APPENDIX 6

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

Z=RECIPRICAL OF TRANSVERSE SLOPE

n=COEFFICIENT OF ROUGHNESS IN MANNING'S FORMULA

s=GRADE OF CHANNEL IN FT./FT.

y=DEPTH AT CURB OR DEEPEST POINT IN FT.

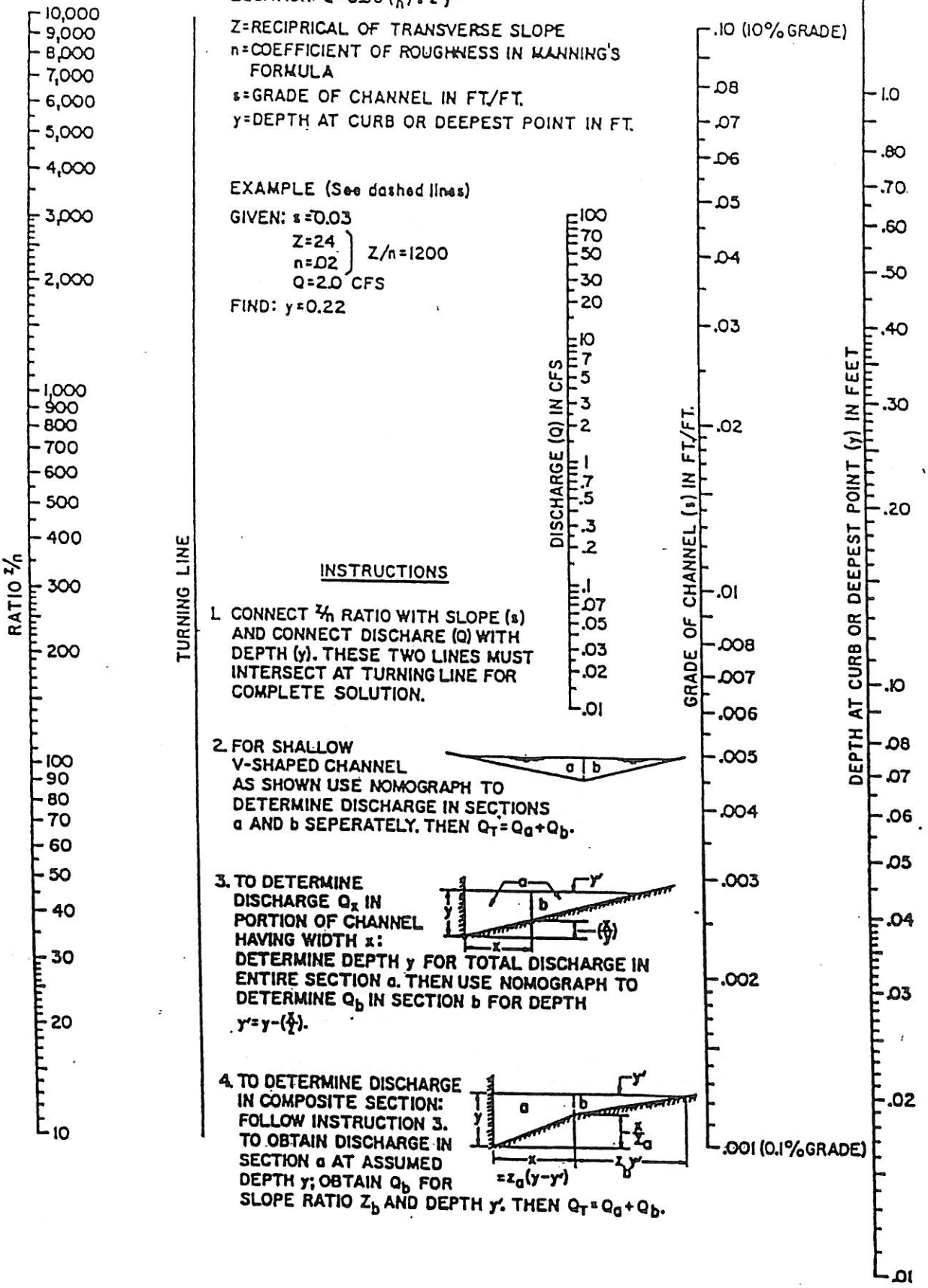
EXAMPLE (See dashed lines)

GIVEN: s=0.03

Z=24, n=.02 } Z/n=1200

Q=2.0 CFS

FIND: y=0.22



INSTRUCTIONS

1. CONNECT z/n RATIO WITH SLOPE (s) AND CONNECT DISCHARE (Q) WITH DEPTH (y). THESE TWO LINES MUST INTERSECT AT TURNING LINE FOR COMPLETE SOLUTION.

