PROFESSIONAL ENGINEERING CONSULTANTS
PROFESSIONAL ASSOCIATION

DRAINAGE PLAN

AND

SUPPORTING CALCULATIONS

FOR
AMARADO ESTATES THIRD ADDITION
TO WICHITA, SEDGWICK COUNTY, KANSAS

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

FEBRUARY 13, 1987

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

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[redacted]

Date Feb. 9, 1987 Page 1 of

Project Amarado 3rd

Item Drainage Plan - System 200

I HYDROLOGY

Soil Type : V_a B_a T_a

Lot Size ≈ 1/4 Ac.

	Hyd. Group	B	C	D
C_2		0.44	0.48	0.50
C_{100}		0.61	0.68	0.76

2 YR

Assume t_c = 15 min ∴ I_2 = 3.83

Node	C_2	I_2	A	Q_2
214	0.44	3.83	9.87	16.6
213	0.44	3.83	0.48	0.8
212	0.44	3.83	2.31	3.9
211	0.44	3.83	2.12	3.6
210	0.44	3.83	0.69	1.2
209	0.45	3.83	3.44	5.9
208	0.48	3.83	1.25	2.3
207	0.46	3.83	0.73	1.3
206	0.49	3.83	0.55	1.0
205	0.49	3.83	1.48	2.8
204	0.50	3.83	0.62	1.2
203	0.50	3.83	0.64	1.2
202	0.47	3.83	3.74	6.7
201	0.50	3.83	0.10	0.2
200	—	—	—	(End of System)

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Project Amarado 3rd

Item Drainage Plan - System 200

Hydrology - 100-yr

Node	C_{100}	I_{100}	A	Q_{100}
214	0.61	7.37	9.87	44.4
213	0.61	7.37	0.48	2.2
212	0.61	7.37	2.31	10.4
211	0.61	7.37	2.12	9.5
210	0.61	7.37	0.69	3.1
209	0.63	7.37	3.44	16.0
208	0.68	7.37	1.25	6.3
207	0.64	7.37	0.73	3.4
206	0.72	7.37	0.55	2.9
205	0.72	7.37	1.48	7.9
204	0.76	7.37	0.62	3.5
203	0.76	7.37	0.64	3.6
202	0.66	7.37	3.74	18.2
201	0.76	7.37	0.10	0.6
200	—	—	—	—

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Project Amarado 3rd Addition

Item Drainage Plan - System 200

II FLOOD ROUTING / INLET SIZING (2 YR)

Node	Q_2	Inlet Condition	L	Q_{int} ≠	Q_{bypass}	to
214	16.6	Sump	10'	13.0 *	3.6	212
213	0.8	Sump	5	0.8	0	—
212	3.9 +3.6+2.2=9.7	Sump	10'	9.7	0	—
211	3.6	On Grade	5'	40% · 1.4	2.2	212
210	1.2	On Grade	5'	61% · 0.7	0.5	207
209	5.9	Sump	5'	5.9	0	—
208	2.3	Sump	5'	2.3	0	-
207	1.3 +0.5 =1.8	Sump	5'	1.8	0	-
206	1.0	On Grade	5'	66% = 0.7	0.3	203
205	2.8	Sump	5'	2.8	0	—
204	1.2	Sump	5'	1.2	0	-
203	1.2+0.3 =1.5	Sump	5'	1.5	0	—
202	6.7	Catch Basin Sump	N/A	6.7	0	—
201	0.2	On Grade	5'	0.2	0	—
200	—	—	—	—	—	

* Water overtop crown to Node 212

≠ Q_2 as input in SWS Computer Program.

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Project Amarado 3rd Addition

Item Drainage Plan · System 200

Street Flow - 2yr

Node	Q_2	Distribution	street slope	d		Comment
214	16.6	≈ 100% (W) = 16.6	0.4%	0.55'	OK	3.6 cfs overtop crown to Node 212
213	0.8	50% (N) = 0.4	0.8%	0.12'		OK
		50% (S) = 0.4	0.32%	0.15'		OK
212	9.7	75% (W) = 7.5	0.40%	0.42'		OK
		25% (S) = 2.2	0.32%	0.28'		OK
211	3.6	100% (S) = 3.6	0.32%	0.34'		OK
210	1.2	100% (W) = 1.2	0.31%	0.22'		OK
209	5.9	80% (W) = 4.7	0.31%	0.37'		OK
		20% (S) = 1.2	0.40%	0.22'		OK
208	2.3	≈ 100% (S) = 2.3	0.40%	0.28'		OK
207	1.8	≈ 100% (W) = 1.8	0.31%	0.26'		OK
206	1.0	100% (W) = 1.0	0.31%	0.21'		OK
205	2.8	50% (W) = 1.4	0.31%	0.24'		OK
		50% (S) = 1.4	0.32%	0.24'		OK
204	1.2	50% (E) = 0.6	1.32%	0.13'		OK
		50% (S) = 0.6	0.32%	0.18'		OK
203	1.5	80% (W) = 1.2	0.31%	0.23'		OK
		20% (E) = 0.3	1.32%	0.10'		OK
202	No street Flow (Rear Yard Catch Basin)					
201	0.2	100% (E) = 0.2	1.32%	0.10'		OK

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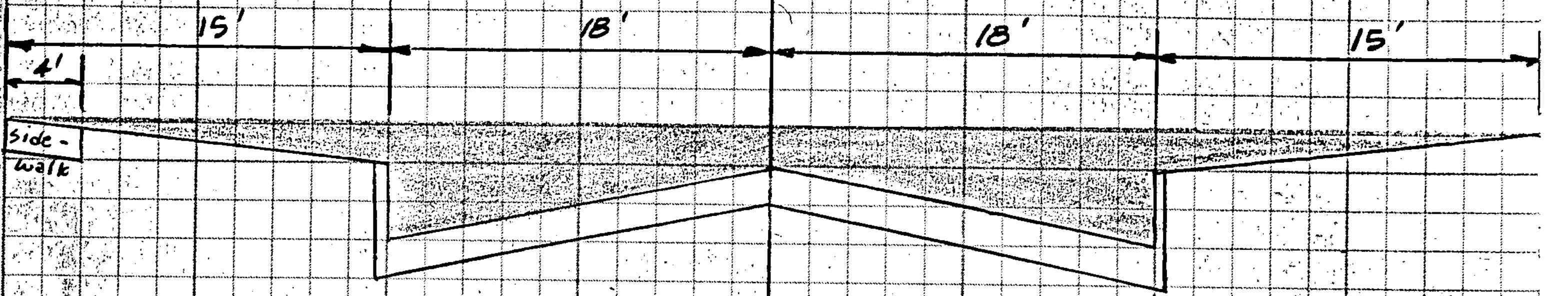
Project: Amarado 3rd Addition

Item: Drainage Plan - System 200

STREET FLOW - 100-YR



Use Manning's Eq'n

$Q = 1.486/n \; AR^{2/3} \; S^{1/2}$

$n = \dfrac{(4' \times 0.014) + (10.5 \times 0.03) + 2(1.05 \times 0.013) + (36 \times 0.016) + (14.5 \times 0.0}{67.1}$

$= 0.021$

$A = (2 \times \frac{1}{2} \times 15 \times 0.4) + (36 \times 0.4) + (2 \times \frac{1}{2} \times 18 \times 0.55)$

$= 30.3$

$p = (2 \times 15) + (2 \times 0.55) + (2 \times 18)$

$= 67.1$

$R = A/p = 0.451565$

$R^{2/3} = 0.5886$

$Q = \dfrac{1.486}{0.021} \times 30.3 \times 0.5886 \times S^{1/2}$

$Q = 1{,}262.0 \; S^{1/2}$

Check Street Flow - 100-yr

Q_{100} : Node	214	= 44.4	
	213	= 2.2	
	211	= 10.4	
	210	= 9.5	
	209	= 16.0	
	208	= 6.3	
	207	= 3.4	
	206	= 2.9	
	205	= 4.0	(50% overflows into channel)
	204	= 1.7	(50% " " ")
	203	= 3.6	
	202	= 0.0	(overflows into channel)
	201	= 0.6	
		105 cfs	

Q_2 (pipe 203-201) = 40.4

$Q_{street} = Q_{100} - Q_{2pipe}$

= 105.0 - 40.4 = 64.6 cfs

From Previous Page, Q_{max} street = $1262\sqrt{s}$

w/ s = 0.0031 '/' Q_{max} = 70.3 cfs ∴ 100 Street Flow OK

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Date Feb. 12, 1987

Project Amarado 3rd

Item Drainage Plan System 200

Check Existing Flow & Compare to Proposed Runoff

Existing Flow Into 2 C.B's

Use Rational Formula $Q = cIA$

2 YR

C:

40	Ac	@	.18	= 7.2
2	Ac	@	.26	= 0.52
11	Ac	@	.30	= 3.30
53				11.02

composite c = 11.02/53 = 0.21

t_c : Overland Flow ± 800' @ 0.23 fps = 58
1000' Chan. Flow (Terrace) @ 2.5 fps = 7
65 min

$I_2 = 1.59$

$Q_2 = c_2 I_2 A$

$= 0.21 \times 1.59 \times 53$

$= 17.7$

Compare to Proposed $Runoff_2$ = 24.8 cfs

Proposed Conditions would Add 7.1 cfs to Existing System For 2-yr storm.

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Date Feb 12, 1987 Page 8 of

Project Amarado 3rd

Item Drainage Plan System 200

100 yr

C:

40 Ac @ 0.39	=	15.60	
2 Ac @ 0.53	=	1.06	
11 Ac @ 0.65	=	7.15	
53		23.81	

composite $c = 23.81 / 53 = 0.45$

$t_c = 65$ min

$I_{100} = 3.57$

$Q_{100} = c_{100} I_{100} A$

$= 0.45 \times 3.57 \times 53$

$= 85.1$

Compare to Proposed $Runoff_{100} = 66.5$ cfs

Proposed Conditions Would Reduce Flow In Existing System By 18.6 cfs For 100 yr storm.

"rado 200"

```
100 j,  149.2000  200    3   15   14
110 t,amarado 3rd addition
120 t,drainage plan
130 t,2 year storm analysis
140 i,  214    0.44    9.87    0.00    0.00   13.00   15.00   155.20
150 i,  213    0.44    0.48    0.00    0.00    0.80   15.00   155.50
160 i,  212    0.44    2.31    0.00    0.00    9.70   15.00   155.20
170 i,  211    0.44    2.12    0.00    0.00    1.40   15.00   156.20
180 i,  210    0.44    0.69    0.00    0.00    0.70   15.00   155.40
190 i,  209    0.45    3.44    0.00    0.00    5.90   15.00   154.70
200 i,  208    0.48    1.25    0.00    0.00    2.30   15.00   154.60
210 i,  207    0.46    0.73    0.00    0.00    1.80   15.00   154.60
220 i,  206    0.49    0.55    0.00    0.00    0.70   15.00   154.10
230 i,  205    0.49    1.48    0.00    0.00    2.80   15.00   153.80
240 i,  204    0.50    0.62    0.00    0.00    1.20   15.00   153.70
250 i,  203    0.50    0.64    0.00    0.00    1.50   15.00   153.70
260 i,  202    0.47    3.74    0.00    0.00    6.70   15.00   153.70
270 i,  201    0.50    0.10    0.00    0.00    0.20   15.00   154.90
280 m,  200   149.20
290 p,  214  212    38.00   24 0.013   5.00   0.00
300 p,  213  212    60.00   15 0.013  75.00   0.00
310 p,  212  211   110.00   30 0.013  85.00   0.00
320 p,  211  210   295.00   36 0.013   0.00   0.00
330 p,  210  207   277.00   36 0.013   0.00   0.00
340 p,  209  208    85.00   15 0.013  90.00   0.00
350 p,  208  207    45.00   18 0.013  90.00   0.00
360 p,  207  206   293.00   36 0.013   0.00   0.00
370 p,  206  203   202.00   36 0.013   0.00   0.00
380 p,  205  204    85.00   15 0.013  90.00   0.00
390 p,  204  203    45.00   18 0.013  90.00   0.00
400 p,  203  201    71.00   36 0.013   0.00   0.00
410 p,  202  201    24.00   18 0.013  90.00   0.00
420 p,  201  200    73.00   36 0.013  90.00   0.00
430 e
```

10

Date: 02-12-1987
Time: 09:32:27

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amarado 3rd addition
drainage plan
2 year storm analysis

Storm Frequency = 2-Year

* * * HYDROLOGY * * *

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)
214	212	0.44	9.87	0.00	0.0	15.00	4.06	13.00	15.00	4.06	13.00	13.00	24"	4.14	38.00	0.15	15.15
213	212	0.44	0.48	0.00	0.0	15.00	4.06	0.80	15.00	4.06	0.80	0.80	15"	0.65	60.00	1.53	16.53
212	211	0.44	2.31	0.00	0.0	15.00	4.06	9.70	15.15	4.04	9.66	23.39	30"	4.77	110.00	0.38	15.54
211	210	0.44	2.12	0.00	0.0	15.00	4.06	1.40	15.54	4.00	1.38	24.78	36"	3.51	295.00	1.40	16.94
210	207	0.44	0.69	0.00	0.0	15.00	4.06	0.70	16.94	3.87	0.67	25.44	36"	3.60	277.00	1.28	18.22
209	208	0.45	3.44	0.00	0.0	15.00	4.06	5.90	15.00	4.06	5.90	5.90	15"	4.81	85.00	0.29	15.29
208	207	0.48	1.25	0.00	0.0	15.00	4.06	2.30	15.29	4.03	2.28	8.18	18"	4.63	45.00	0.16	15.46
207	206	0.46	0.73	0.00	0.0	15.00	4.06	1.80	18.22	3.76	1.67	34.79	36"	4.92	293.00	0.99	19.22
206	203	0.49	0.55	0.00	0.0	15.00	4.06	0.70	19.22	3.69	0.64	35.42	36"	5.01	202.00	0.67	19.89
205	204	0.49	1.48	0.00	0.0	15.00	4.06	2.80	15.00	4.06	2.80	2.80	15"	2.28	85.00	0.62	15.62
204	203	0.50	0.62	0.00	0.0	15.00	4.06	1.20	15.62	4.00	1.18	3.98	18"	2.25	45.00	0.33	15.95
203	201	0.50	0.64	0.00	0.0	15.00	4.06	1.50	19.89	3.64	1.34	40.42	36"	5.72	71.00	0.21	20.09
202	201	0.47	3.74	0.00	0.0	15.00	4.06	6.70	15.00	4.06	6.70	6.70	18"	3.79	24.00	0.11	15.11
201	200	0.50	0.10	0.00	0.0	15.00	4.06	0.20	20.09	3.62	0.18	46.59	36"	6.59	73.00	0.18	20.28

Date: 02-12-1987
Time: 09:32:27

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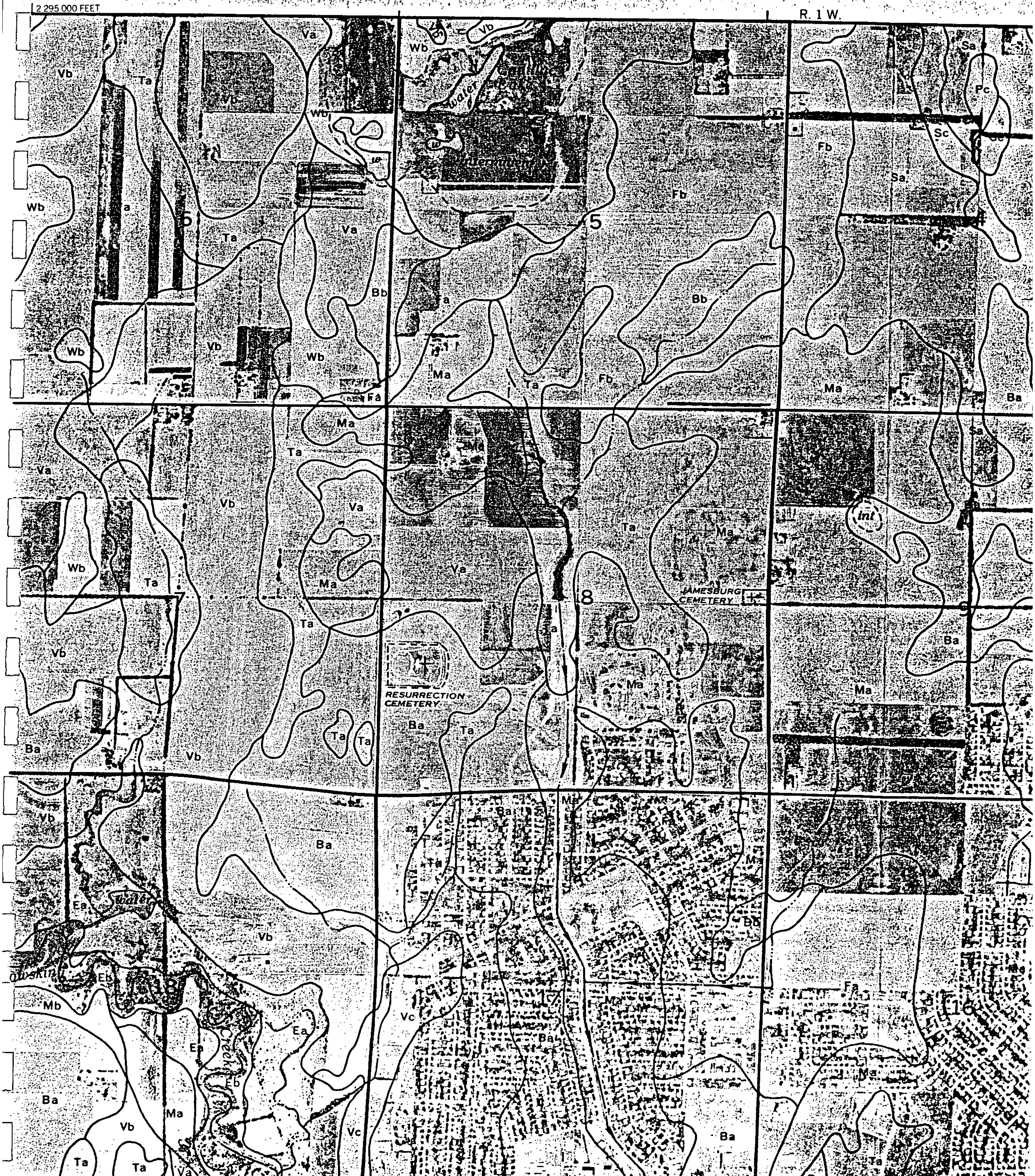
amarado 3rd addition
drainage plan
2 year storm analysis

Storm Frequency = 2-Year

* * * HYDRAULICS * * *

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)
214	0.00330	0.1255	0.0000	0.0000	0.0000	0.0000	0.0000	0.1255	154.1187	155.2000	1.08
213	0.00015	0.0092	0.0000	0.0000	0.0000	0.0000	0.0000	0.0092	154.0024	155.5000	1.50
212	0.00325	0.3579	0.0000	0.0087	0.0000	0.0041	0.4614	0.8321	153.9932	155.2000	1.21
211	0.00138	0.4070	0.0000	0.0324	0.0000	0.1647	-0.1165	0.4876	153.1611	156.2000	3.04
210	0.00146	0.4031	0.0000	0.0010	0.0000	0.0000	0.0280	0.4321	152.6736	155.4000	2.73
209	0.00834	0.7091	0.0000	0.0000	0.0000	0.0000	0.0000	0.7091	153.6422	154.7000	1.06
208	0.00607	0.2731	0.0000	0.0052	0.0000	0.1795	0.2340	0.6917	152.9332	154.6000	1.67
207	0.00272	0.7970	0.0000	0.0175	0.0000	0.0000	0.3608	1.1752	152.2415	154.6000	2.36
206	0.00282	0.5697	0.0000	0.0014	0.0000	0.0000	0.0417	0.6127	151.0662	154.1000	3.03
205	0.00188	0.1597	0.0000	0.0000	0.0000	0.0000	0.0000	0.1597	150.7805	153.8000	3.02
204	0.00144	0.0646	0.0000	0.0004	0.0000	0.0404	0.0619	0.1674	150.6208	153.7000	3.08
203	0.00367	0.2607	0.0000	0.0118	0.0000	0.0000	0.2522	0.5247	150.4535	153.7000	3.25
202	0.00407	0.0976	0.0000	0.0000	0.0000	0.0000	0.0000	0.0976	150.0264	153.7000	3.67
201	0.00488	0.3562	0.0000	0.0167	0.0000	0.0000	0.3558	0.7287	149.9287	154.9000	4.97
200	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	149.2000	149.2000	0.00


2 295 000 FEET
R. 1 W.
Va
Vb
Wb
Ta
Fb
Sa
Pc
Sc
Bb
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JAMESBURG CEMETERY
RESURRECTION CEMETERY
int
Creek

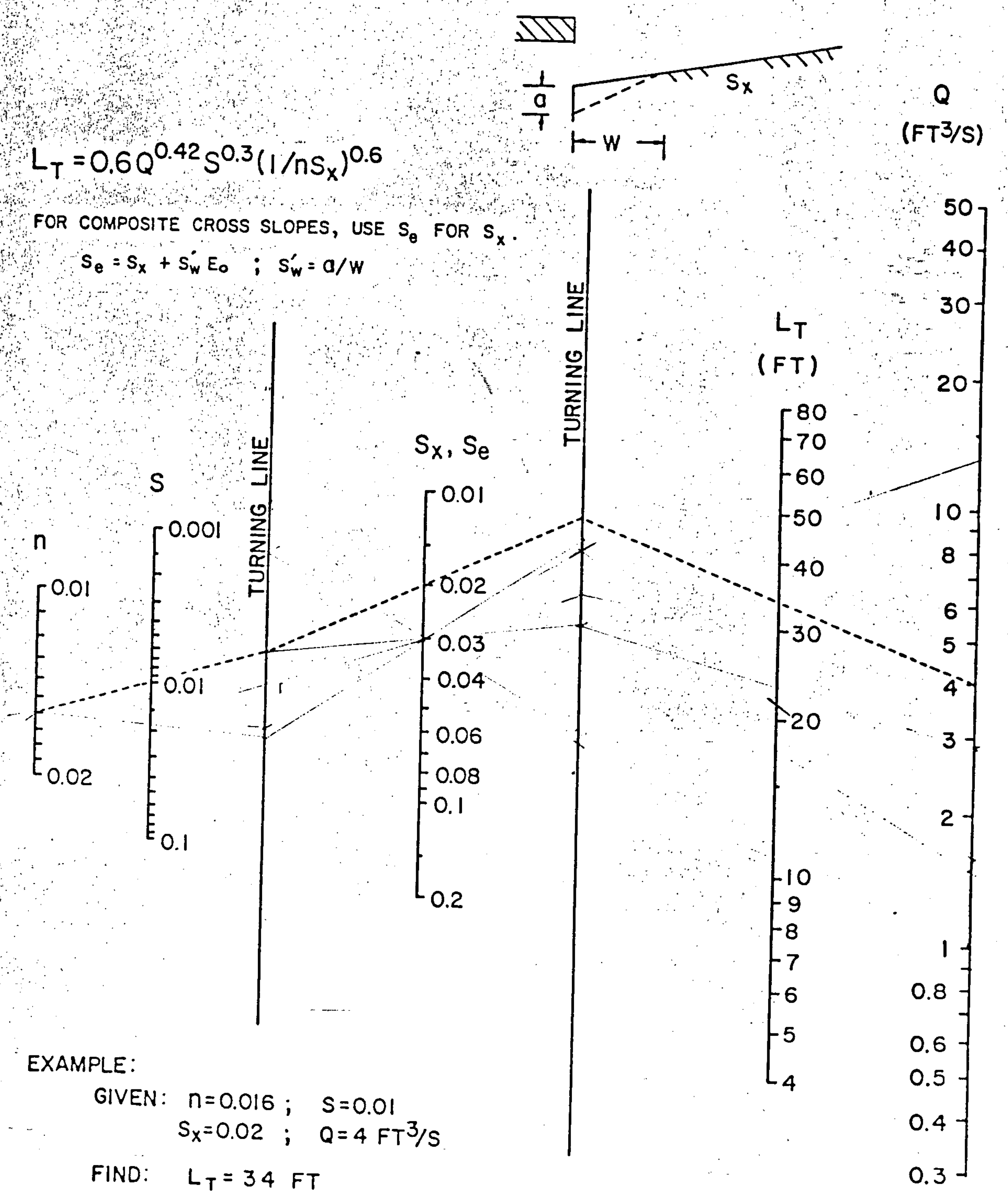


CHART 9. Curb-opening and slotted drain inlet length for total interception.

From: HEC-12, Drainage of Highway Pavements, FHWA, Mar. 1984.

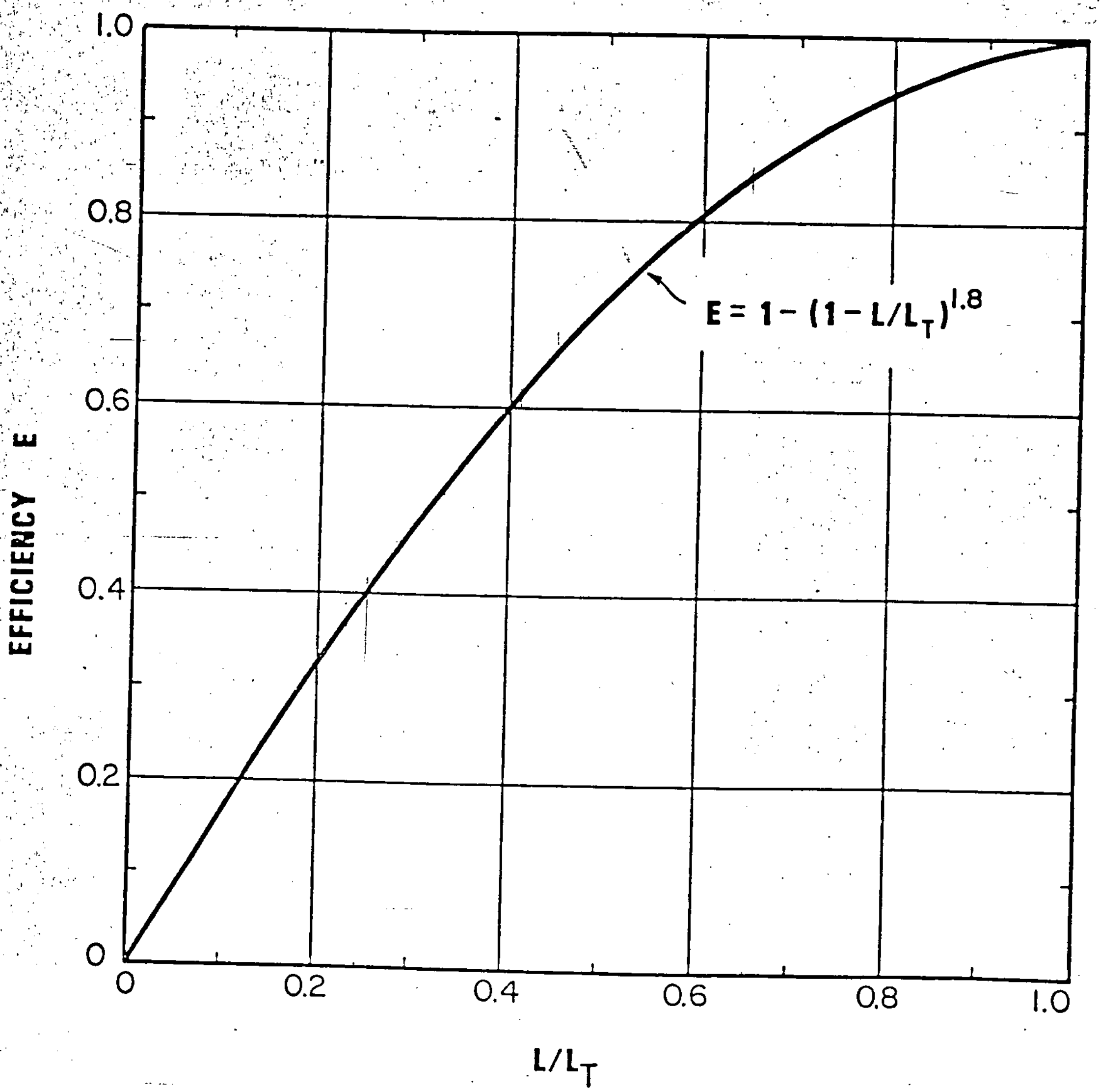


CHART 10. Curb-opening and slotted drain inlet interception efficiency.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, FHWA, Mar. 1984

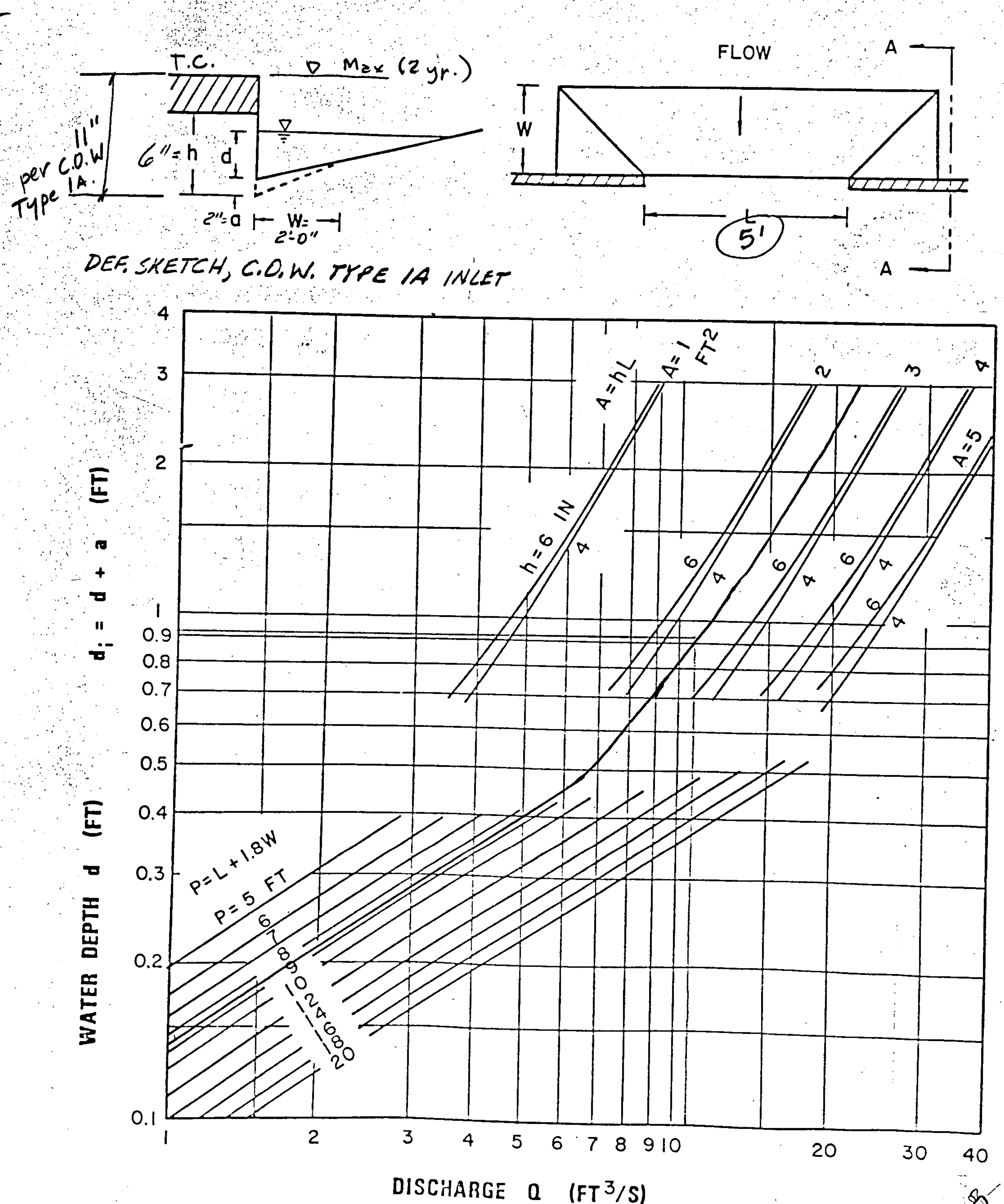


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, Drainage of Highway Pavements, F.H.W.A., MAR., 1984

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

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

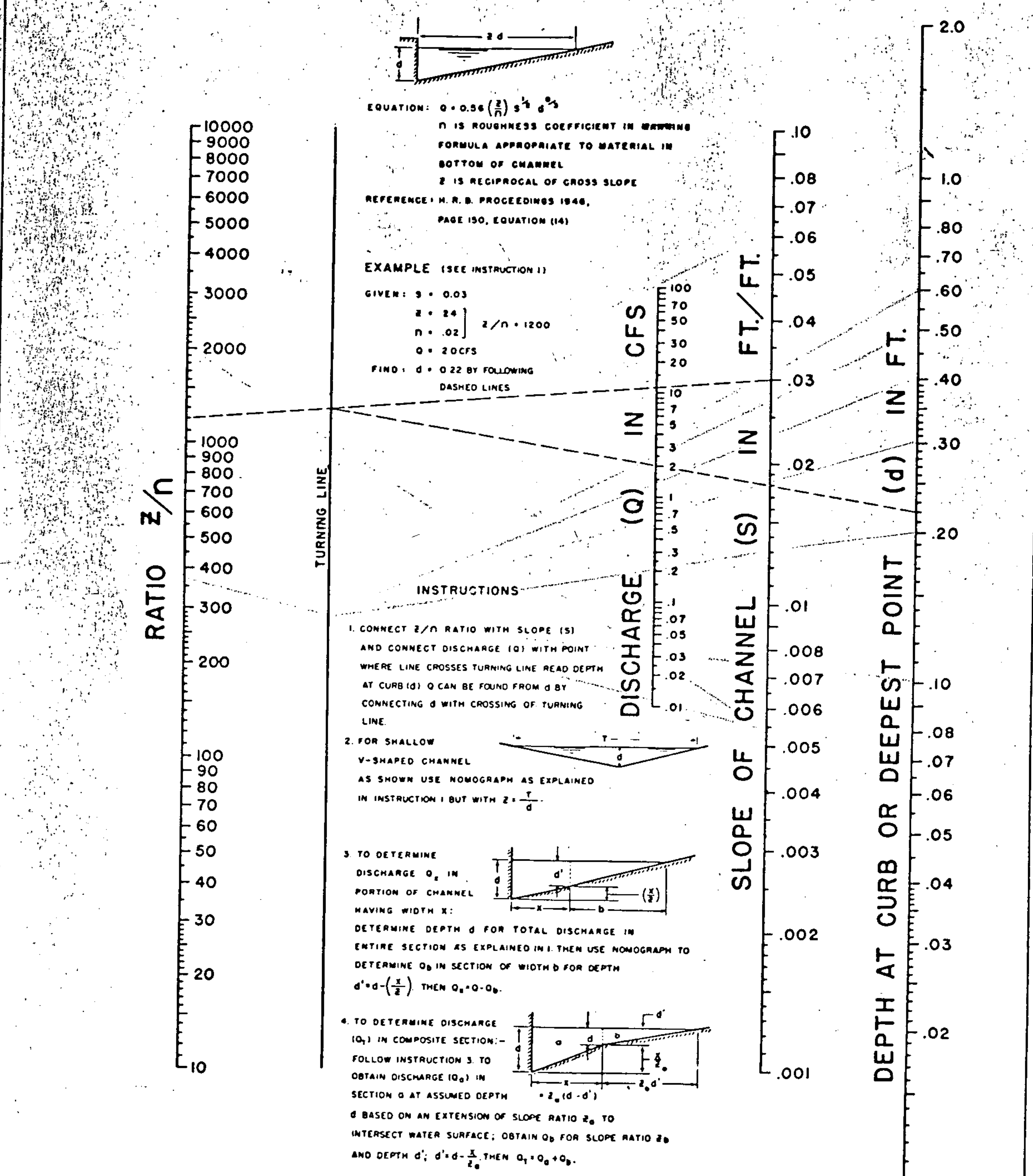
DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	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

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

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

Chart 1



BUREAU OF PUBLIC ROADS
REV. JAN. 1968

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

Professional Engineering Consultants, Professional Association, 1440 East English, Wichita, Kansas, Zip Code / 67211

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Project Amarado 3rd

Item Drainage Plan - System 100

I. Hydrology

Soil Type : V_2 & T_a

Lot Size : ≈ 0.25 Ac.

Hyd. Group	B	D
C_2	0.44	0.50
C_{100}	0.61	0.76

2YR Assume t_c = 15 min. (All Nodes) ∴ I_2 = 3.83

Node	C_2	I_2	A	Q_2
100	-	-	-	0
101	0.50	3.83	0.69	1.3
102	0.50	3.83	1.15	2.2
103	0.50	3.83	0.45	0.9
104	0.47	3.83	2.71	4.9
105	0.47	3.83	4.26	7.7
106	0.44	3.83	0.83	1.4
107	0.50	3.83	0.83	1.6
108	0.48	3.83	1.57	2.9
109	0.44	3.83	0.85	1.4
110	0.44	3.83	0.76	1.3
111	0.44	3.83	2.98	5.0
112	0.44	3.83	0.23	0.4
113	0.44	3.83	1.84	3.1

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Item Drainage Plan - System 100

Hydrology (Cont'd)

Node	C_2	I_2	A	Q_2
114	0.44	3.83	4.34	7.3
115	0.44	3.83	5.28	8.9
116	0.44	3.83	3.58	6.0

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Item Drainage Plan - System 100

100 - YR (t_c = 15 min) I_{100} = 7.37

Node	C_{100}	I_{100}	A	Q_{100}
100	—	—	—	0
101	0.76	7.37	0.69	3.9
102	0.76	7.37	1.15	6.4
103	0.76	7.37	0.45	2.5
104	0.69	7.37	2.71	13.8
105	0.69	7.37	4.26	21.7
106	0.66	7.37	0.83	4.0
107	0.76	7.37	0.83	4.6
108	0.73	7.37	1.57	8.4
108	0.61	7.37	0.85	3.8
110	0.61	7.37	0.76	3.4
111	0.61	7.37	2.98	13.4
112	0.61	7.37	0.23	1.0
113	0.61	7.37	1.84	8.3
114	0.61	7.37	4.34	19.5
115	0.61	7.37	5.28	23.7
116	0.61	7.37	3.58	16.1

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Item Drainage Plan - System 100

II 2 YR ROUTING / INLET SIZING

Node	Q_2	Inlet Condition	L	Q_{int} *	Q_{bypass}	to
116	6.0	Sump	5'	6.0	0	-
115	8.9	Sump	5'	8.9	0	-
114	7.3	Sump	5'	7.3	0	-
113	3.1	Sump	5'	3.1	0	-
112	0.4	On Grade	5'	85% = 0.3	0.1	109
111	5.0	Sump	5'	5.0	0	-
110	1.3	Sump	5'	1.3	0	-
109	1.4 + 0.1 = 1.5	Sump	5'	1.5	0	-
108	2.9	Sump	5'	2.9	0	-
107	1.6	Sump	5'	1.6	0	-
106	1.4	Sump	5'	1.4	0	-
105	7.7	Sump	5'	7.7	0	-
104	4.9	Sump	5'	4.9	0	-
103	0.9	On Grade	5'	66% = 0.6	0.3	101
102	2.2	Sump	5'	2.2	0	-
101	1.3 + 0.3 = 1.6	Sump	5'	1.6	0	-
100	0	End Section	-	-	-	-

* Q_2 as input in Storm Water Sewer Program

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Item Drainage Plan - System 100

Street Flow - 2yr

Node	Q_2	Distribution	Street slope	d	comment
116	6.0	100% (N) = 6.0	0.32%	0.40'	OK
115	8.9	100% (N) = 8.9	0.32%	0.47'	OK
114	7.3	70% (N) = 5.1	0.32%	0.38'	OK
		30% (W) = 2.2	1.35%	0.21'	OK
113	3.1	100% (W) = 3.1	1.35%	0.25'	OK
112	0.4	100% (W) = 0.4	0.32%	0.15'	OK
111	5.0	80% (W) = 4.0	0.32%	0.35'	OK
		20% (N) = 1.0	0.32%	0.21'	OK
110	1.3	100% (N) = 1.3	0.32%	0.23'	OK
109	1.5	80% (W) = 1.2	0.32%	0.22'	OK
		20% (E) = 0.3	0.32%	0.15'	OK
108	2.9	70% (W) = 2.0	0.32%	0.27'	OK
		30% (N) = 0.9	0.32%	0.20'	OK
107	1.6	100% (N) = 1.6	0.32%	0.25'	OK
106	1.4	75% (W) = 1.1	0.32%	0.22'	OK
		25% (E) = 0.3	0.32%	0.15'	OK
105	7.7	90% (N) = 6.9	0.32%	0.43'	OK
		10% (S) = 0.8	0.32%	0.19'	OK
104	4.9	80% (N) = 3.9	0.32%	0.35'	OK
		20% (S) = 1.0	0.32%	0.21'	OK
103	0.9	100% (W) = 0.9	0.32%	0.20'	OK
102	2.2	50% (N) = 1.1	0.32%	0.22'	OK
		50% (S) = 1.1	0.32%	0.22'	OK
101	1.6	100% (N) = 1.6	0.32%	0.25'	OK

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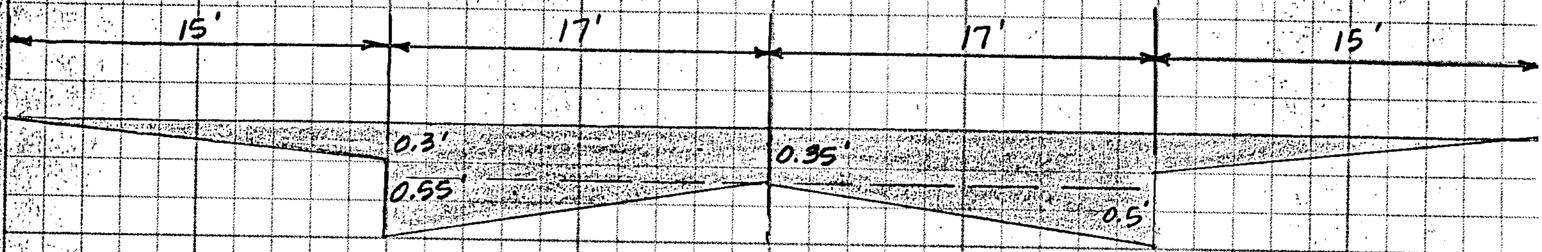
Item Drainage Plan - System 100

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



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

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

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

$$n = 1.4413 / 65.1 = 0.0221$$

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

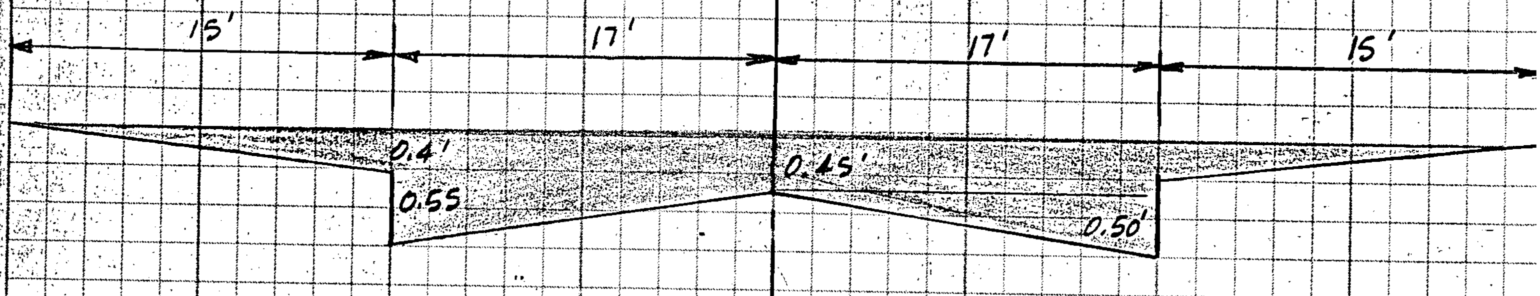
$$p = (2 \times 15) + (2 \times 17) + (2 \times 0.55)$$
$$= 65.1'$$

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

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

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

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



n: 0.0221 (see previous sheet)

A = 2(½ × 15' × 0.4') + (34 × 0.45') + 2(½ × 17 × 0.5')
= 29.8 SF

P = 65.1'

R = A/P = 29.8/65.1 = 0.4577

$R^{2/3}$ = 0.594

$Q = \frac{1.486}{0.0221} \times 29.8 \times 0.594 \times s^{1/2}$

$Q = 1,190.2\ s^{1/2}$

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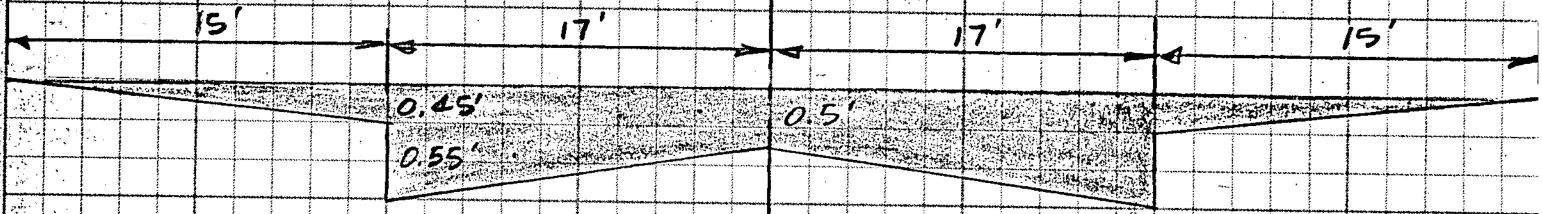
Item Drainage Plan - System 100

(Walk Grade = 0.45')



n: 0.0221 (see previous sheet)

$A = 2(\frac{1}{2} \times 15' \times 0.45') + (34' \times 0.5) + 2(\frac{1}{2} \times 17' \times 0.5')$

$= 32.25$ SF

$p = 65.1$

$R = A/p = 32.25/65.1 = 0.4954$

$R^{2/3} = 0.626$

$Q = \frac{1.486}{n} A R^{2/3} s^{1/2}$

$= \frac{1.486}{0.0221} \times 32.25 \times 0.626 \times s^{1/2}$

$Q = 1357.5 \; s^{1/2}$

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Item Drainage Plan - System 100

1. Check Street Flow Approaching Nodes 115 - 116

Q_{100}: Node 116 = 16.1 cfs
115 = 23.7
39.8

Q_2 (pipe) = 0

$Q_{street} = Q_{100} - Q_2 = 39.8 - 0 = 39.8$

$Q_{max} = 882^{.3} \times s^{1/2}$
= 49.9 cfs

Street Flow OK
(Use 0.3 Walk Gr.)

2. Check Street Flow Approaching Nodes 114 113

Q_{100}: Node

116	16.1 cfs
115	23.7
114	30% × 19.5 = 5.9
113	8.3
	54 cfs

Q_2 (pipe) 113-113 = 14.9

$Q_{street} = Q_{100} - Q_{2\,pipe} = 54.0 - 14.9 = 39.1$ cfs

Q_{max} = 49.9

Street Flow OK
(Use 0.3 Walk Gr.)

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Item Drainage Plan - System 100

3. Check Street Flow Approaching Nodes 109-112

Q_{100}:	Node		
		116	16.1 cfs
		115	23.7
		114	19.5
		113	8.3
		112	1.0
		111	80% x 8.4 = 6.7
		109	80% x 3.8 = 3.0
			78.3

Q_2 pipe (112-109) = 25.3

$Q_{street} = Q_{100} - Q_2 = 78.3 - 25.3 = 53.0$ cfs

$Q_{max} = 1,190.2\ s^{1/2}$

w/ $s = 0.32\%$, $Q_{max} = 67.3$

Street Flow OK

(Use 0.4 Walk Gr)

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Project Amarado 3rd

Item Drainage Plan System 100

4. Check Street Flow Approaching Node 108

Q_{100} :

	Node	
	116	16.1 cfs
	115	23.7
	114	19.5
	113	8.3
	112	1.0
	111	13.4
	110	3.4
	109	3.8
	108	8.4
		97.6

$Q_{2\ (pipe)\ 109\text{-}106} = 32.5$

$Q_{street} = Q_{100} - Q_2 = 97.6 - 32.5 = 65.1$

$Q_{max} = 67.3$

Street Flow OK
(Use 0.4 Walk Gr)

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5. Check Street Flow Approaching Node 102-101 (W)

Q_{100}: Node

Node	Flow
116	16.1 cfs
115	23.7
114	19.5
113	8.3
112	1.0
111	13.4
110	3.4
109	3.8
108	8.4
107	4.6
106	4.0
103	2.5
102	50% × 6.4 = 3.2
101	30% × 3.9 = 1.2
	113.1 cfs

Q_2 (pipe) 103-101 = 38.5

$Q_{street} = Q_{100} - Q_2 = 113.1 - 38.5 = 74.6$ cfs

$Q_{max} = 1357.5\ s^{1/2}$
w/ s = 0.32%, Q_{max} = 76.8 cfs

Street Flow OK
(Use 0.45' WalkGr)

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Project Amarado 3rd

Item Drainage Plan System 100

6. Check Street Flow Approaching Nodes 105-104

Q_{100}: Node 105 21.7 cfs
104 13.8
35.5 cfs

$Q_2 = 0$

$Q_{street} = Q_{100} - Q_2 = 35.5 - 0 = 35.5$ cfs

$Q_{max} = 49.9$ cfs

Street Flow OK
(Use 0.3' Walk Gr

7. Check Street Flow Approaching Nodes 102-101 (N)

Q_{100}: Nodes 105 21.7 cfs
104 13.8
102 50% × 6.4 = 3.2
101 70% × 3.9 = 2.7
41.4 cfs

$Q_{2(pipe)}$ = 12.6
104-101

$Q_{street} = Q_{100} - Q_2 = 41.4 - 12.6 = 28.8$ cfs

$Q_{max} = 49.9$

Street Flow OK
(Use 0.3' Wlk Gr)

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Date Feb. 13, 1987

Project Amarado 3rd Addition

Item Drainage Plan - System 100

Check Pipe Size Needed For Q_{100} At Outfall:

Q_{100} = 154.5 cfs

HGL @ Channel = 152.9

HGL @ Street = ℄ = 154.35

Hydraulic Slope = $\frac{154.35 - 152.9}{180}$ = 0.8%

Option 1 42" (Needed For 2-yr) Q_{pipe} = 87 cfs

Option 2 48" Q_{pipe} = 124 cfs

Option 3 54" Q_{pipe} = 170 cfs

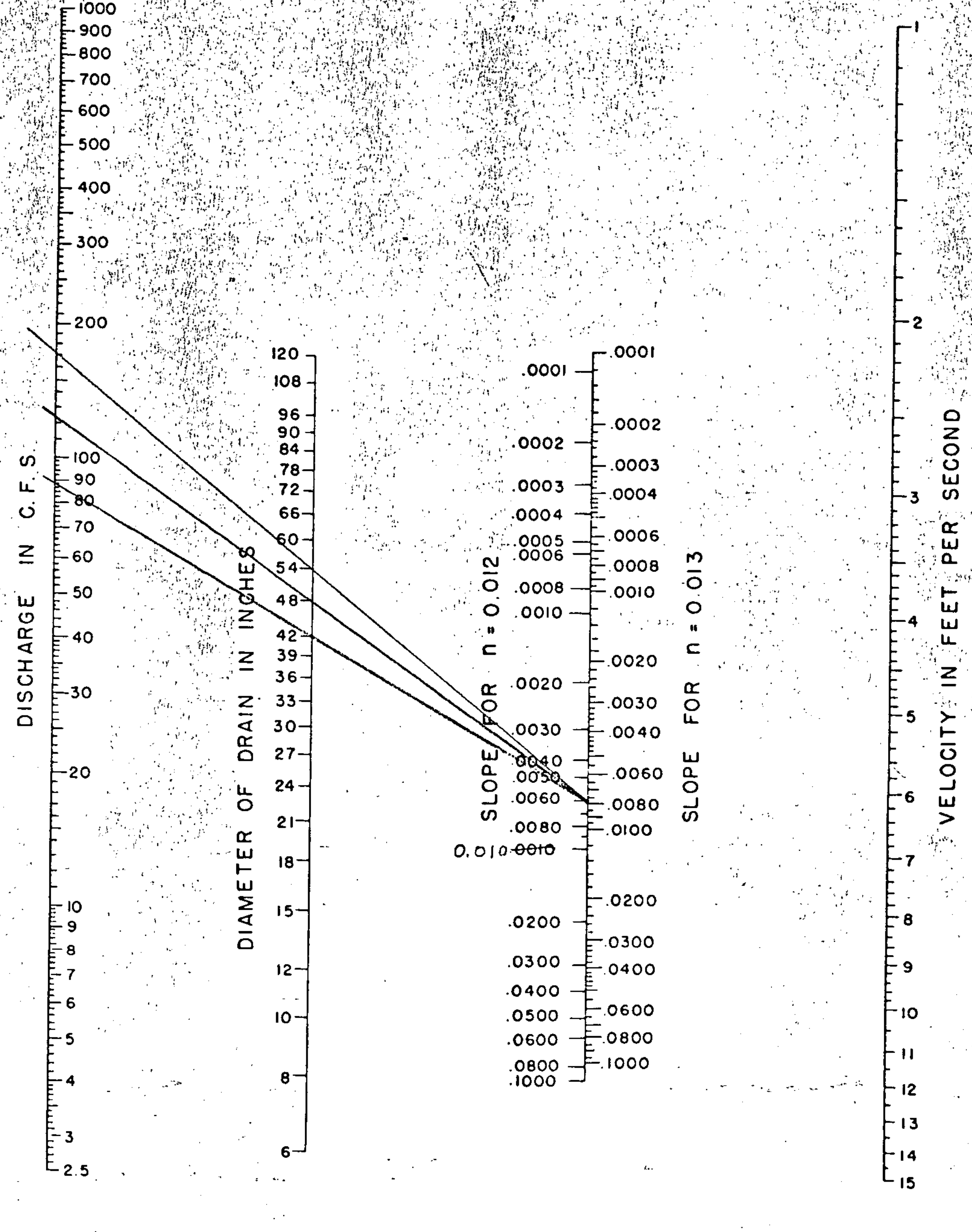
A small amount of overland flow is acceptable during 100-year storm. Therefore, OPTION 2 is selected:

Q_{pipe} = 124 cfs (48" RCP)

$Q_{overflow\ swale}$ = 154.5 - 124 = 30.5 cfs

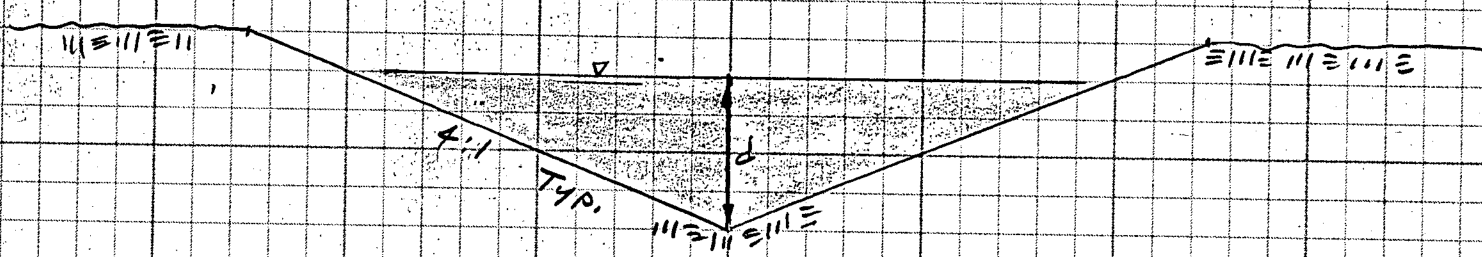
Inlets @ Nodes 102 + 101 sized to handle

124 - 38.5 (Q[illegible]) - 12.6 (Q[illegible]) = 75.9 c[illegible]



Nomograph for computing required size of circular drain, flowing full - n = 0.012 OR 0.013

Overflow Swale $Q = 30.5$ cfs



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

$Q = 30.5$
$n = 0.03$
$s = 0.8\%$

$AR^{2/3} = \frac{Q \times n}{1.486 \times s^{1/2}} = \frac{30.5 \times 0.03}{1.486 \times 0.008^{1/2}} = \frac{0.915}{0.132912} = 6.88$

d	A	P	R	$R^{2/3}$	$AR^{2/3}$
1.0'	4.00	8.25	0.49	0.62	2.47
1.1'	4.84	9.07	0.53	0.66	3.18
1.2'	5.76	9.90	0.58	0.70	4.02
1.3'	6.76	10.72	0.63	0.74	4.97
1.4'	7.84	11.54	0.68	0.77	6.06
1.5'	9.00	12.37	0.73	0.81	7.28 ←

USE $d = 1.5'$ $V = Q/A = 30.5/9 = 3.4$ fps.

Project Amarado 3rd Addition

Item Drainage Plan - System 100

Inlet sizing (Nodes 102 & 101)

Q = 75.9 cfs

Q_{max} (10' inlet) = 28 cfs (2.8 cfs / Ft)

Q_{max} (5' inlet) = 14 cfs (2.8 cfs / Ft)

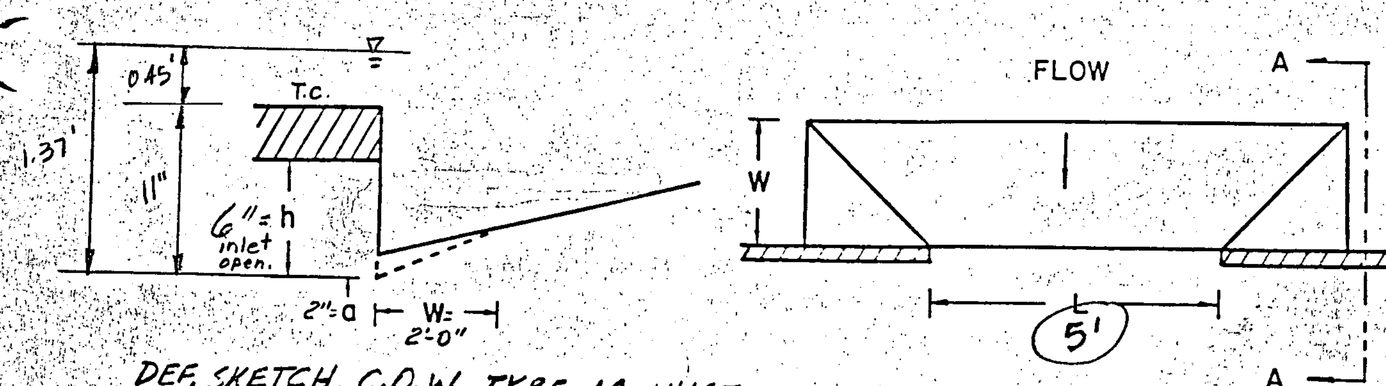
(assumes ponding elev. to TC + 0.45')

Total Length of Inlets Needed = 75.9 cfs / 2.8 cfs/Ft = 27.1'

Use 2 - 15' Special Curb Inlets

OR

3 - 10' Type 1A Curb Inlets.



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

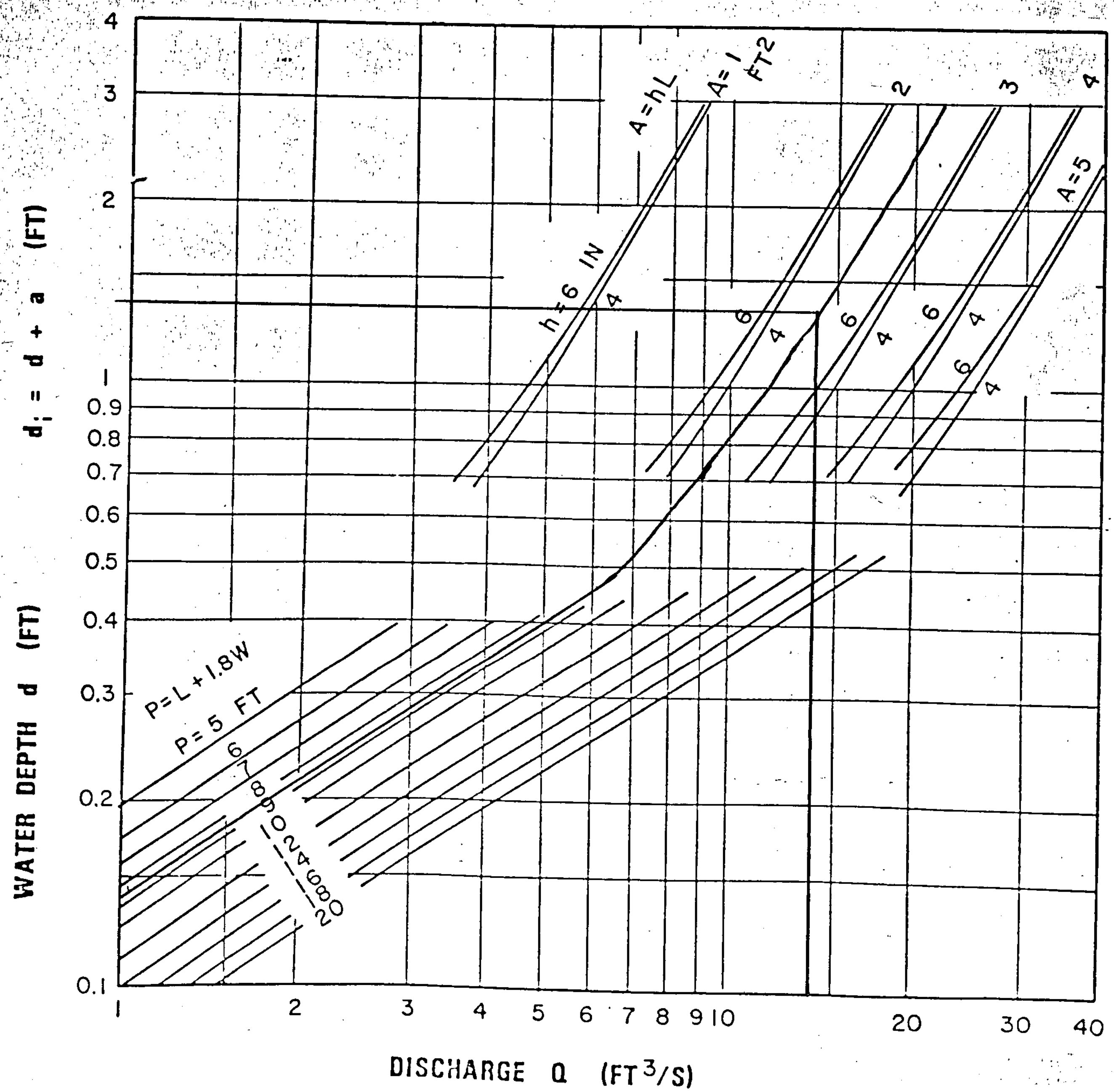
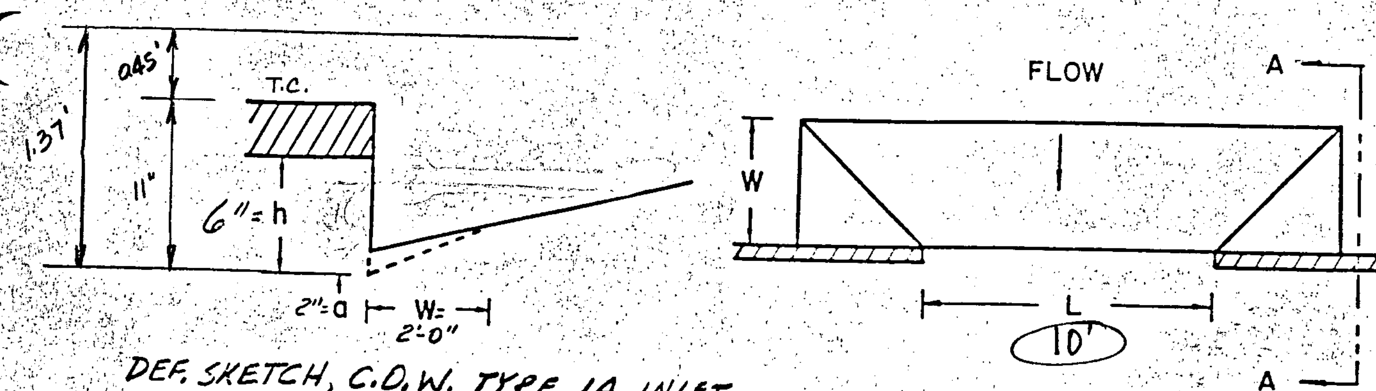


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, Drainage of Highway Pavements, F.H.W.A., MAR., 1984



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

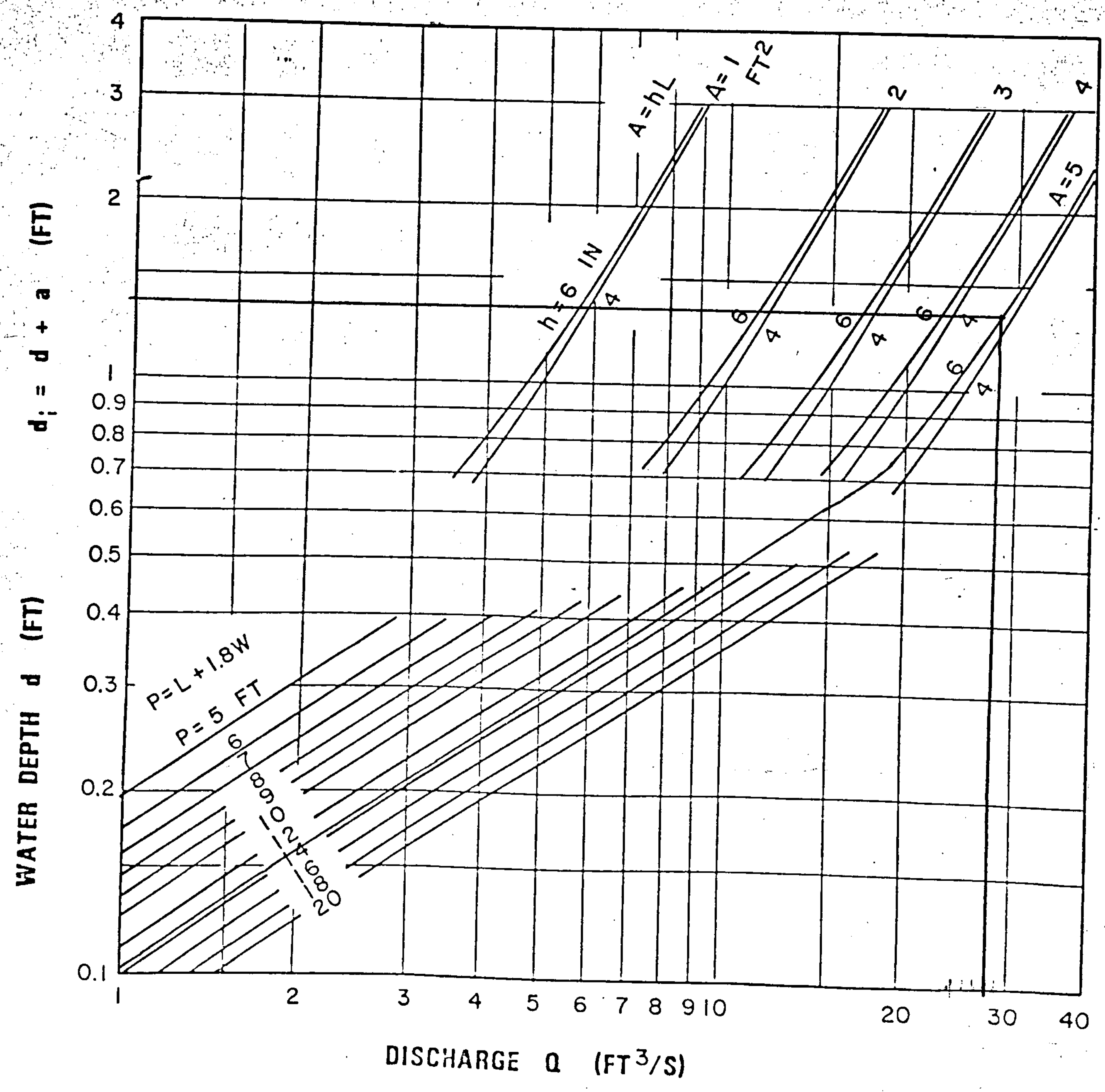


CHART 12. Depressed curb-opening inlet capacity in sump locations.

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

```
100 j,  149.9000  100   3  17  16
110 t,amarado 3rd addition
120 t,drainage plan
130 t,2 year storm analysis
140 i,  116    0.44    3.58    0.00    0.00    6.00   15.00   157.10
150 i,  115    0.44    5.28    0.00    0.00    8.90   15.00   157.10
160 i,  114    0.44    4.34    0.00    0.00    7.30   15.00   155.40
170 i,  113    0.44    1.84    0.00    0.00    3.10   15.00   155.40
180 i,  112    0.44    0.23    0.00    0.00    0.30   15.00   155.10
190 i,  111    0.44    2.98    0.00    0.00    5.00   15.00   154.40
200 i,  110    0.44    0.76    0.00    0.00    1.30   15.00   154.70
210 i,  109    0.44    0.85    0.00    0.00    1.50   15.00   154.40
220 i,  108    0.48    1.57    0.00    0.00    2.90   15.00   154.30
230 i,  107    0.50    0.83    0.00    0.00    1.60   15.00   154.10
240 i,  106    0.44    0.83    0.00    0.00    1.40   15.00   154.10
250 i,  105    0.47    4.26    0.00    0.00    7.70   15.00   153.90
260 i,  104    0.47    2.71    0.00    0.00    4.90   15.00   153.90
270 i,  103    0.50    0.45    0.00    0.00    0.60   15.00   154.10
280 i,  102    0.50    1.15    0.00    0.00    2.20   15.00   153.90
290 i,  101    0.50    0.69    0.00    0.00    1.60   15.00   153.90
300 m,  100  149.90
310 p,  116  115   38.00   18 0.013 120.00   0.00
320 p,  115  113  280.00   24 0.013  20.00   0.00
330 p,  114  113   38.00   18 0.013  90.00   0.00
340 p,  113  112  180.00   30 0.013  20.00   0.00
350 p,  112  109  210.00   36 0.013   0.00   0.00
360 p,  110  111   90.00   15 0.013  90.00   0.00
370 p,  111  109   38.00   24 0.013  90.00   0.00
380 p,  109  106  430.00   36 0.013  10.00   0.00
390 p,  108  107   90.00   15 0.013  90.00   0.00
400 p,  107  106   38.00   18 0.013  90.00   0.00
410 p,  106  103  240.00   42 0.013  50.00   0.00
420 p,  103  101   70.00   42 0.013  60.00   0.00
430 p,  102  101   38.00   15 0.013   0.00   0.00
440 p,  105  104   38.00   18 0.013  90.00   0.00
450 p,  104  101  350.00   24 0.013  70.00   0.00
460 p,  101  100  170.00   42 0.013  90.00   0.00
470 e
```

Date: 02-12-1987
Time: 09:33:30

Input File: rado100

amarado 3rd addition
drainage plan
2 year storm analysis

Storm Frequency = 2-Year

* * * HYDROLOGY * * *

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)
116	115	0.44	3.58	0.00	0.0	15.00	4.06	6.00	15.00	4.06	6.00	6.00	18"	3.40	38.00	0.19	15.19
115	113	0.44	5.28	0.00	0.0	15.00	4.06	8.90	15.19	4.04	8.86	14.86	24"	4.73	280.00	0.99	16.17
114	113	0.44	4.34	0.00	0.0	15.00	4.06	7.30	15.00	4.06	7.30	7.30	18"	4.13	38.00	0.15	15.15
113	112	0.44	1.84	0.00	0.0	15.00	4.06	3.10	16.17	3.94	3.01	24.98	30"	5.09	180.00	0.59	16.76
112	109	0.44	0.23	0.00	0.0	15.00	4.06	0.30	16.76	3.89	0.29	25.27	36"	3.58	210.00	0.98	17.74
110	111	0.44	0.76	0.00	0.0	15.00	4.06	1.30	15.00	4.06	1.30	1.30	15"	1.06	90.00	1.42	16.42
111	109	0.44	2.98	0.00	0.0	15.00	4.06	5.00	15.00	4.06	5.00	6.19	24"	1.97	38.00	0.32	15.32
109	106	0.44	0.85	0.00	0.0	15.00	4.06	1.50	17.74	3.80	1.40	32.52	36"	4.60	430.00	1.56	19.30
108	107	0.48	1.57	0.00	0.0	15.00	4.06	2.90	15.00	4.06	2.90	2.90	15"	2.36	90.00	0.63	15.63
107	106	0.50	0.83	0.00	0.0	15.00	4.06	1.60	15.63	3.99	1.57	4.47	18"	2.53	38.00	0.25	15.88
106	103	0.44	0.83	0.00	0.0	15.00	4.06	1.40	19.30	3.68	1.27	37.94	42"	3.94	240.00	1.01	20.31
103	101	0.50	0.45	0.00	0.0	15.00	4.06	0.60	20.31	3.61	0.53	38.47	42"	4.00	70.00	0.29	20.61
102	101	0.50	1.15	0.00	0.0	15.00	4.06	2.20	15.00	4.06	2.20	2.20	15"	1.79	38.00	0.35	15.35
105	104	0.47	4.26	0.00	0.0	15.00	4.06	7.70	15.00	4.06	7.70	7.70	18"	4.36	38.00	0.15	15.15
104	101	0.47	2.71	0.00	0.0	15.00	4.06	4.90	15.15	4.04	4.88	12.58	24"	4.00	350.00	1.46	16.60
101	100	0.50	0.69	0.00	0.0	15.00	4.06	1.60	20.61	3.59	1.41	53.41	42"	5.55	170.00	0.51	21.12

Date: 02-12-1987
Time: 09:33:30

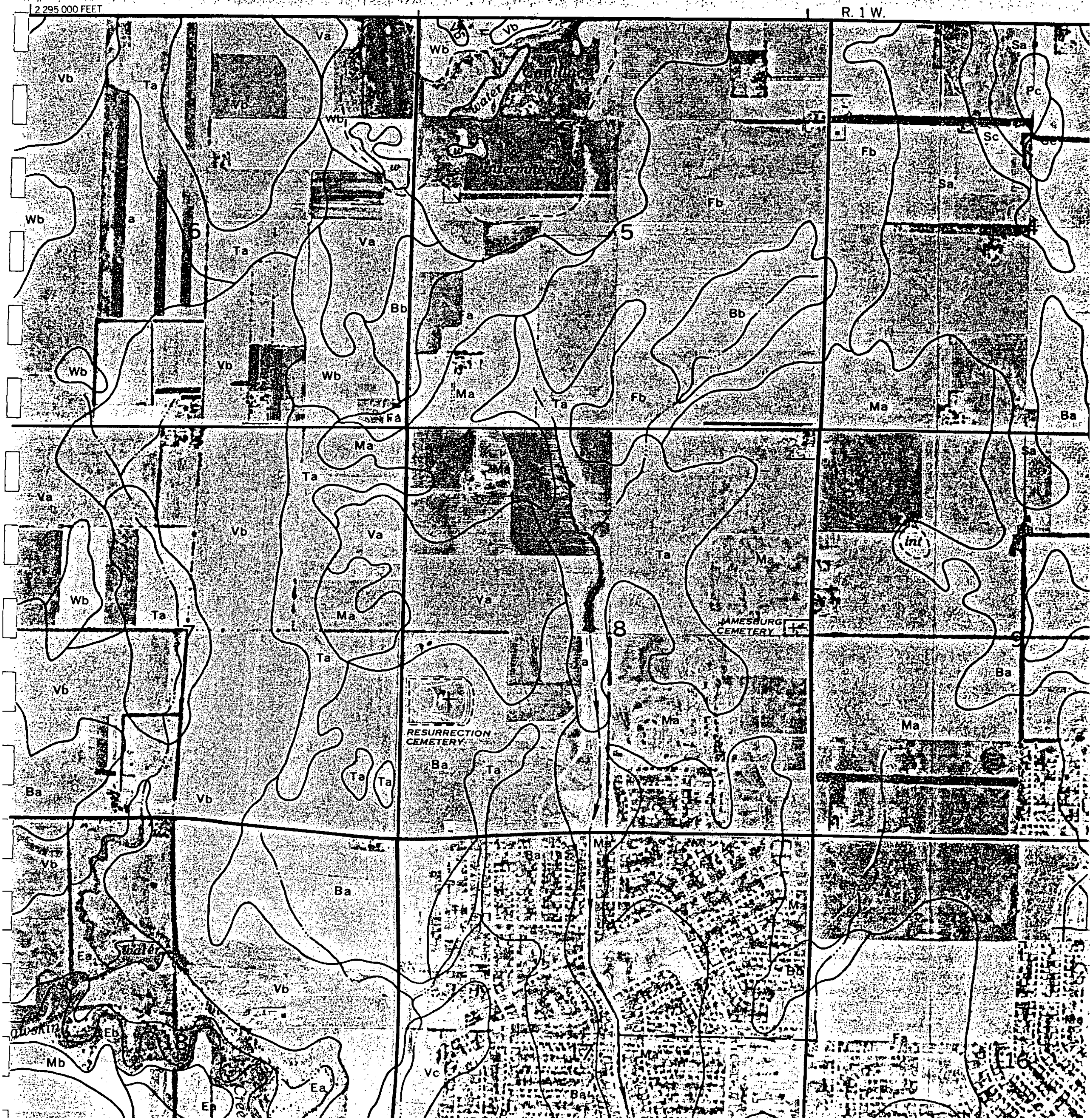
Input File: rado100

amarado 3rd addition
drainage plan
2 year storm analysis

Storm Frequency = 2-Year

*** HYDRAULICS ***

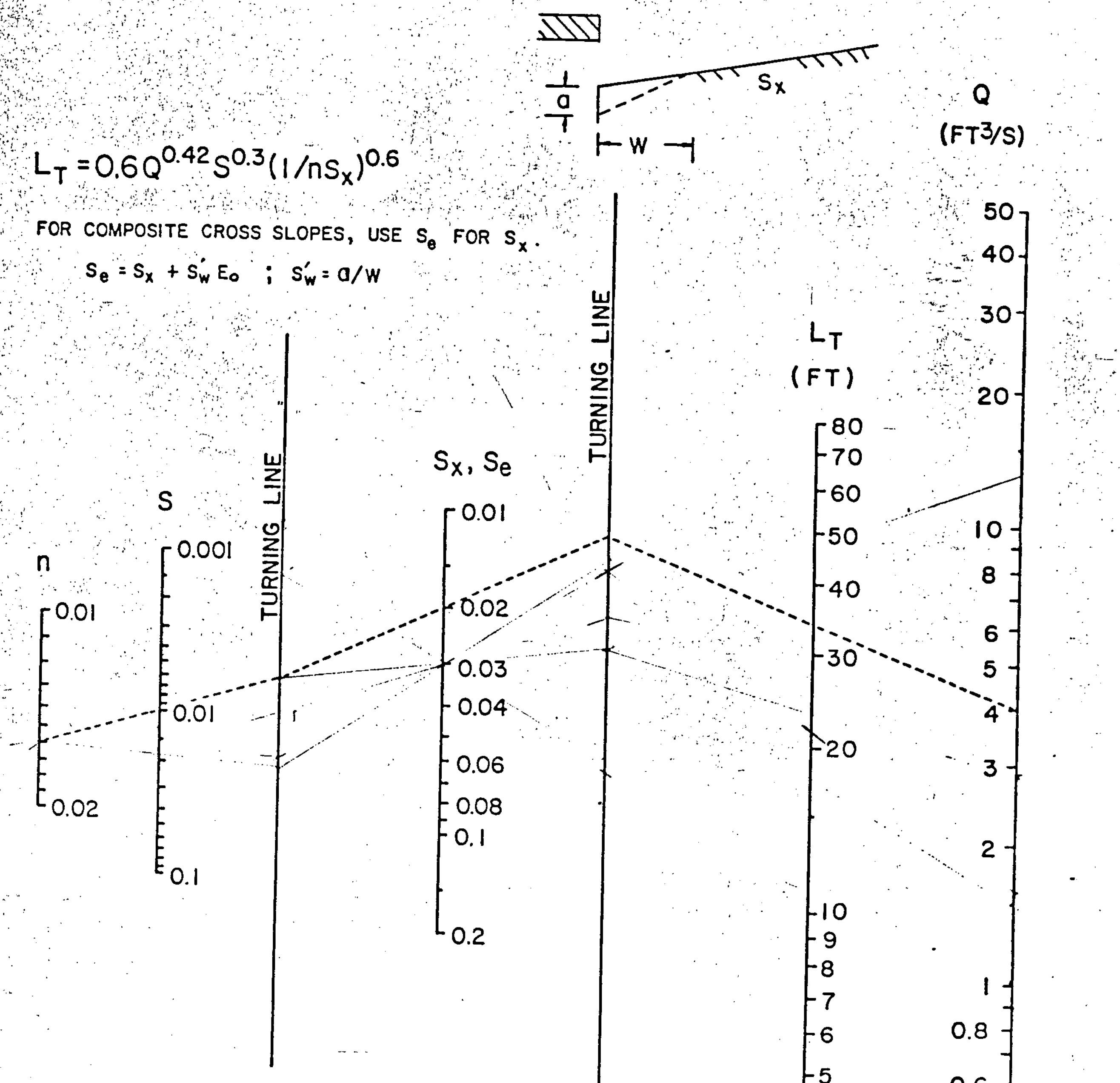
Node	Hyd-Slope (Ft/Ft)	Friction (Ft)	Bend (Ft)	Transition (Ft)	Manhole (Ft)	Deflection (Ft)	Junction (Ft)	Total (Ft)	Hyd-Gl Elevation	Desired Elevation	Diff. (Ft)
116	0.00326	0.1240	0.0000	0.0000	0.0000	0.0000	0.0000	0.1240	156.2361	157.1000	0.86
115	0.00431	1.2077	0.0000	0.0168	0.0000	0.1264	0.6514	2.0023	156.1121	157.1000	0.99
114	0.00483	0.1835	0.0000	0.0000	0.0000	0.0000	0.0000	0.1835	154.2933	155.4000	1.11
113	0.00371	0.6678	0.0000	0.0055	0.0000	0.0286	0.4599	1.1618	154.1098	155.4000	1.29
112	0.00144	0.3015	0.0000	0.0408	0.0000	0.0331	-0.1784	0.1970	152.9480	155.1000	2.15
111	0.00075	0.0284	0.0000	0.0043	0.0000	0.0087	0.1569	0.1983	152.9493	154.4000	1.45
110	0.00040	0.0364	0.0000	0.0000	0.0000	0.0000	0.0000	0.0364	152.9858	154.7000	1.71
109	0.00238	1.0222	0.0000	0.0130	0.0000	0.0000	0.2704	1.3057	152.7511	154.4000	1.65
108	0.00202	0.1814	0.0000	0.0000	0.0000	0.0000	0.0000	0.1814	151.8430	154.3000	2.46
107	0.00181	0.0689	0.0000	0.0013	0.0000	0.0434	0.1026	0.2162	151.6616	154.1000	2.44
106	0.00142	0.3412	0.0000	0.0174	0.0000	0.0118	0.0094	0.3798	151.4454	154.1000	2.65
105	0.00537	0.2042	0.0000	0.0000	0.0000	0.0000	0.0000	0.2042	152.5600	153.9000	1.34
104	0.00309	1.0826	0.0000	0.0092	0.0000	0.1474	0.2346	1.4738	152.3558	153.9000	1.54
103	0.00146	0.1023	0.0000	0.0007	0.0000	0.0596	0.0209	0.1836	151.0656	154.1000	3.03
102	0.00116	0.0441	0.0000	0.0000	0.0000	0.0000	0.0000	0.0441	150.9261	153.9000	2.97
101	0.00282	0.4791	0.0000	0.0230	0.0000	0.0763	0.4036	0.9820	150.8820	153.9000	3.02
100	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	149.9000	149.9000	0.00


2 295 000 FEET
R. 1 W.
Vb
Ta
Va
Wb
Fb
Sa
Pc
Sc
Bb
Ma
Ba
Fa
6
5
8
9
18
17
16
int
JAMESBURG
CEMETERY
RESURRECTION
CEMETERY
water
Ea
Eb
Mb
Vc
Creek

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

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, FHWA, Mar. 1984.

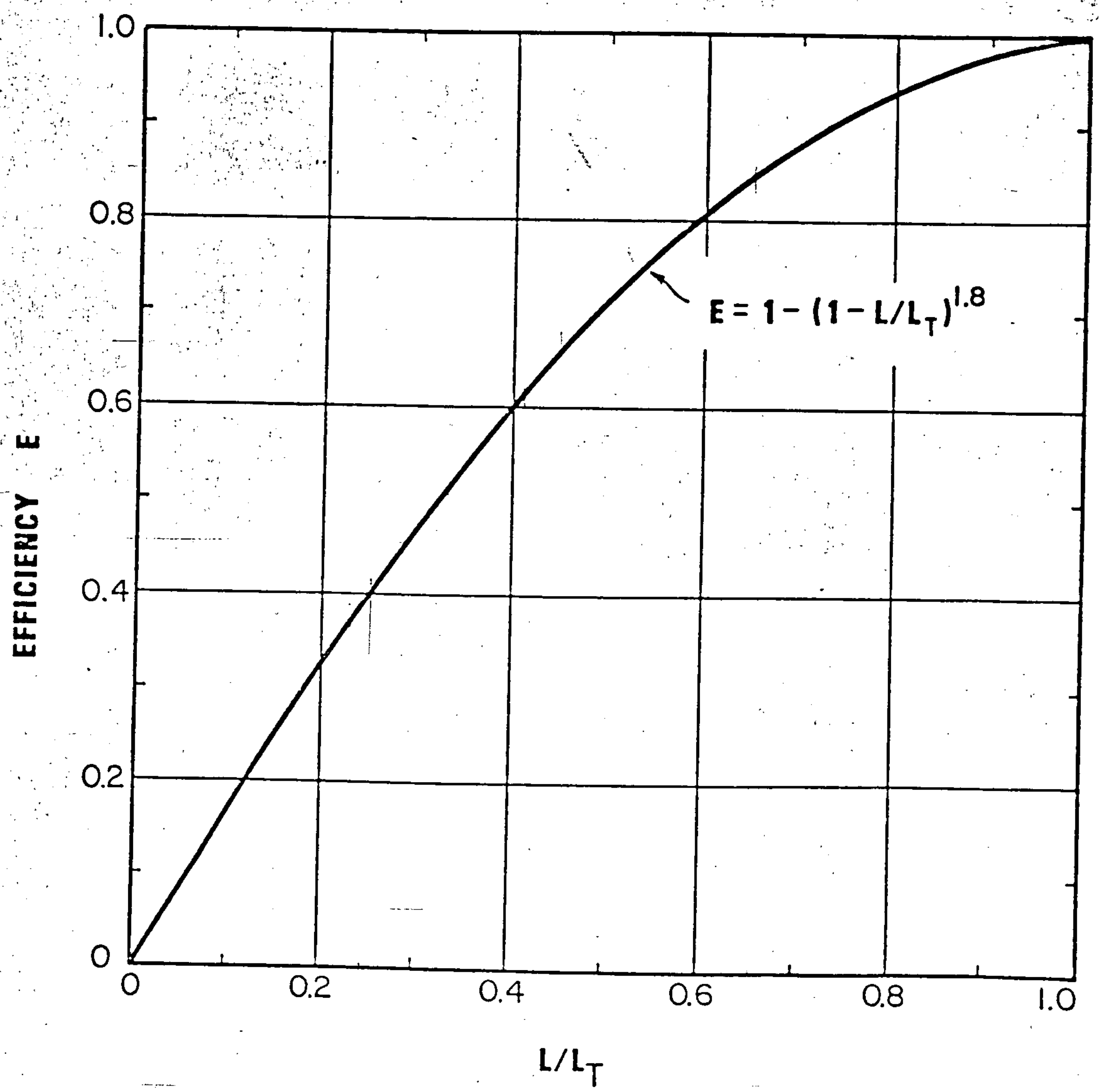
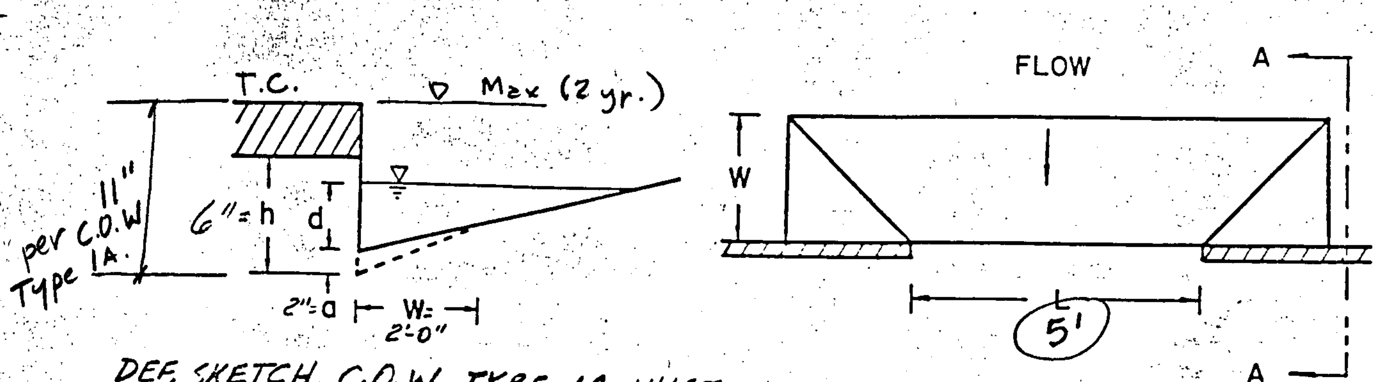


CHART 10. Curb-opening and slotted drain inlet interception efficiency.

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



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

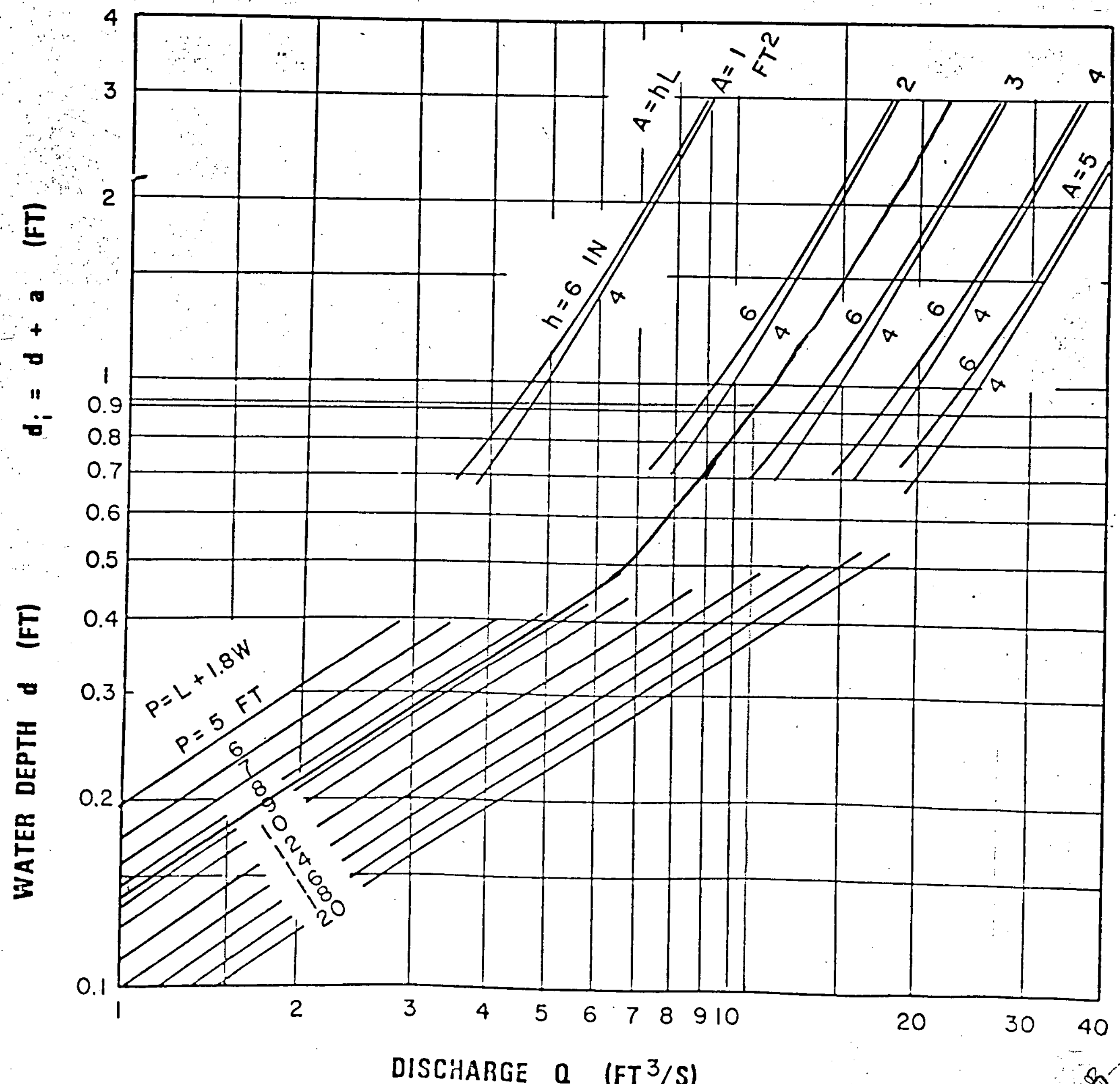


CHART 12. Depressed curb-opening inlet capacity in sump locations.

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

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

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

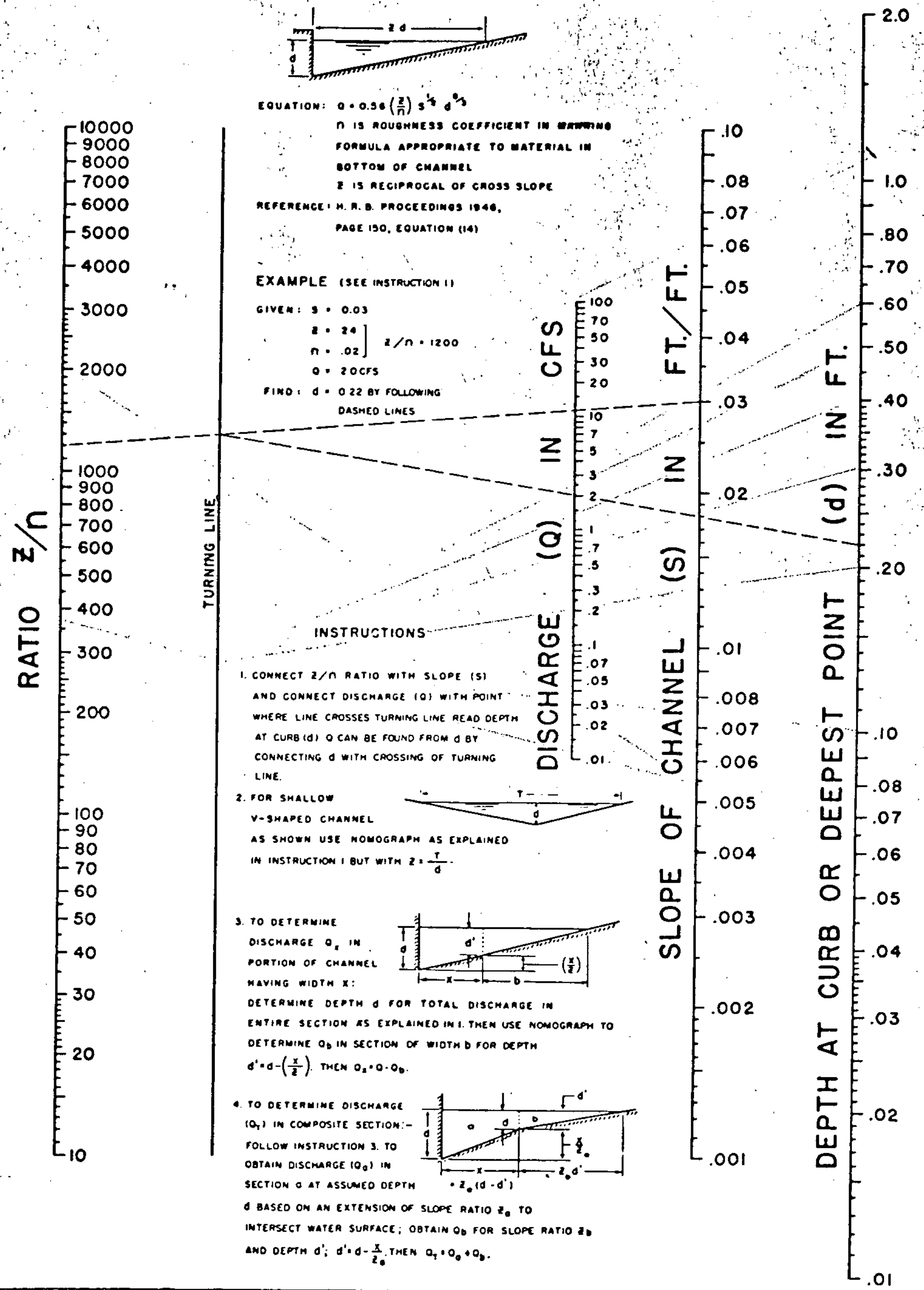
DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	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

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

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

Chart 1



EQUATION: $Q = 0.56 \left(\frac{z}{n}\right) S^{1/2} d^{8/3}$

n IS ROUGHNESS COEFFICIENT IN MANNING FORMULA APPROPRIATE TO MATERIAL IN BOTTOM OF CHANNEL

z IS RECIPROCAL OF CROSS SLOPE

REFERENCE: H. R. B. PROCEEDINGS 1946, PAGE 150, EQUATION (14)

EXAMPLE (SEE INSTRUCTION 1)

GIVEN: $S = 0.03$

$z = 24$, $n = .02$] $z/n = 1200$

$Q = 2.0$ CFS

FIND: $d = 0.22$ BY FOLLOWING DASHED LINES

INSTRUCTIONS

1. CONNECT z/n RATIO WITH SLOPE (S) AND CONNECT DISCHARGE (Q) WITH POINT WHERE LINE CROSSES TURNING LINE READ DEPTH AT CURB (d). Q CAN BE FOUND FROM d BY CONNECTING d WITH CROSSING OF TURNING LINE.

2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH AS EXPLAINED IN INSTRUCTION 1 BUT WITH $z = \frac{T}{d}$.

3. TO DETERMINE DISCHARGE Q_x IN PORTION OF CHANNEL HAVING WIDTH x: DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION AS EXPLAINED IN 1. THEN USE NOMOGRAPH TO DETERMINE Q_b IN SECTION OF WIDTH b FOR DEPTH $d' = d - \left(\frac{x}{z}\right)$. THEN $Q_x = Q - Q_b$.

4. TO DETERMINE DISCHARGE (Q_T) IN COMPOSITE SECTION:– FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE (Q_a) IN SECTION a AT ASSUMED DEPTH d BASED ON AN EXTENSION OF SLOPE RATIO z_a TO INTERSECT WATER SURFACE; OBTAIN Q_b FOR SLOPE RATIO z_b AND DEPTH d'; $d' = d - \frac{x}{z_a}$. THEN $Q_T = Q_a + Q_b$.

BUREAU OF PUBLIC ROADS
REV. JAN. 1968

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS