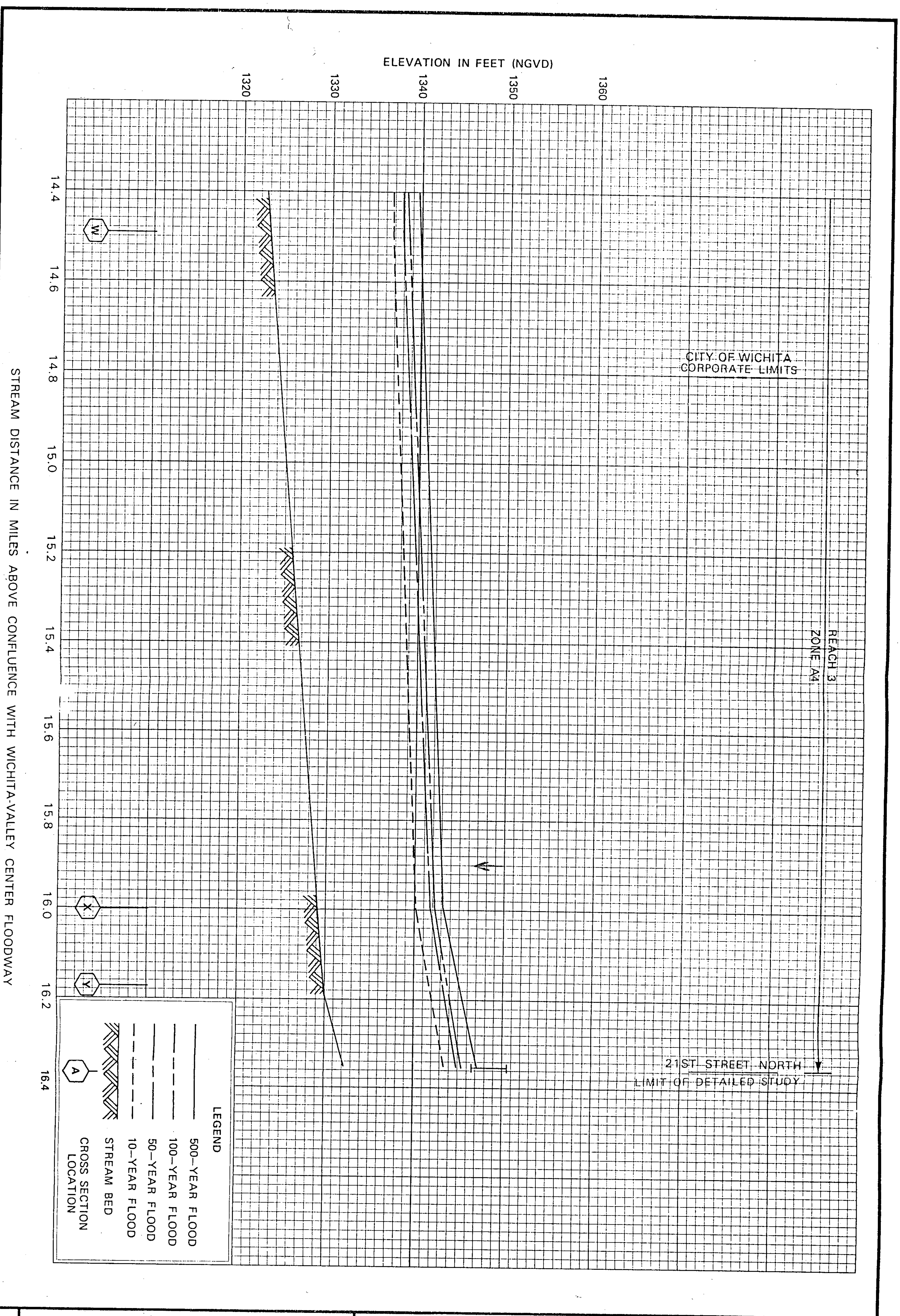
49.9

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ARKANSAS RIVER					
At Washington Street	40,830	27,200	46,200	55,200	77,800
Downstream of Kansas Turnpike		31,500	31,500	31,500	31,500
SPRING CREEK					
At mouth at the Arkansas River	31.6	5,760	10,300	12,600	19,100
At State Highway 15	30.9	5,690	10,200	12,500	18,900
Upstream of confluence of Dry Creek	23.9	4,960	8,920	10,900	16,500
DRY CREEK					
At confluence with Spring Creek	4.8	2,130	3,850	4,690	7,100
DRY CREEK TRIBUTARY					
At mouth at Dry Creek	0.6	610	875	1,000	1,300
COWSKIN CREEK					
At U.S. Highway 54	107.0	7,600	14,100	17,400	27,000
Upstream of confluence of Calfskin Creek	90.0	6,850	12,700	15,680	24,340
At Central Avenue	84.0	6,570	12,190	15,050	23,350
At State Highway 96	37.0	2,420	4,450	5,440	8,200
COWSKIN CREEK SOUTH					
Downstream of 95th Street South	6.8	2,200	3,760	4,340	5,800
