

CALCULATIONS

FOR

DRAINAGE STUDY

MALLARD COVE

AN ADDITION TO

SEDGWICK COUNTY KANSAS

1979

R&G

MALLARD COVE

①

DRAINAGE AREAS

DRAINAGE AREA # 1

$$2028 - 3517 - 4994 = 1483 = 14.83 \text{ sq. in.} \\ = \underline{\underline{0.85 \text{ Ac.}}}$$

AREA # 2

$$9803 - 6377 - 2912 = 3445.5 = 34.445 \text{ sq. in.} \\ = \underline{\underline{1.98 \text{ Ac.}}}$$

AREA # 3

$$9744 - 12583 - 15419 = 2837.9 = 28.379 \text{ sq. in.} \\ = \underline{\underline{1.63 \text{ Ac.}}}$$

AREA # 4

$$800 \times 35 / 43560 = \underline{\underline{0.64 \text{ Ac.}}}$$

AREA # 5

$$5573 - 4425 - 3284 = 1144.5 = 11.445 \text{ sq. in.} \\ = \underline{\underline{0.66 \text{ Ac.}}}$$

AREA # 6

$$8456 - 6458 - 4441 = 2007.5 = 20.075 \text{ sq. in.} \\ = \underline{\underline{1.15 \text{ Ac.}}}$$

AREA # 7

$$9486 - 5652 - 1837 = 3824.5 = 38.245 \text{ sq. in.} \\ = \underline{\underline{2.19 \text{ Ac.}}}$$

AREA # 8

$$9708 - 7887 - 6051 = 1828.9 = 18.289 \text{ sq. mi.}$$

$$= \underline{1.05 \text{ AC.}}$$

AREA # 9

$$9885 - 7985 - 6013 = 1936 = 19.36 \text{ sq. mi.}$$

$$= 1.11 \text{ AC.}$$

AREA # 10

$$6724 - 5719 - 4705 = 1009.9 = 10.099 \text{ sq. mi.}$$

$$= 0.58 \text{ AC.}$$

DRAINAGEAREA # 1

$$D. A = 0.85 \text{ AC.}$$

$$L = 230 \text{ FEET} = 0.044 \text{ MILES}$$

$$F = 1.2$$

$$T.C. = \left( \frac{11.9 \times 0.044^3}{1.2} \right)^{0.389} \times 60 = 3.9 \text{ MIN.}$$

$$Q_2 = 0.9 \times 4.4 \times 0.85 = 3.37 \text{ cfs}$$

$$Q_{100} = 0.9 \times 9.5 \times 0.85 = 7.27 \text{ cfs}$$

AREA # 2

$$D. A = 1.98 \text{ AC.}$$

$$L = 900 = 0.17 \text{ MILES}$$

$$F = 2.6 \text{ FT}$$

$$T.C. = \left( \frac{11.9 \times 0.17^3}{2.6} \right)^{0.389} \times 60 = 13.92 \text{ MIN.}$$

$$Q_2 = 0.6 \times 3.3 \times 1.98 = 3.92 \text{ cfs}$$

$$Q_{100} = 0.6 \times 7.0 \times 1.98 = 8.32 \text{ cfs}$$

AREA # 3

D.A =  $1.63 / 2 = 0.815$  AC. FROM EACH SIDE OF CATCH BASIN

DISCHARGE FROM EAST SIDE OF CATCH BASIN

$$L = 310 \text{ FT} = 0.059 \text{ MILES}$$

$$F = 0.9 \text{ FT}$$

$$T.C. = \left( \frac{11.9 \times 0.059^3}{0.9} \right)^{0.385} \times 60 = 7.73 \text{ MIN}$$

$$Q_2 = 1.00 \times 4.8 \times 0.815 = 3.9 \text{ cfs}$$

$$Q_{100} = 1.00 \times 9.5 \times 0.815 = 7.74 \text{ cfs}$$

DRAINAGE FROM WEST SIDE OF CATCH BASIN

$$L = 320 \text{ FEET} = 0.0606 \text{ MILES}$$

$$F = 1.5 \text{ FEET}$$

$$T.C. = \left( \frac{11.9 \times 0.0606^3}{1.5} \right)^{0.385} \times 60 = 5.22 \text{ MIN}$$

$$Q_2 = 1.0 \times 4.8 \times 0.815 = 3.9 \text{ cfs}$$

$$Q_{100} = 1.0 \times 9.5 \times 0.815 = 7.74 \text{ cfs}$$

TOTAL DISCHARGE TO CATCH BASIN

$$Q_2 = 3.9 + 3.9 = 7.8 \text{ cfs}$$

$$Q_{100} = 7.74 + 7.74 = 15.48 \text{ cfs}$$

AREA # 4

DA = 0.64 Ac.

L = 800 = 0.152 MILES

F = 2.4 FEET

T.C. =  $\left( \frac{11.9 \times 0.152}{2.4} \right)^{0.385} \times 60 = 12.6 \text{ MIN.}$

Q<sub>2</sub> = 0.6 x 3.5 x 0.64 = 1.34 cfs ]

Q<sub>100</sub> = 0.6 x 7.0 x 0.64 = 2.69 cfs.]

AREA # 5

A = 0.66 Ac.

L = 688 FEET = 0.13 MILES

F = 1.95 FEET

T.C. =  $\left( \frac{11.9 \times 0.13}{1.95} \right)^{0.385} \times 60 = 11.4 \text{ MIN.}$

Q<sub>2</sub> = 0.6 x 3.7 x 0.66 = 1.47 cfs ]

Q<sub>100</sub> = 0.6 x 7.5 x 0.66 = 2.97 cfs.]

AREA # 6

A = 1.15 Ac.

L = 688 = 0.13 MILES

F = 1.95 FEET

T.C. = 11.4 MIN.

Q<sub>2</sub> = 0.6 x 3.7 x 1.15 = 2.55 cfs ]

Q<sub>100</sub> = 0.6 x 7.5 x 1.15 = 5.18 cfs.]

AREA # 7

AREA NORTH OF CATCH BASIN

$$9470 - 4604 - 3759 = 855.5 = 8.555 \text{ sq. in.}$$

$$= 0.49 \text{ ac.}$$

$$L = 120 \text{ FEET} = 0.023 \text{ MILE}$$

$$F = 1 \text{ FEET}$$

$$T.C. = \left( \frac{11.9 \times 0.023^3}{1} \right)^{0.385} \times 60 = 2.0 \text{ MIN.}$$

$$Q_2 = 1.0 \times 4.7 \times 0.49 = 2.30 \text{ cfs}$$

$$Q_{100} = 1.0 \times 9.5 \times 0.49 = 4.66 \text{ cfs}$$

AREA SOUTH OF CATCH BASIN

$$D. A. = 2.19 - 0.49 = 1.7 \text{ ac.}$$

$$L = 340 \text{ FEET} = 0.064 \text{ MILES}$$

$$F = 3 \text{ FEET}$$

$$T.C. = \left( \frac{11.9 \times 0.064^3}{3} \right)^{0.385} \times 60 = 4.3 \text{ MIN.}$$

$$Q_2 = 1.0 \times 4.7 \times 1.7 = 7.99 \text{ cfs}$$

$$Q_{100} = 1.0 \times 9.5 \times 1.7 = 16.15 \text{ cfs}$$

TOTAL DRAINAGE INTO CATCH BASIN

$$Q_2 = 2.3 + 7.99 = 10.29 \text{ cfs}$$

$$Q_{100} = 4.66 + 16.15 = 20.81 \text{ cfs}$$



AREA # 8

D.A = 1.05 AC.

L = 240 FEET = 0.045 MILES

F = 0.5 FEET

T.C. =  $\left( \frac{11.9 \times 0.045^3}{0.5} \right)^{0.385} \times 60 = 5.6 \text{ Min.}$

$Q_2 = 1.0 \times 4.7 \times 1.05 = 4.9 \text{ CFS}$   
 $Q_{100} = 1.0 \times 9.5 \times 1.05 = 9.98 \text{ CFS.}$

AREA #9

A = 1.11 AC.

L = 580 FEET = 0.11 MILES

F = 1.5 FEET

T.C. =  $\left( \frac{11.9 \times 0.11^3}{1.5} \right)^{0.385} \times 60 = 10.4 \text{ Min.}$

$Q_2 = 0.6 \times 3.8 \times 1.11 = 2.53 \text{ CFS}$   
 $Q_{100} = 0.6 \times 7.5 \times 1.11 = 5.00 \text{ CFS}$

AREA #10

A = 0.58 AC.

L = 500 FEET = 0.095 MILES

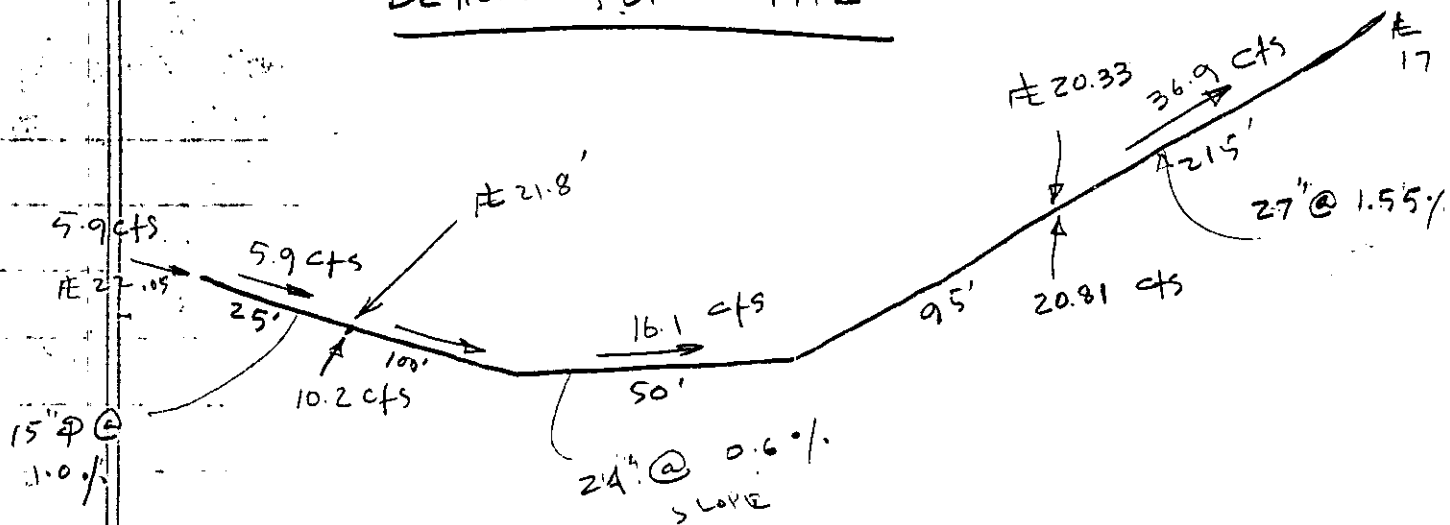
F = 1.5 FEET

T.C. = ~~0.6~~  $\left( \frac{11.9 \times 0.095^3}{1.5} \right)^{0.385} \times 60 = 8.8 \text{ Min.}$

$Q_2 = 0.6 \times 4.1 \times 0.58 = 1.43 \text{ CFS}$   
 $Q_{100} = 0.6 \times 8.4 \times 0.58 = 2.92 \text{ CFS}$

SEWER PIPE  
DESIGN FOR PIPE

(7)



~~SLOPE 0.4%~~

~~INLET~~

$$\begin{aligned}
 FL (IN) &= 24.68 - 1 - 1 - \frac{1.5}{100} \times 20.65 \\
 &= 22.18 \approx 22.00 \text{ FT}
 \end{aligned}$$

15"  $\phi$  @ 1.0% SLOPE

$$Q = 6.2 \text{ cfs} > 5.9 \text{ cfs} \quad v = 5.2 \text{ f/s}$$

24"  $\phi$  @ 0.6% SLOPE

$$Q = 18.0 \text{ cfs} > 16.1 \text{ cfs}$$

27"  $\phi$  @ 1.55% SLOPE

$$Q = 39 \text{ cfs} > 36.9 \text{ cfs}$$

INLETS

N. SIDE

$$Q = 9.9 \text{ cfs}$$

USE 2 - INLETS

E. SIDE

$$Q = 10.2 \text{ cfs}$$

USE 3 INLETS

S.S. # 1

$E (IN) = 19.3$

$E (OUT) = 17.0$

$L = 110 \text{ FT}$

$Q_{100} = 7.27$

$S = 2.3/100 = 2.1 \%$

15"  $\phi$  @ 2.1%

$Q = 9.2 \text{ cfs}$   
CAPACITY

$V = 7.6 \text{ ft/sec.}$

S.S. # 2

$Q_{100} = 15.48 \text{ cfs}$

$L = 195 \text{ FT}$

$E (IN) = 19.0$

$FL (OUT) = 17.0$

$S = 2/195 = 1.03 \%$

21"  $\phi$  @ 1.03% SLOPE

$Q = 16 \text{ cfs}$

$V = 6.5 \text{ ft/sec.}$

S.S. # 3

$Q_{100} = 9.98$

$E (IN) = 19.6$

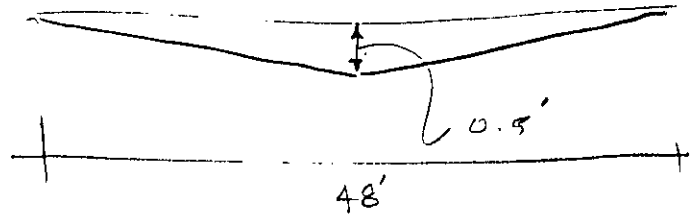
$E (OUT) = 17.0$

$L = 90 \text{ FT.}$

$S = 2.9 \%$

$Q = 12.0 \text{ cfs}$

## CAPACITY OF CRITICAL PARKING SECTION



$$S = 0.3\%$$

$$A = 0.5 \times 48 = 24 \text{ Ft}^2$$

$$P = 48 \text{ Ft}$$

$$R = 0.5$$

$$Q = 24 \times \frac{1.486}{0.013} \times 0.5^{2/3} \times 0.003^{1/2}$$

$$= 94.7 \text{ cfs} \quad \leftarrow \quad \underline{\underline{\text{GOOD}}}$$

## INLET GRATING CAPACITY

$$S_L = \frac{0.5}{24} \times 100 = 2.08 \approx 2\%$$

$$S_T = 0.003$$

TRY CODE NO. 3908-0009 USE GRAPH No. 3

$$K = 29.9$$

$$Q = 29.9 \times 0.5^{5/3} = 8.0 \text{ cfs}$$

DESIGN FOR MAIN CULVERT ASSUMING 140 CFS. FROM OUTSIDE THE ADDITION

$Q_{100} = 140 + 2.92 + 5.0 + 2.97 + 5.18 + 4.66 + 16.15$   
 $= 176.88 \approx \underline{\underline{177 \text{ C.F.S.}}}$

TRY 3' x 7' R.C. B.C.

$F_L \text{ (IN) ELEV.} = 19.0 \text{ FEET}$   
 $F_L \text{ (OUT) ELEV.} = 17.0 \text{ FEET}$   
 $\text{LENGTH} = 122 + 51 + 312 = 485 \text{ FEET}$

$\text{SLOPE} = \frac{2}{485} = 0.41 \%$

INLET CONTROL

$\text{HW ELEV.} = \underline{\underline{24.68}}$   
 $\text{HW} = 24.68 - 19.0 = 5.68 \text{ FEET}$   
~~LOSS AS~~

OUTLET CONTROL

$A = 7 \times 3 = 21 \text{ S.F.T.}$   
 $V = \frac{Q}{A} = \frac{177}{21} = 8.43 \text{ FT/SEC.}$   
 $H_v = \frac{V^2}{2g} = \frac{8.43^2}{2 \times 32.2} = 1.01 \text{ FT.} \leftarrow$   
 $H_e = 0.4 \times 1.01 = 0.40 \text{ FT.} \leftarrow$   
 $R = \frac{3 \times 7}{2(7+3)} = 1.03$

$$H_f = \frac{29 \times 0.012^2 \times 8.43^2 \times 485}{1 \times 1.05^{1.33} \times 2 \times 32.2}$$

$$= 2.09 \text{ Ft. } \leftarrow$$

$$Q/s = \frac{177}{7} = 25.3 \text{ c.f.s. / ft.}$$

$$d_c = 2.7 \text{ ft. (GRAPH No. 1)}$$

$$T_w = \frac{3 + 2.7}{2} = 2.85 \text{ Ft. } \leftarrow$$

LOSS AT BENDS

$$H_B = 0.25 \times \frac{V^2}{2g} \left( \sqrt{\frac{\Delta_1}{90}} + \sqrt{\frac{\Delta_2}{90}} \right) \text{ (PAGE 16)}$$

$$\Delta_1 = 27^\circ \quad \Delta_2 = 30^\circ$$

$$H_B = 0.25 \times 1.01 (0.548 + 0.977)$$

$$= 0.28 \text{ Ft. } \leftarrow$$

$$H_w = 1.01 + 0.4 + 2.09 + 2.85 + 0.28$$

$$= 6.63 \text{ Ft.}$$

$$H_w \text{ ELEV.} = 17 + 6.63 = \underline{\underline{23.63 \text{ Ft.}}}$$

USE HEAD WATER ELEV. FROM INLET CONTROL

$$H_w = 5.68 \text{ Ft}$$

USE 45° WING WALL ENTRANCE

~~etc 177/7 = 25.3 c.f.s. / ft~~

FROM GRAPH NO. 2

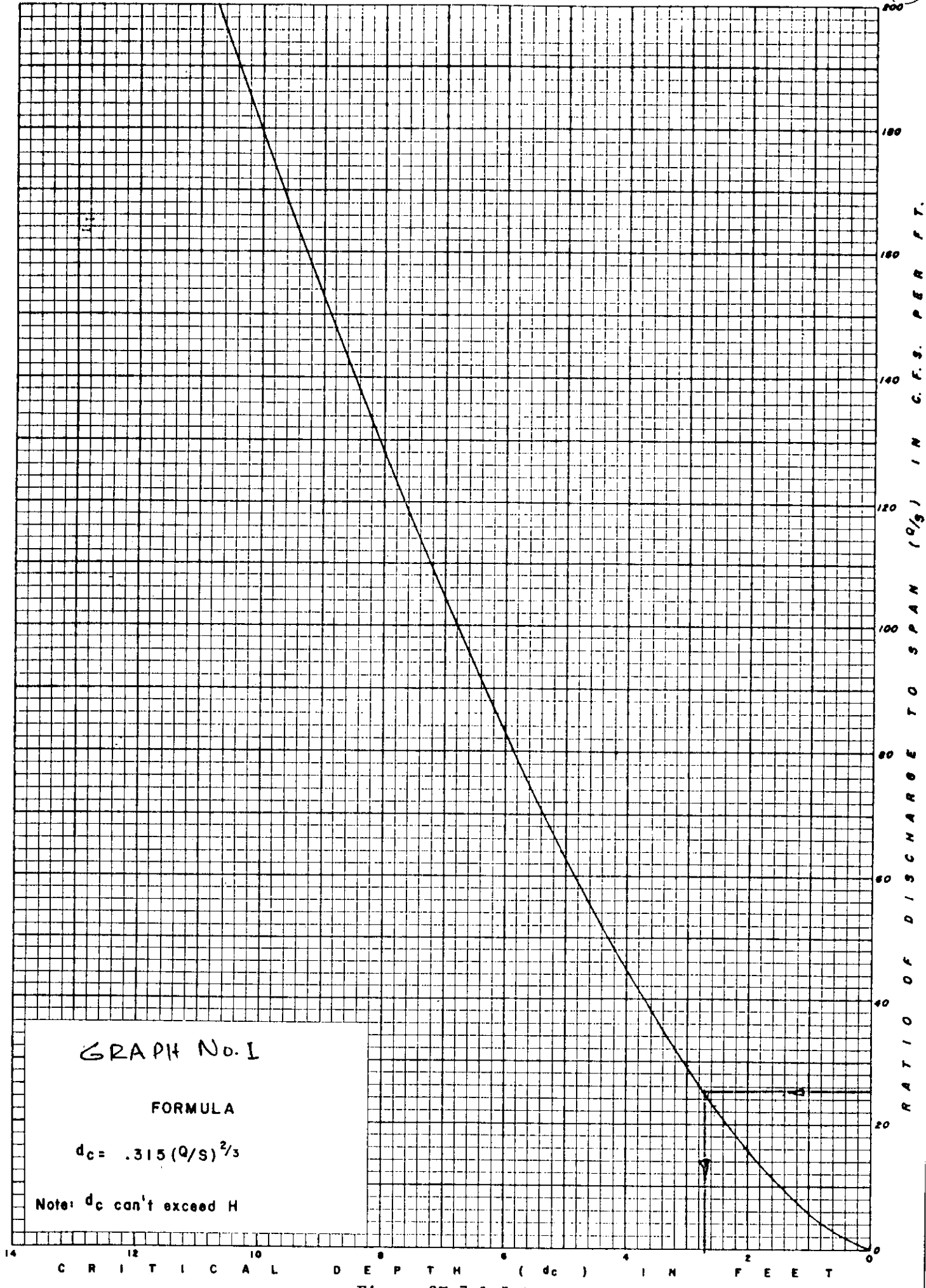
$$\frac{Q}{S} = 29.5$$

$$S = \frac{177}{29.5} = 6 \text{ FT.} < 7 \text{ FT.}$$

O.K.

# CRITICAL DEPTH ( $d_c$ ) RECTANGULAR SECTION

13



GRAPH No. I

FORMULA

$$d_c = .315(Q/S)^{2/3}$$

Note:  $d_c$  can't exceed H

14 12 10 8 6 4 2 0  
C R I T I C A L D E P T H (  $d_c$  ) I N F E E T

R A T I O O F D I S C H A R G E T O S P A N (  $Q/S$  ) I N C . F . S . P E R F . T .

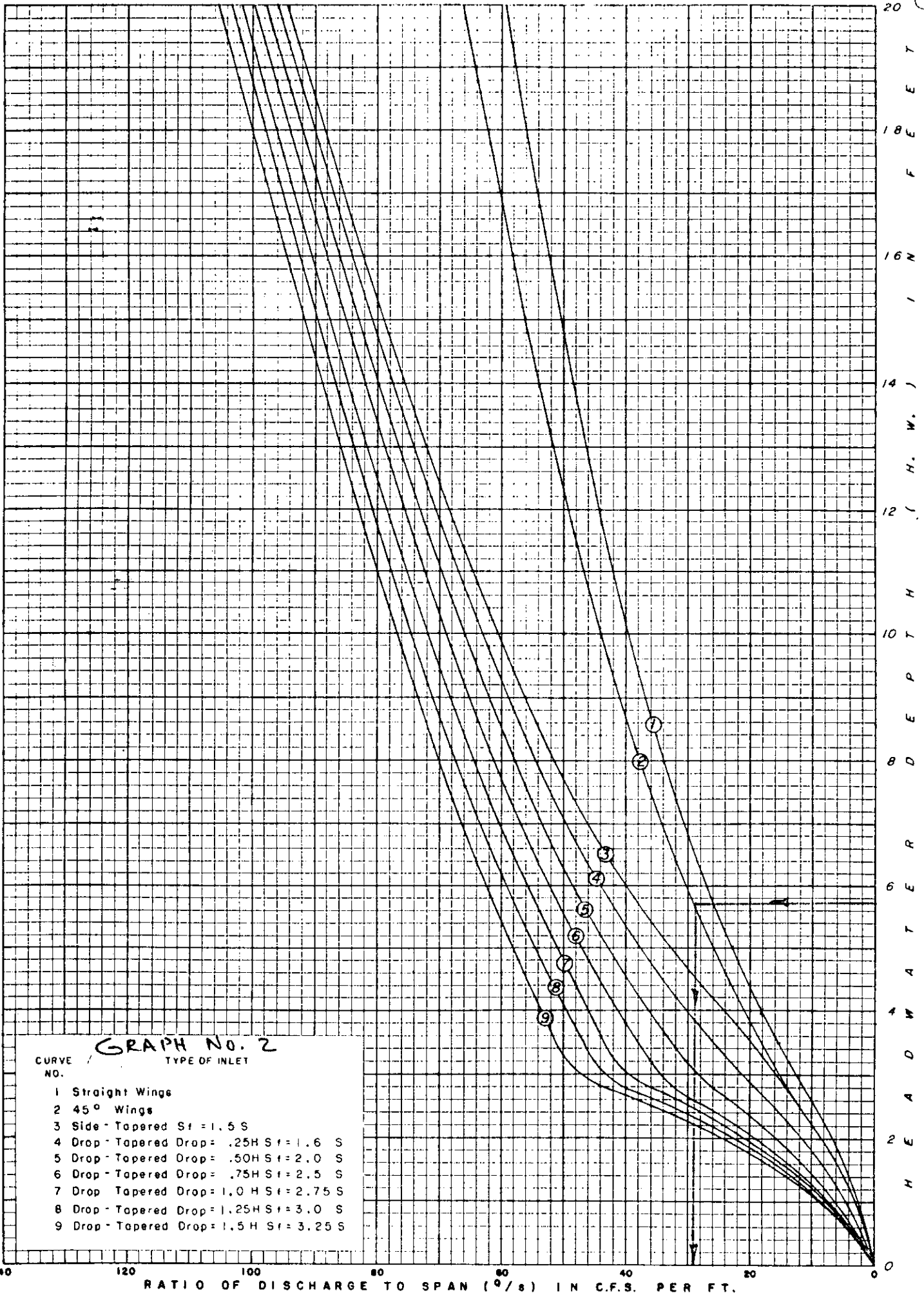
Q

Q

Q

# REINFORCED CONCRETE BOXES (H=3')

14



**GRAPH NO. 2**

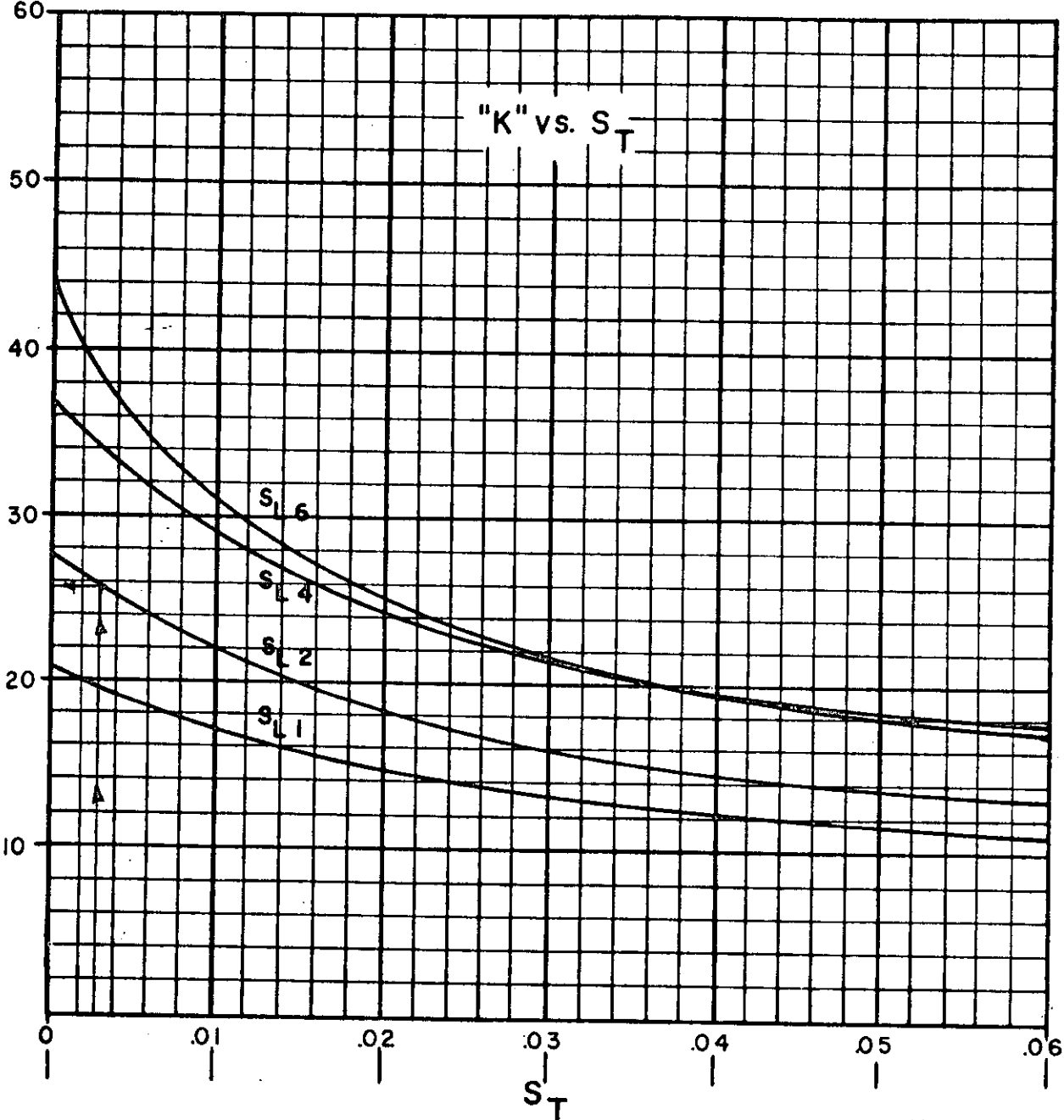
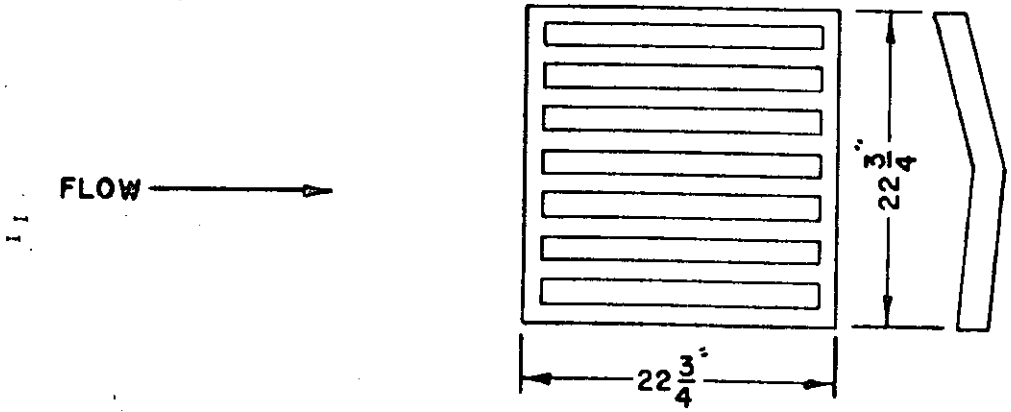
CURVE NO.	TYPE OF INLET
1	Straight Wings
2	45° Wings
3	Side-Tapered $S_f = 1.5 S$
4	Drop-Tapered Drop = .25H $S_f = 1.6 S$
5	Drop-Tapered Drop = .50H $S_f = 2.0 S$
6	Drop-Tapered Drop = .75H $S_f = 2.5 S$
7	Drop-Tapered Drop = 1.0H $S_f = 2.75 S$
8	Drop-Tapered Drop = 1.25H $S_f = 3.0 S$
9	Drop-Tapered Drop = 1.5H $S_f = 3.25 S$

140 120 100 80 60 40 20 0

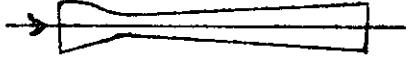
RATIO OF DISCHARGE TO SPAN ( $Q/S$ ) IN C.F.S. PER FT.

20 18 16 14 12 10 8 6 4 2 0

HEAD (H) IN FEET



$S_T$  = TRANSVERSE GUTTER SLOPE      GRAPH No. 3  
 $S_L$  = LONGITUDINAL GUTTER SLOPE  
 K = GRATE INLET COEFFICIENT

Nature of Special Resistance	Loss in Terms Multiple of $V^2/2g$	Authority
<p><u>22½° Bend</u> Use ½ of loss for 90° Bend of same radius</p> <p><u>Obtuse-Angled Elbows</u> Deflection of pipe less than 90°, multiply values for sq. elbow and 90° curves by</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <math display="block">\frac{\text{deflection, degrees}}{90 \text{ deg.}}^2</math> </div>		<p>Fuller, King, Davis. Also Am. &amp; New Eng. W. W. Std.</p> <p>Hydraulics Schoder &amp; Dawson</p>
<p><u>Any Bend</u> (except at 90° consider entire velocity head as lost) Δ = angle of bend</p>	$0.25 \sqrt{\frac{\Delta}{90^\circ}}$	<p>"Handbook of Applied Hydraulics" by Davis, p. 454, 1st Ed., 1942</p>
<p><u>Wye Branches or 45° Laterals</u> Use ¾ of the loss for a tee or</p>	<p>1.0</p>	<p>King &amp; Davis Am. &amp; New Eng. W. W. Stds.</p>
<p><b><u>VENTURI METERS</u></b></p>		
<p>The loss of head occurs mostly in and downstreamwards from the divergence.</p>		
<p><u>Loss between upstream and &amp; Throat</u> (in terms of throat vel.)</p>	<p>.03 to .06</p>	<p>"Hydraulics" Schoder &amp; Dawson</p>
<p><u>Total loss through Meter for</u> (in terms of throat vel.)</p>		
<p><u>Total angle of divergence</u> = ± 5 deg.</p>	<p>1/7 to 1/10</p>	<p>"Hydraulics" Schoder &amp; Dawson</p>
<p><u>Total angle of divergence</u> = ± 15 deg.</p>	<p>1/3 to 1/16</p>	<p>Ditto</p>
<p>Note: (The lower values of the above multipliers go with large throats, and the larger values with small throats whose diam. = 1/3 to 1/2 the diam. of the pipe.)</p>		
<p><u>Long Tube</u> (losses in terms of throat vel.)</p>		
<div style="text-align: center;">  </div>		

ics"  
Inst.

dr.