2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH TO DETERMINE DISCHARGE IN SECTIONS a AND b SEPERATELY. THEN $Q_T = Q_a + Q_b$.

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

4. TO DETERMINE DISCHARGE IN COMPOSITE SECTION: FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE IN SECTION a AT ASSUMED DEPTH y; OBTAIN Q_b FOR SLOPE RATIO Z_b AND DEPTH y'. THEN $Q_T = Q_a + Q_b$.

City of
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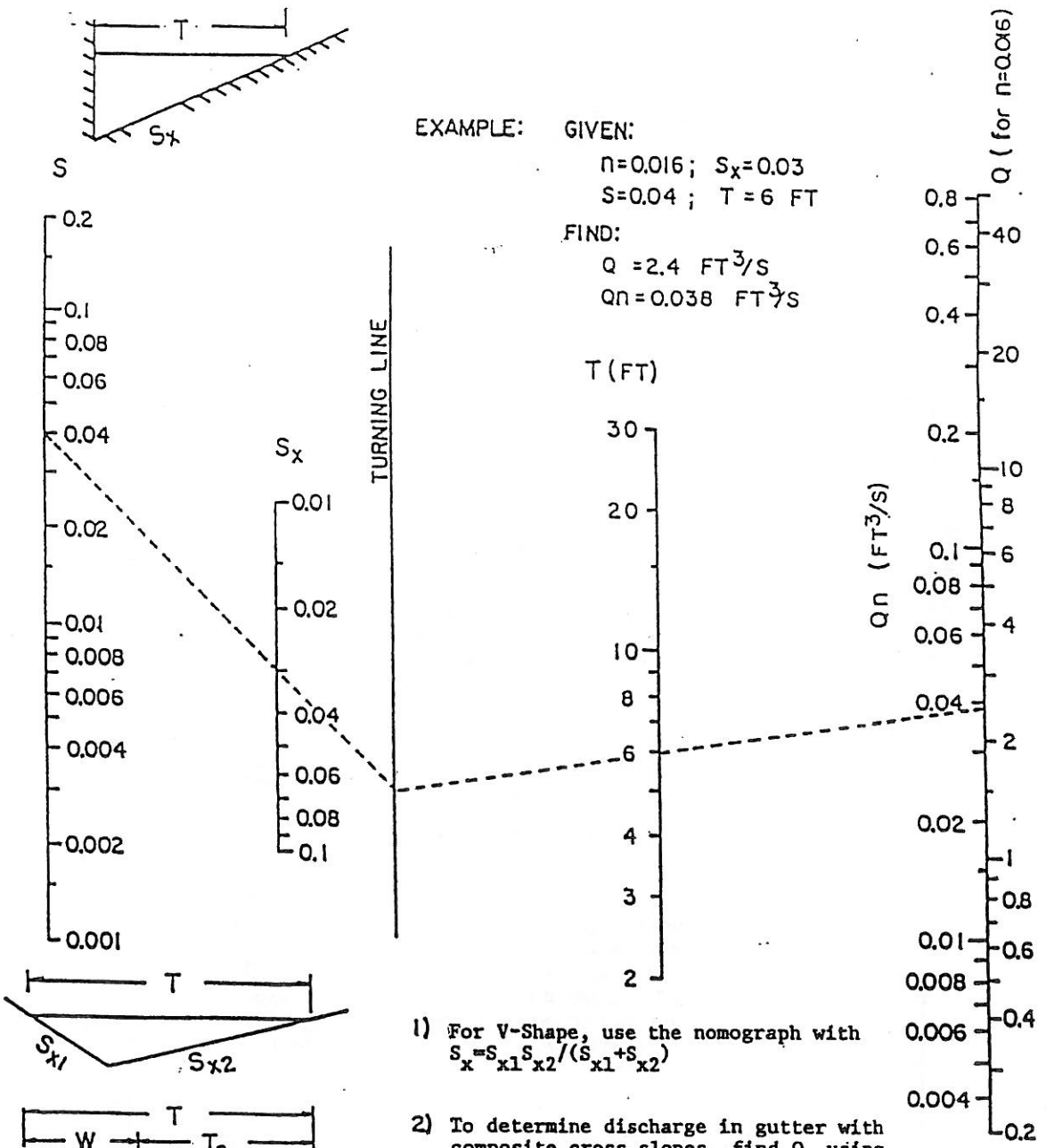
Arkansas

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

Source: AHTD

Figure 6.1

$$Q = \frac{0.56}{n} S_x^{1.67} S^{0.5} T^{2.67}$$



EXAMPLE: GIVEN:

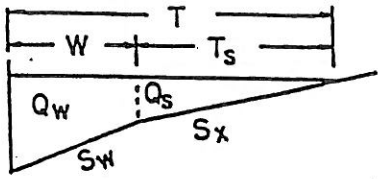
$n = 0.016$; $S_x = 0.03$

$S = 0.04$; $T = 6$ FT

FIND:

$Q = 2.4$ FT^3/S

$Qn = 0.038$ FT^3/S



1) For V-Shape, use the nomograph with $S_x = S_{x1} S_{x2} / (S_{x1} + S_{x2})$

2) To determine discharge in gutter with composite cross slopes, find Q_s using T_s and S_x. Then, use Figure 6.4 to find E_o. The total discharge is $Q = Q_s/(1-E_o)$, and $Q_w = Q - Q_s$.

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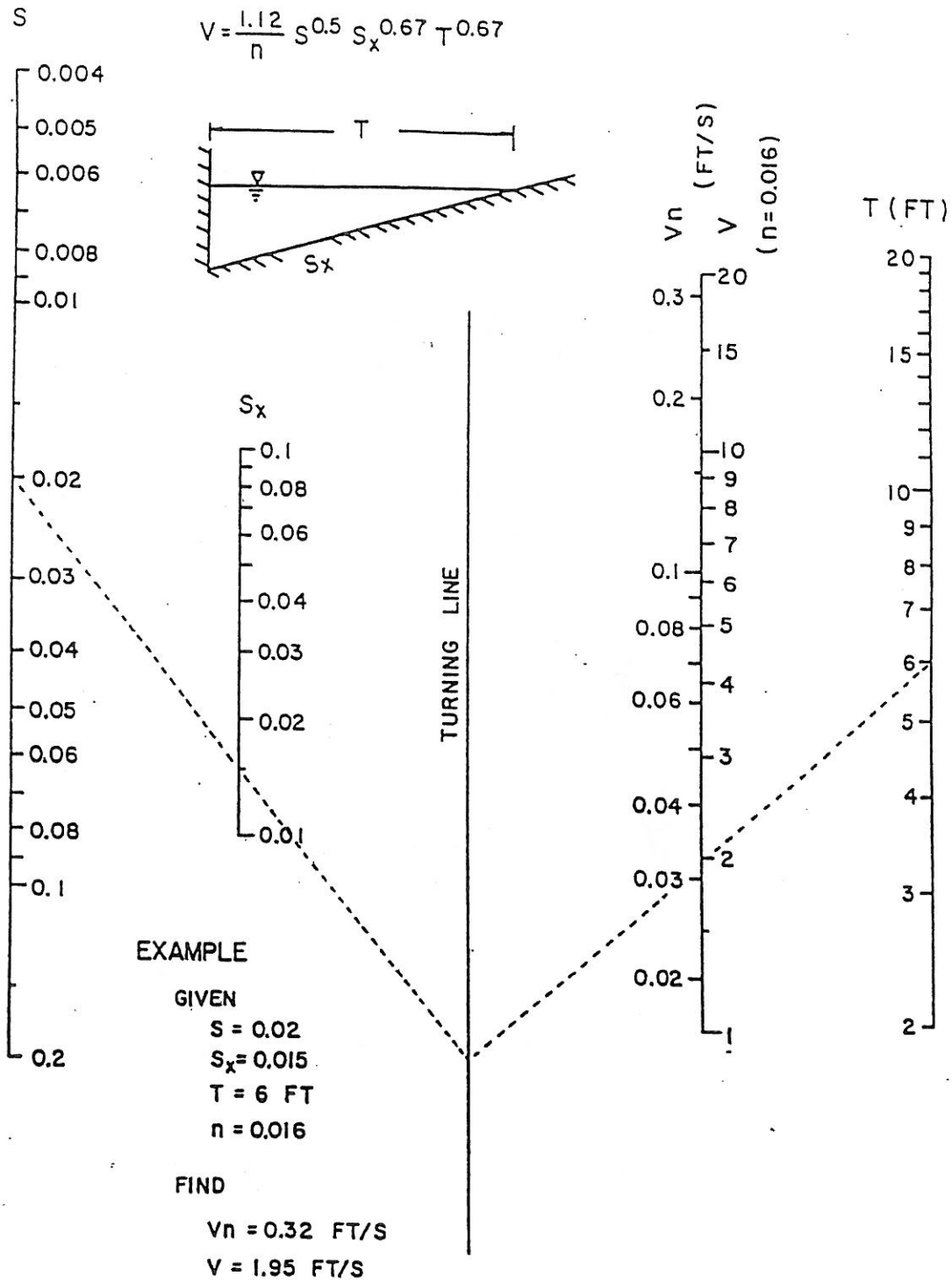
FLOW IN TRIANGULAR GUTTER SECTIONS

Source: Federal Highway Administration
Circular 12 - Figures 6.3 - 6.5

Figure 6.2



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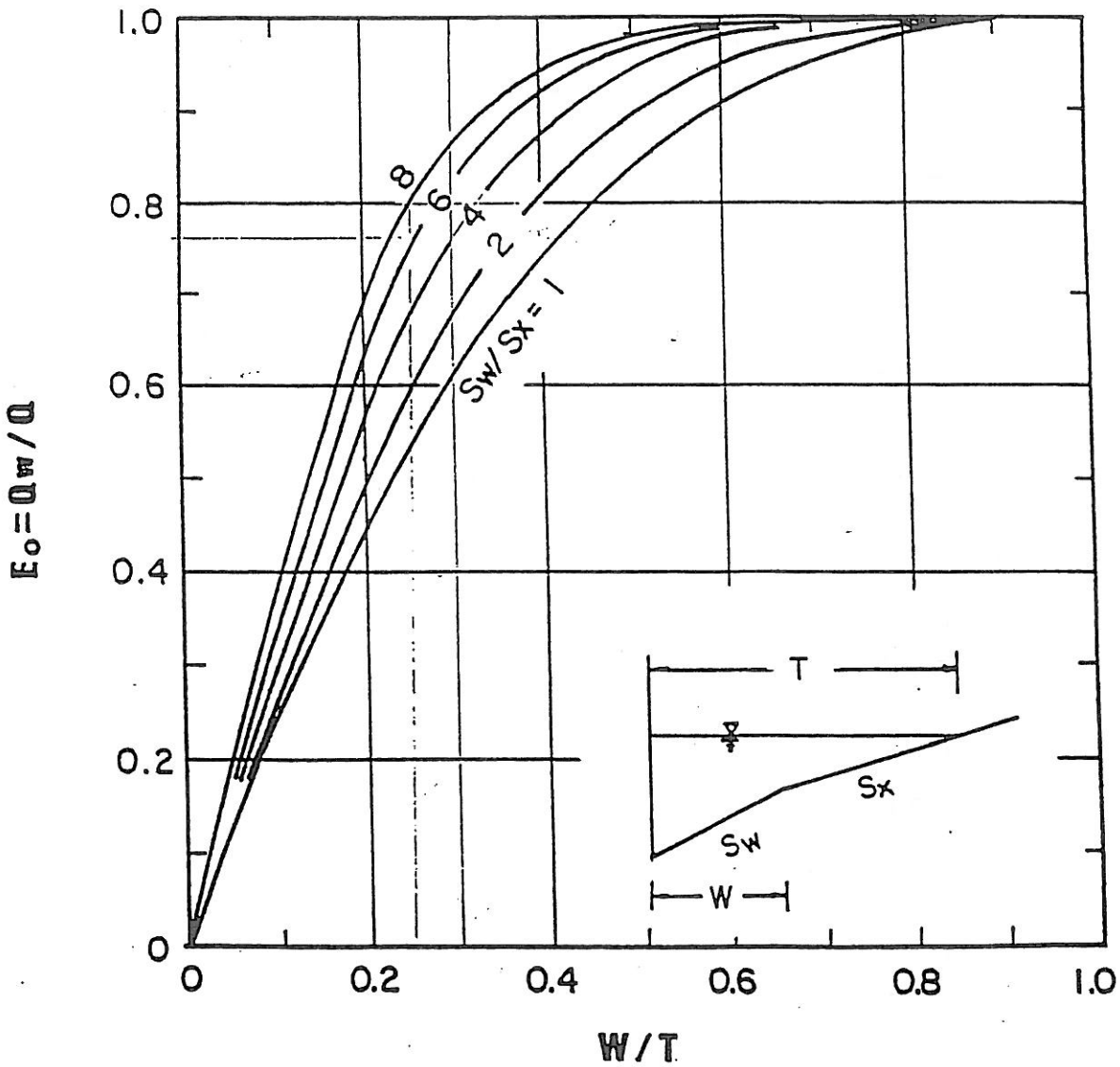
VELOCITY IN TRIANGULAR GUTTER SECTIONS

Figure 6.3



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RATIO OF FRONTAL FLOW TO TOTAL GUTTER FLOW

Figure 6.4

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FLOW IN TRIANGLE CURB SECTIONS AT DIFFERENT STREET SLOPES

FLOW IN TRIANGLE CURB SECTIONS AT DIFFERENT STREET SLOPES

TOTAL FLOW Qt (CFS)	n	RDWY SLOPE S (%)	CROSS SLOPE Sx (%)	PONDED WIDTH T (FT)	DEPTH AT CURB d (FT)	VEL V (FPS)
< 0.50% Street Slope>						
1.0	0.015	0.50%	3.33%	5.8	0.19	1.78
2.0	0.015	0.50%	3.33%	7.5	0.25	2.12
3.0	0.015	0.50%	3.33%	8.8	0.29	2.34
4.0	0.015	0.50%	3.33%	9.8	0.33	2.52
5.0	0.015	0.50%	3.33%	10.6	0.35	2.66
6.0	0.015	0.50%	3.33%	11.4	0.38	2.79
7.0	0.015	0.50%	3.33%	12.0	0.40	2.90
8.0	0.015	0.50%	3.33%	12.7	0.42	3.00
9.0	0.015	0.50%	3.33%	13.2	0.44	3.09
10.0	0.015	0.50%	3.33%	13.8	0.46	3.17
12.5	0.015	0.50%	3.33%	15.0	0.50	3.35
< 1.00% Street Slope>						
1.0	0.015	1.00%	3.33%	5.1	0.17	2.30
2.0	0.015	1.00%	3.33%	6.6	0.22	2.74
3.0	0.015	1.00%	3.33%	7.7	0.26	3.04
4.0	0.015	1.00%	3.33%	8.6	0.29	3.26
5.0	0.015	1.00%	3.33%	9.3	0.31	3.45
6.0	0.015	1.00%	3.33%	10.0	0.33	3.61
7.0	0.015	1.00%	3.33%	10.6	0.35	3.76
8.0	0.015	1.00%	3.33%	11.1	0.37	3.88
9.0	0.015	1.00%	3.33%	11.6	0.39	4.00
10.0	0.015	1.00%	3.33%	12.1	0.40	4.11
17.9	0.015	1.00%	3.33%	15.0	0.50	4.75
< 2.00% Street Slope>						
1.0	0.015	2.00%	3.33%	4.5	0.15	2.99
2.0	0.015	2.00%	3.33%	5.8	0.19	3.56
3.0	0.015	2.00%	3.33%	6.8	0.23	3.94
4.0	0.015	2.00%	3.33%	7.5	0.25	4.23
5.0	0.015	2.00%	3.33%	8.2	0.27	4.47
10.0	0.015	2.00%	3.33%	10.6	0.35	5.32
15.0	0.015	2.00%	3.33%	12.4	0.41	5.90
20.0	0.015	2.00%	3.33%	13.8	0.46	6.34
25.0	0.015	2.00%	3.33%	15.0	0.50	6.70

TOTAL FLOW Qt (CFS)	n	RDWY SLOPE S (%)	CROSS SLOPE Sx (%)	PONDED WIDTH T (FT)	DEPTH AT CURB d (FT)	VEL V (FPS)
< 3.00% Street Slope>						
1.0	0.015	3.00%	3.33%	4.2	0.14	3.48
2.0	0.015	3.00%	3.33%	5.4	0.18	4.14
3.0	0.015	3.00%	3.33%	6.3	0.21	4.58
4.0	0.015	3.00%	3.33%	7.0	0.23	4.92
5.0	0.015	3.00%	3.33%	7.6	0.25	5.21
10.0	0.015	3.00%	3.33%	9.8	0.33	6.20
15.0	0.015	3.00%	3.33%	11.5	0.38	6.86
20.0	0.015	3.00%	3.33%	12.8	0.42	7.38
25.0	0.015	3.00%	3.33%	13.9	0.46	7.80
30.0	0.015	3.00%	3.33%	14.9	0.49	8.17
31.0	0.015	3.00%	3.33%	15.0	0.50	8.23
< 4.00% Street Slope>						
1.0	0.015	4.00%	3.33%	3.9	0.13	3.87
2.0	0.015	4.00%	3.33%	5.1	0.17	4.61
3.0	0.015	4.00%	3.33%	5.9	0.20	5.10
4.0	0.015	4.00%	3.33%	6.6	0.22	5.48
5.0	0.015	4.00%	3.33%	7.2	0.24	5.80
10.0	0.015	4.00%	3.33%	9.3	0.31	6.90
15.0	0.015	4.00%	3.33%	10.9	0.36	7.64
20.0	0.015	4.00%	3.33%	12.1	0.40	8.21
25.0	0.015	4.00%	3.33%	13.1	0.44	8.69
30.0	0.015	4.00%	3.33%	14.1	0.47	9.09
35.5	0.015	4.00%	3.33%	15.0	0.50	9.49
< 5.00% Street Slope>						
1.0	0.015	5.00%	3.33%	3.8	0.13	4.21
2.0	0.015	5.00%	3.33%	4.9	0.16	5.01
3.0	0.015	5.00%	3.33%	5.7	0.19	5.55
4.0	0.015	5.00%	3.33%	6.3	0.21	5.96
5.0	0.015	5.00%	3.33%	6.9	0.23	6.31
10.0	0.015	5.00%	3.33%	8.9	0.30	7.50
15.0	0.015	5.00%	3.33%	10.4	0.35	8.31
20.0	0.015	5.00%	3.33%	11.6	0.39	8.93
25.0	0.015	5.00%	3.33%	12.6	0.42	9.45
30.0	0.015	5.00%	3.33%	13.5	0.45	9.89
40.0	0.015	5.00%	3.33%	15.0	0.50	10.63

TOTAL FLOW Qt (CFS)	n	RDWY SLOPE S (%)	CROSS SLOPE Sx (%)	PONDED WIDTH T (FT)	DEPTH AT CURB d (FT)	VEL V (FPS)
< 6.00% Street Slope>						
1.0	0.015	6.00%	3.33%	3.7	0.12	4.51
2.0	0.015	6.00%	3.33%	4.7	0.16	5.36
3.0	0.015	6.00%	3.33%	5.5	0.18	5.94
4.0	0.015	6.00%	3.33%	6.1	0.20	6.38
5.0	0.015	6.00%	3.33%	6.7	0.22	6.75
10.0	0.015	6.00%	3.33%	8.6	0.29	8.03
15.0	0.015	6.00%	3.33%	10.1	0.34	8.90
20.0	0.015	6.00%	3.33%	11.2	0.37	9.56
30.0	0.015	6.00%	3.33%	13.0	0.43	10.59
40.0	0.015	6.00%	3.33%	14.5	0.48	11.38
43.5	0.015	6.00%	3.33%	15.0	0.50	11.62
< 8.00% Street Slope>						
1.0	0.015	8.00%	3.33%	3.5	0.12	5.02
2.0	0.015	8.00%	3.33%	4.5	0.15	5.97
3.0	0.015	8.00%	3.33%	5.2	0.17	6.62
4.0	0.015	8.00%	3.33%	5.8	0.19	7.11
5.0	0.015	8.00%	3.33%	6.3	0.21	7.52
10.0	0.015	8.00%	3.33%	8.2	0.27	8.95
15.0	0.015	8.00%	3.33%	9.5	0.32	9.91
20.0	0.015	8.00%	3.33%	10.6	0.35	10.65
30.0	0.015	8.00%	3.33%	12.4	0.41	11.79
40.0	0.015	8.00%	3.33%	13.8	0.46	12.67
50.0	0.015	8.00%	3.33%	15.0	0.50	13.40
< 10.00% Street Slope>						
1.0	0.015	10.00%	3.33%	3.3	0.11	5.46
2.0	0.015	10.00%	3.33%	4.3	0.14	6.50
3.0	0.015	10.00%	3.33%	5.0	0.17	7.19
4.0	0.015	10.00%	3.33%	5.6	0.19	7.73
5.0	0.015	10.00%	3.33%	6.1	0.20	8.18
10.0	0.015	10.00%	3.33%	7.9	0.26	9.73
20.0	0.015	10.00%	3.33%	10.2	0.34	11.58
30.0	0.015	10.00%	3.33%	11.9	0.39	12.82
40.0	0.015	10.00%	3.33%	13.2	0.44	13.78
50.0	0.015	10.00%	3.33%	14.4	0.48	14.57
56.0	0.015	10.00%	3.33%	15.0	0.50	14.99

Figure 6.5