At 79th Street South	6.2	1,100	1,700	1,950	2,500
At Chicago, Rock Island & Pacific Railroad	1.9	970	1,480	1,680	2,200
CALFSKIN CREEK					
At mouth at Cowskin Creek	17.0	4,170	6,170	7,490	11,000
Upstream of Clearwater Road	9.1	2,700	3,830	4,710	7,400
Upstream of U.S. Highway 54	7.3	2,420	3,500	4,260	6,500


35
36
31
2
1
6
Creek
WEST
STREET
119TH
RM20
Y
Y
X
X
12
7
PRIVATE ROAD
RM19
Cowskin
Creek
11
W
V
V
U
U
RM18
13TH STREET NORTH
PERRY
AZURE
T
T
RM17
14
13
119TH STREET WEST
18
R 2 W
R 1 W
O


ZONE A
35
ZONE C
ZONE C
36
2
ZONE A
Creek
1
WEST
STREET
RM20
1345
ZONE B
119TH
1342
12
1341
Cowskin
Creek
RM19
PRIVATE ROAD
10
11
ZONE A4
1339
ZONE C
ZONE B
1338
RM18
13TH
STREET
NORTH
PERRY
AZURE
1337
ZONE B
1336
RM17
ZONE A4
1330
1334
15
14
13
ZONE A4
ZONE B
1331
ZONE A4
ZONE B
18
C
ZONE A
ZONE C
R 2 W
119TH STREET WEST
R 1 W



13P	FEDERAL EMERGENCY MANAGEMENT AGENCY **SEDGWICK COUNTY, KS** (UNINCORPORATED AREAS)	**FLOOD PROFILES** **COWSKIN CREEK**

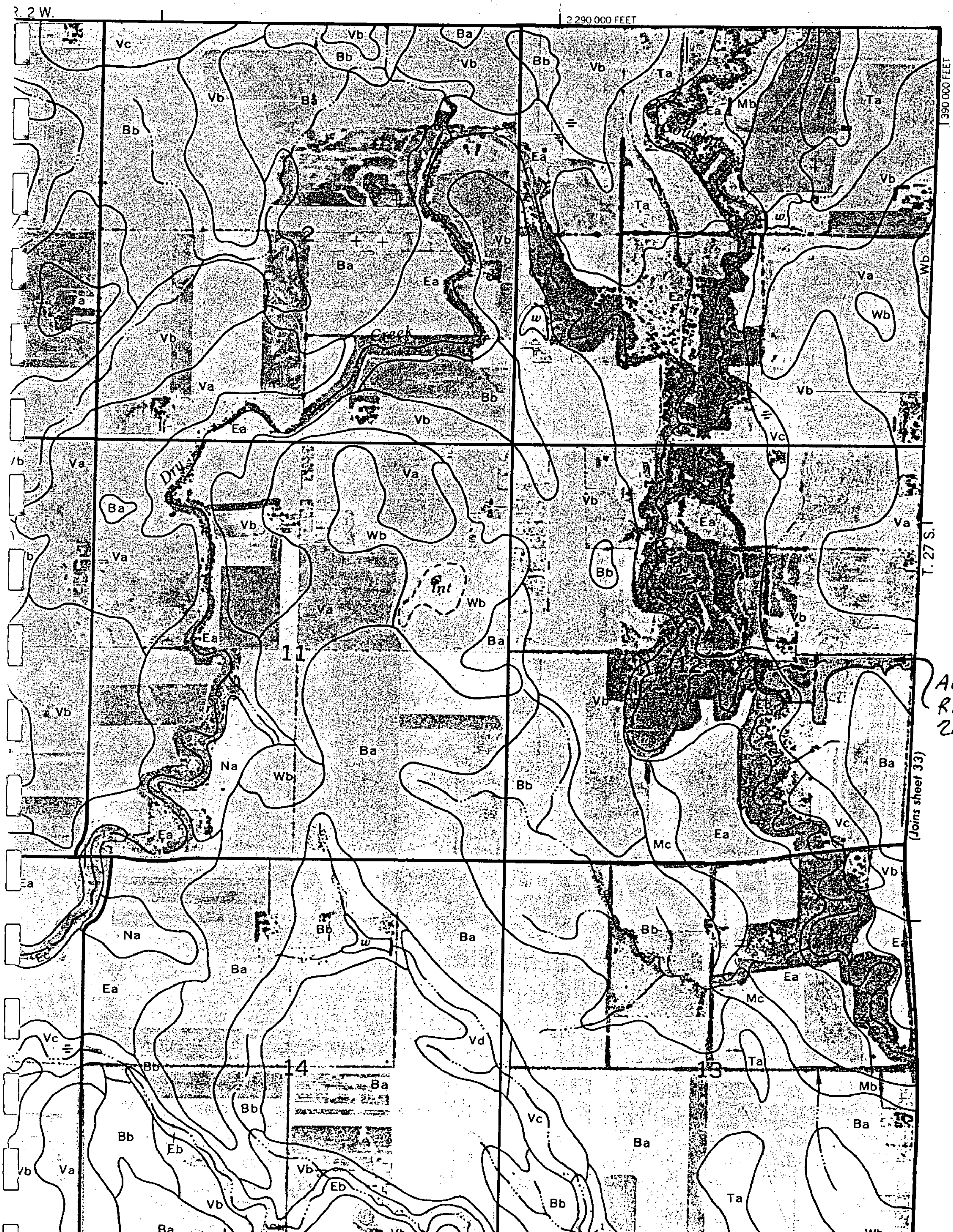

R. 2 W.
2 290 000 FEET
390 000 FEET
T. 27 S.
(Joins sheet 33)
2
11
14
13
Dry Creek
Vc
Vb
Ba
Bb
Ta
Ea
Mb
Va
Wb
Na
Mc
Vd
Eb
Ec
w
AUTUMN RIDGE 2ND ADD

EXHIBIT NO. 1

SOIL LEGEND

SYMBOL	HYDROLOGIC GROUP	NAME
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loans, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loan, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loan
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent lopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

ATTACHMENT D

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
Single Family (Soil Group D)					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
Multi-Family (Soil Group D)					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
Single Family (Soil Group C)					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
Multi-Family (Soil Group C)					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
Single-Family (Soil Group B)					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
Multi-Family (Soil Group B)					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
Single Family (Soil Group A)					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
Multi-Family (Soil Group A)					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
7. Undeveloped Urban Areas:					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
Soil Group A					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
Soil Group B					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
Soil Group C					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
Soil Group D					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

April 15, 1986

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

CITY OF WICHITA, KANSAS

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

ATTACHMENT A CONTINUED
Page 2

DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
85	1.06	1.30	1.72	2.02	2.37	2.71	3.01
86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

ATTACHMENT A CONTINUED
Page 3

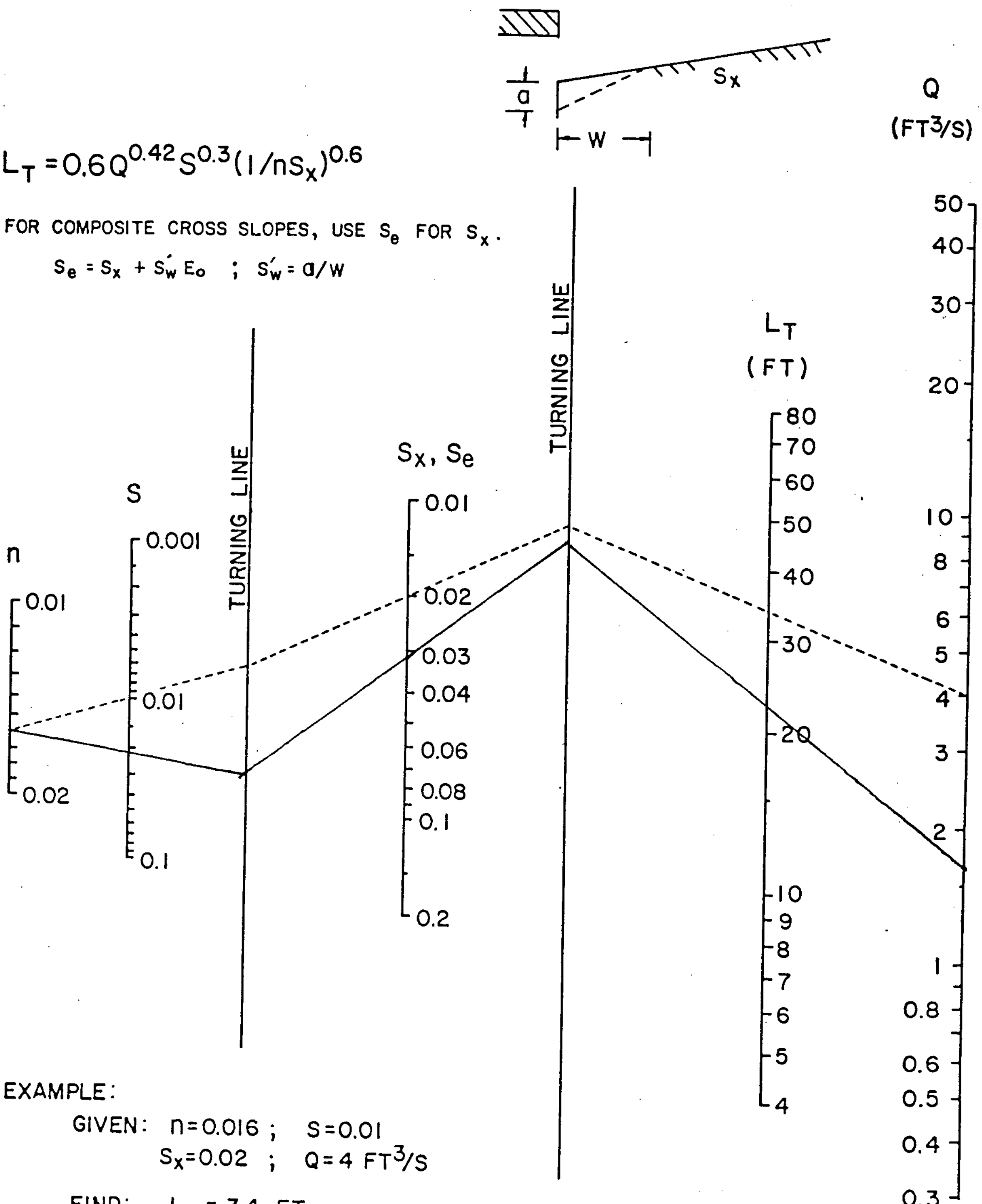
DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

DURATION IN HOURS	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

$L_T = 0.6 Q^{0.42} S^{0.3} (1/nS_x)^{0.6}$

FOR COMPOSITE CROSS SLOPES, USE S_e FOR S_x.

$S_e = S_x + S'_w E_o$; $S'_w = a/W$



EXAMPLE:

GIVEN: n=0.016 ; S=0.01

S_x=0.02 ; Q=4 FT^3/S

FIND: L_T = 34 FT

CHART 9. Curb-opening and slotted drain inlet length for total interception.

From: HEC-12, Drainage of Highway Pavements, F.H.W.A., Mar. 1984.

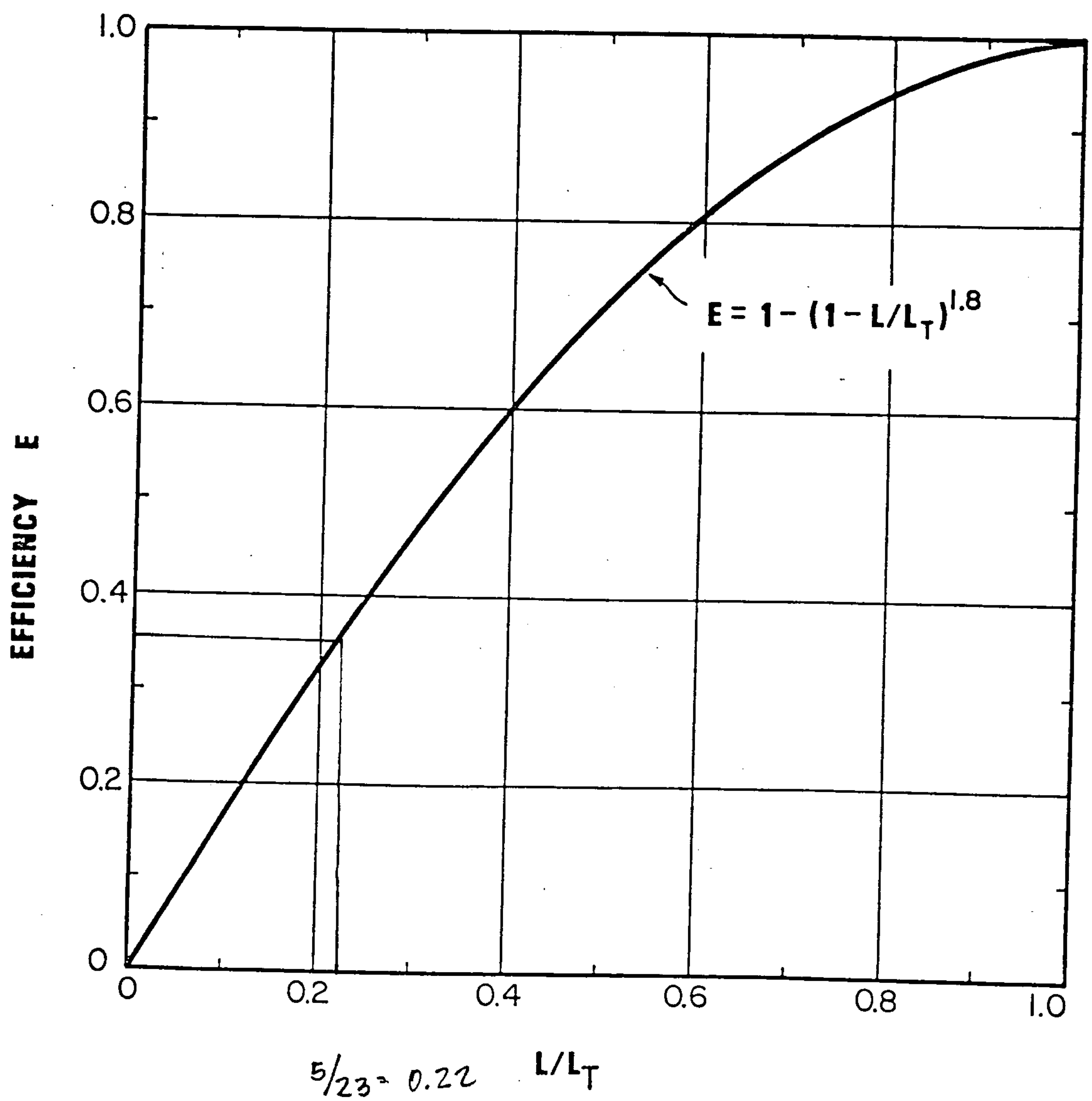
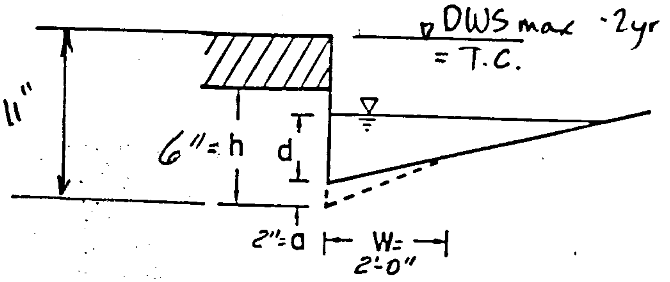
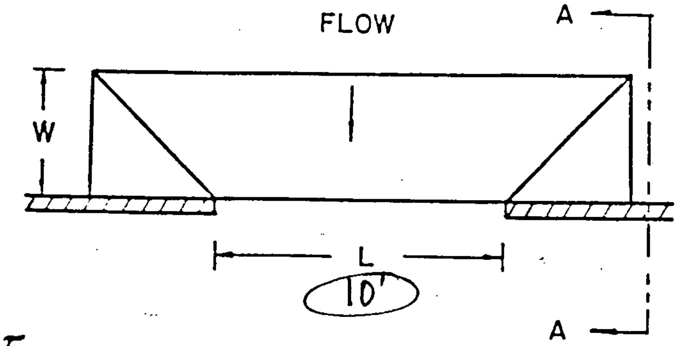


CHART 10. Curb-opening and slotted drain inlet interception efficiency.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., Mar. 1984





DEF. SKETCH, C.O.W. TYPE 1A INLET

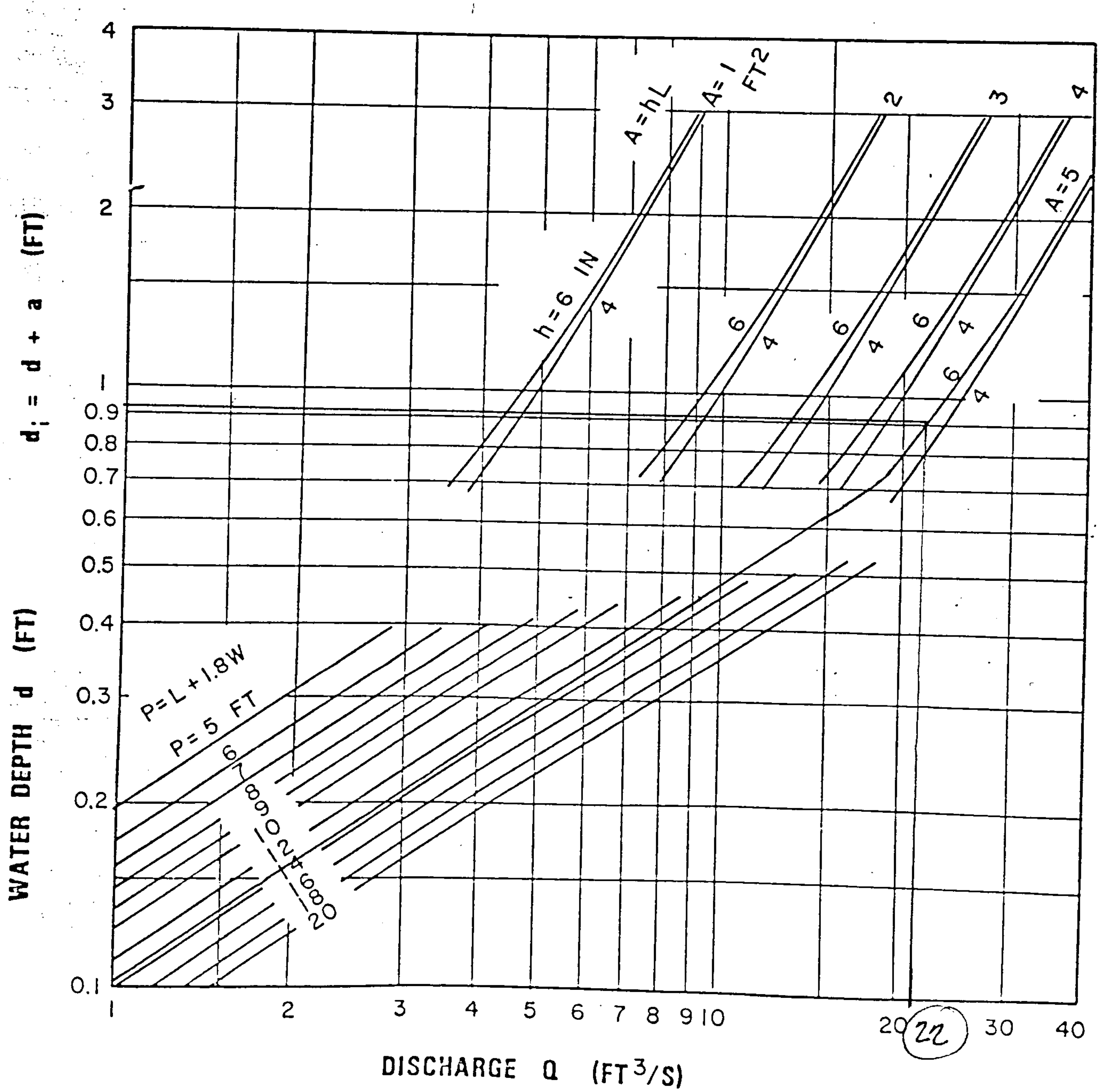
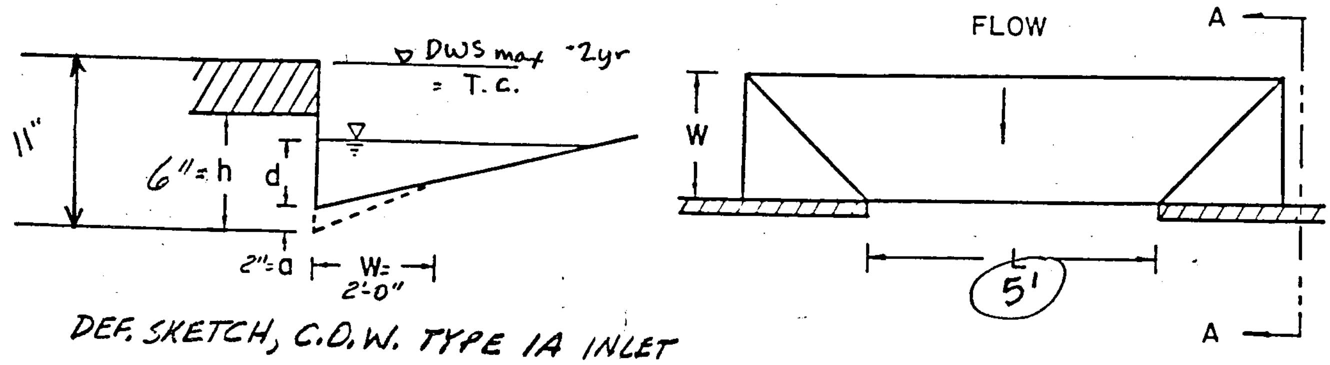


CHART 12. Depressed curb-opening inlet capacity in sump locations.

From: HEC-12, Drainage of Highway Pavements, F.H.W.A., Mar., 1984



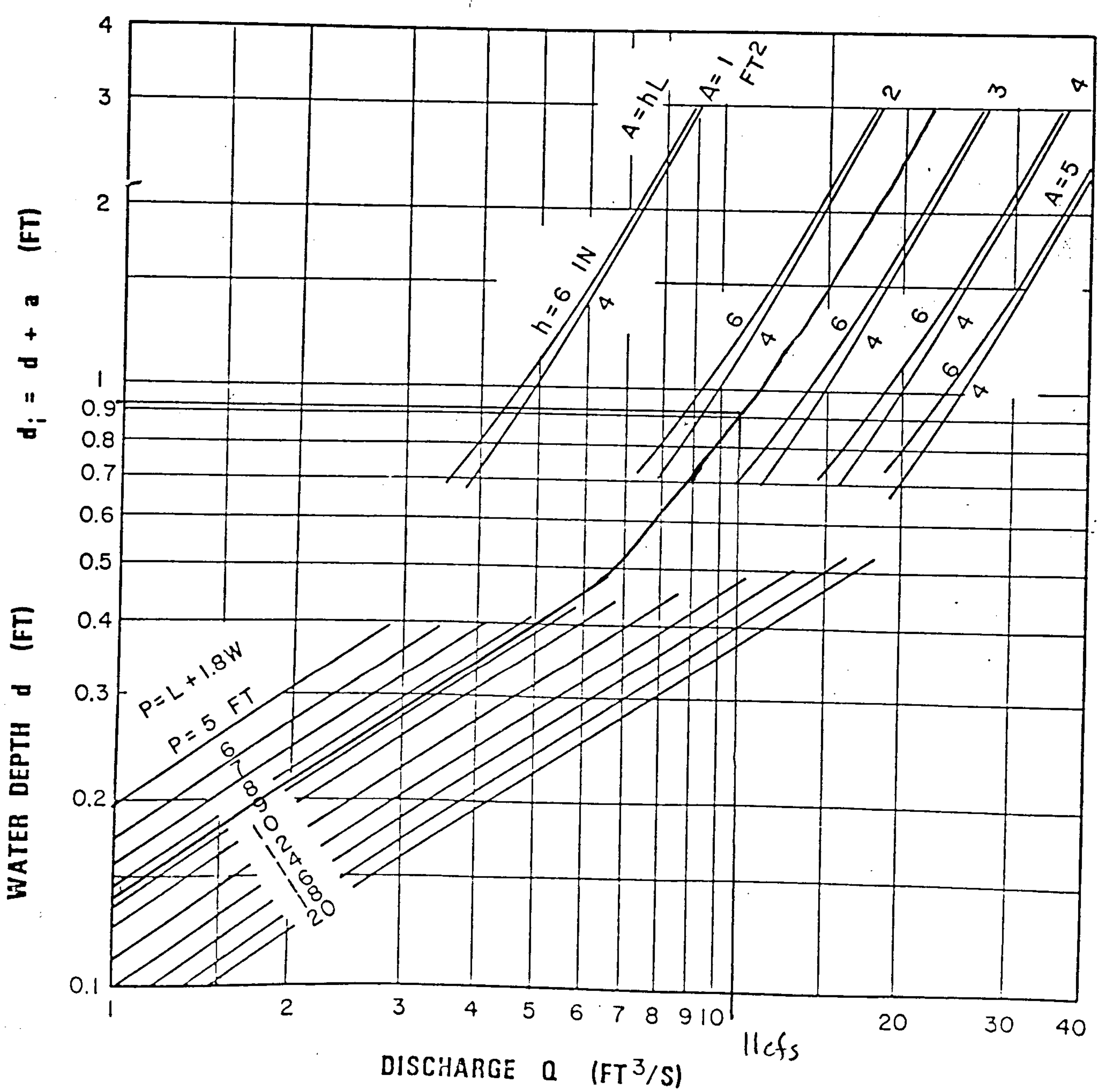
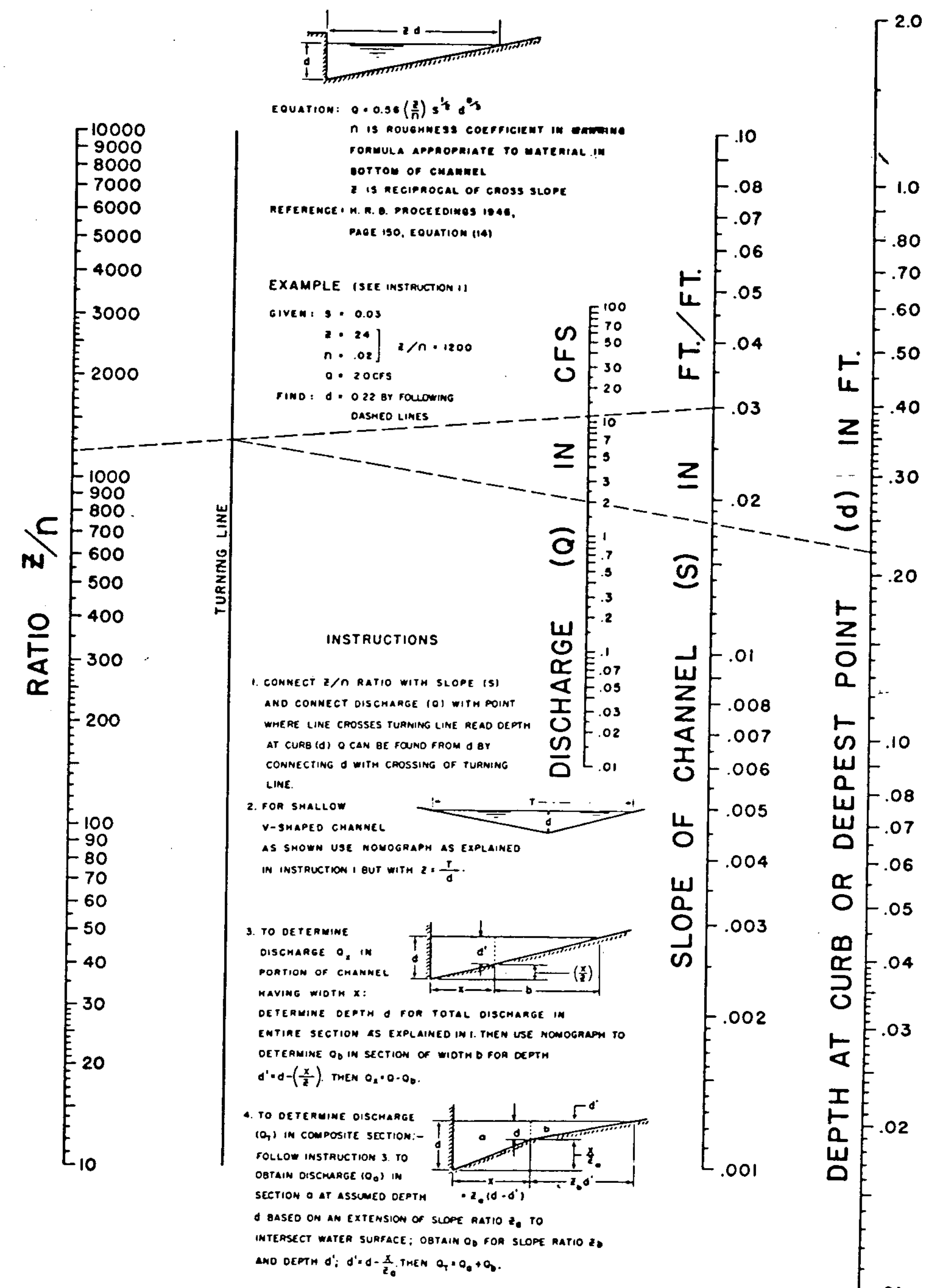


CHART 12. Depressed curb-opening inlet capacity in sump locations.

From: HEC-12, Drainage of Highway Pavements, F.H.W.A., Mar., 1984



BUREAU OF PUBLIC ROADS
REV. JAN. 1968

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS