MOEHRING & ASSOCIATES — CONSULTING ENGINEERS

# DRAINAGE PLAN
# AND
# SUPPORTING CALCULATIONS

## WHEATLAND ADDITION
## SEDGWICK COUNTY, KANSAS

PREPARED BY

MOEHRING & ASSOCIATES
CONSULTING ENGINEERS

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433 S. HYDRAULIC — WICHITA, KANSAS 67211 — 263-8291

## PREFACE

Attached hereto are the computations for the referenced drainage plan.

The publication "Interim Drainage and Storm Sewer Policy for Design Criteria and Documentations, City of Wichita", revised 7/1/87, was used as a guide for the hydrologic and hydraulic computations. This publication is hereinafter referred to as the "Policy Manual".

Manual #1, as referenced therein, refers to "Design of Urban Highway Drainage - The State of the Art", by Reitz & Jens, Inc., April, 1980. Manual #2 refers to "Drainage of Highway Pavements, Hydraulic Engineering Circular #12", by Tye Engineering, Inc., March, 1984.

## HYDROLOGY METHODS

The rational method was used for hydrologic analysis. Runoff coefficients were based on the table provided in Attachment D, of the "Policy Manual".

The time of concentration for overland flow was determined by the Kinematic Wave Theory, as presented in Section 4.1.3, pgs. 14-15 of Manual #2. Time of travel in street gutters was determined by the method used in Section 4.1.3, pg. 17, of Manual #2. The minimum time of concentration for design purposes was taken to be 15 minutes.

The two-year return period storm was used as the basis of design, per Table 1 of the "Policy Manual". Also, a check was made to verify that the 100-year runoff was confined to the street right-of-way.

## HYDRAULIC DESIGN

For each inlet, street flooding and inlet capacity was checked for the minor storm. Conveyance in the street was based on the modified Manning Equation:

$$Q = 0.56/n(S_x)^{5/3}(T)^{8/3}\ S^{1/2} \quad \text{(Eq. 4, Manual \#2, pg. 22)}$$

For local streets, curb-deep flow is tolerable for the minor storm. For collectors, a single eight-foot center lane should remain unflooded for the minor storm.

Inlet capacities were determined by the methods presented in Manual #2, using charts 9, 10 and 12. Carryover flows were added to the next inlet downstream.

In this analysis, City of Wichita Type 1A Inlets, 3/8 in/ft street cross-slope, and 6-5/8" Std. curb and gutter were assumed to be utilized.

Pipe systems were designed using the calculated capacity of each inlet, on the basis of a two-year storm.

Preliminary pipe sizes were estimated and tabulated under "Conduit Data". Manning's Equation was used to calculate friction losses in pipes flowing full. Minor losses are accounted for by using conservation of momentum principles. It is desirable to keep the hydraulic grade line approximately 6 inches below the curb flowline elevations.

MAJOR STORM OVERFLOW

For each sub-area, a check was made for conveyance capacity of the major storm. To simplify analysis, the following assumptions were made:

1. The time of concentration is identical for both the major and minor storm. Thus, a ratio of rainfall intensities is used to determine $Q_{100}$ @ each Node.

2. The pipe system capacity during the major storm is assumed to be the same as during the minor storm. This is a conservative assumption, because increased ponding depths during the major storm event will increase the available head on the inlet/pipe system, thus increasing the capacity.

3. The conveyance capacity of the street R/W's was calculated for several gradients, and used as a check against tabulated discharges for the 100 yr. event.

In general, the minimum grade at the right-of-way line is 0.3' above the top of the curb. If walk grades higher than minimum are required to confine the major storm overflow, such walk elevations will be noted and identified.

WHEATLAND ADDITION -

DRAINAGE PLAN HYDROLOGY

A. INITIAL DATA

1. Drainage Areas

| | | |
|---|---|---|
| Total Drainage Area | = | 54.00 Ac. |
| System 100 | = | 50.13 Ac. |
| Offsite Flow to MacArthur | = | 0.74 Ac. |
| Offsite Flow to South | = | 1.47 Ac. |
| Offsite Flow to Hoover Road | = | 1.66 AC. |

2. S.C.S. Hydrologic Soil Groups & Runoff Coefficients

In the drainage basins contributing to System 100, there are 46.95 Ac. of Vanoss soils, in Hydrologic Group "B", and 3.18 Ac. of Tabler soils, in Hydrologic Group "D".

Following, are determinations of Weighted Rational "C" values for System 100. Rational "C" values are from Attachment "D" of the City Policy Manual.

| Soil Group | Soil Area | Land Use | % Imperv. | Rational "C" | % Total Area | | Product (C x %) |
|---|---|---|---|---|---|---|---|
| Weighted "C" Values - System 100 - 2 Yr. Frequency | | | | | | | |
| B | 46.95 | Res.-1/4 Ac. | 38 | 0.44 | 94% | | 41.360 |
| D | 3.18 | Res.-1/4 Ac. | 38 | 0.50 | 6% | | 3.000 |
| | | | | | 100% | = | 44.360 |

Use Weighted "C" = .45 for System 100 - 2 Yr. Frequency.

| Soil Group | Soil Area | Land Use | % Imperv. | Rational "C" | % Total Area | | Product (C x %) |
|---|---|---|---|---|---|---|---|
| Weighted "C" Values - System 100 - 100 Yr. Frequency | | | | | | | |
| B | 46.95 | Res.-1/4 Ac. | 38 | 0.61 | 94% | | 57.340 |
| D | 3.18 | Res.-1/4 Ac. | 38 | 0.76 | 6% | | 4.560 |
| | | | | | 100% | = | 61.90 |

Use Weighted "C" = 0.62 for System 100 - 100 Yr. Frequency.

# WHEATLAND ADDITION - System 100

A. HYDROLOGY - Use rational Method, Q = CIA

1. Tabulation of Rational "C" values for each sub-basin.

| Node | Land Use | Weighted Rational "C" $C_2$ | $C_{100}$ |
|---|---|---|---|
| 114 | Res.1/4 Ac. | 0.45 | 0.62 |
| 113 | Res.1/4 Ac. | 0.45 | 0.62 |
| 112 | Res.1/4 Ac. | 0.45 | 0.62 |
| 110 | Res.1/4 Ac. | 0.45 | 0:62 |
| 109 | Res.1/4 Ac. | 0.45 | 0.62 |
| 108 | Res.1/4 Ac. | 0.45 | 0.62 |
| 107 | Res.1/4 Ac. | 0.45 | 0.62 |
| 106 | Res.1/4 Ac. | 0.45 | 0.62 |
| 105 | Res.1/4 Ac. | 0.45 | 0.62 |
| 104 | Res.1/4 Ac. | 0.45 | 0.62 |
| 103 MH | Res.1/4 Ac. | -- | -- |
| 102 | Res.1/4 Ac. | 0.45 | 0.62 |
| 101 | Res.1/4 Ac. | 0.45 | 0.62 |

100 - End System

2. Determine $T_c$ & I for each sub-basin contributing to each Node.

| Node | $T_o$ min. | $T_g$ min. | $T_c$ min. | $I_2$ in/hr | $I_{100}$ in/hr |
|---|---|---|---|---|---|
| 114 | 10.88 | 4.14 | 15.02 | 3.83 | 7.37 |
| 113 | 9.08 | 3.19 | 15.0 | 3.83 | 7.37 |
| 112 | 15.23 | 4.20 | 19.43 | 3.38 | 6.62 |
| 111 | 11.33 | 5.94 | 17.27 | 3.58 | 6.96 |
| 110 | 13.44 | 6.51 | 19.95 | 3.34 | 6.54 |
| 109 | 15.21 | 7.59 | 22.80 | 3.11 | 6.16 |
| 108 | 17.37 | 5.54 | 22.91 | 3.11 | 6.14 |
| 107 | 16.43 | 3.09 | 19.52 | 3.37 | 6.60 |
| 106 | 15.17 | 1.04 | 16.21 | 3.70 | 7.14 |
| 105 | -- | -- | 15.00 | 3.83 | 7.37 |
| 104 | -- | -- | 15.00 | 3.83 | 7.37 |
| 103 | MH | -- | -- | -- | -- |
| 102 | 16.50 | 2.93 | 19.44 | 3.38 | 6.61 |
| 101 | -- | -- | 15.00 | 3.83 | 7.37 |

100 - End of System

NOTE: $T_o$ = overland flow time, by Kinematic Wave Formula

$T_g$ = gutter flow time, computed as average between zero velocity and maximum velocity occuring at spread of 17 feet, for respective gradients.

$T_c = T_o + T_g$, or minimum of 15 minutes

3. Tabulation of Area, "A", of surface contribution to each inlet.

| Node | Surface Drainage Area (Acres) |
|---|---|
| 114 | 8.70 Ac. |
| 113 | 2.01 Ac. |
| 112 | 5.91 Ac. |
| 111 | 5.70 Ac. |
| 110 | 3.46 Ac. |
| 109 | 7.62 Ac. |
| 108 | 6.93 Ac. |
| 107 | 2.23 Ac. |
| 106 | 1.00 Ac. |
| 105 | 1.09 Ac. |
| 104 | 1.26 Ac. |
| 103 MH | 0 |
| 102 | 1.76 Ac. |
| 101 | 2.46 |
| 100 - End System | Total - 50.13 Ac. |

4. Determine Surface Contributions, $Q_2$ to each Node

| Node | $C_2$ | $I_2$ | A | $Q_2$ |
|---|---|---|---|---|
| 114 | 0.45 | 3.83 | 8.70 | 14.99 cfs |
| 113 | 0.45 | 3.83 | 2.01 | 3.46 cfs |
| 112 | 0.45 | 3.38 | 5.91 | 8.99 cfs |
| 111 | 0.45 | 3.58 | 5.70 | 9.18 cfs |
| 110 | 0.45 | 3.34 | 3.46 | 5.20 cfs |
| 109 | 0.45 | 3.11 | 7.62 | 10.66 cfs |
| 108 | 0.45 | 3.11 | 6.93 | 9.70 cfs |
| 107 | 0.45 | 3.37 | 2.23 | 3.38 cfs |
| 106 | 0.45 | 3.70 | 1.00 | 1.67 cfs |
| 105 | 0.45 | 3.83 | 1.09 | 1.88 cfs |
| 104 | 0.45 | 3.83 | 1.26 | 2.17 cfs |
| 103 MH | 0.45 | -- | -- | -- |
| 102 | 0.45 | 3.38 | 1.76 | 2.68 cfs |
| 101 | 0.45 | 3.83 | 2.46 | 4.24 cfs |

100 - End System

5. Flood Routing/Inlet Sizing - 2 yr. Design

| Node | Inlet Condition | Inlet Length | $Q_2$ Approach | $Q_2$ Intercept | $Q_2$ By-Pass | By-Pass To Node |
|---|---|---|---|---|---|---|
| 114 | Sump | 10 | 14.99 | 14.99 | 0 | - |
| 113 | Sump | 5 | 3.46 | 3.46 | 0 | - |
| 112 | Sump | 5 | 8.99 | 8.99 | 0 | - |
| 111 | On Grade | 5 | 9.18 | 3.30 | 5.88 | 110 |
| 110 | Sump | 5 | 5.88+5.20 | 11.08 | 0 | - |
| 109 | Sump | 5 | 10.66 | 10.66 | 0 | - |
| 108 | Sump | 10 | 9.70 | 9.70 | 0 | - |
| 107 | Sump | 10 | 3.38 | 3.38 | 0 | - |
| 106 | Sump | 5 | 1.67 | 1.67 | 0 | - |
| 105 | Sump | 5 | 1.88 | 1.88 | 0 | - |
| 104 | Sump | 5 | 2.17 | 2.17 | 0 | - |
| 103 | MH | - | - | - | - | - |
| 102 | Grade | 5 | 2.68 | 1.53 | 1.15 | 101 |
| 101 | Sump | 5 | 4.24 | 4.24 | 0 | - |

100 - End System

6. Street Flow Depths - 2 Yr. Design Storm - System 100

| Node | $Q_2$ Approach | Flow Distribution | Street Slope % | Flow Depth | Allowable Depth | Comment |
|---|---|---|---|---|---|---|
| 114 | 14.99 | 95% (E) = 14.24 | 0.92 | 0.47 | 0.55 | OK |
| | | 5% (W) = 0.75 | 0.47 | 0.17 | 0.55 | OK |
| 113 | 3.46 | 90% (E) = 3.11 | 1.08 | 0.27 | 0.55 | OK |
| | | 10% (W) = 0.35 | 0.47 | 0.14 | 0.55 | OK |
| 112 | 8.99 | 90% (E) = 8.90 | 0.54 | 0.43 | 0.55 | OK |
| | | 10% (S) = 0.09 | 0.35 | 0.05 | 0.55 | OK |
| 111 | 12.48 | 100% (E) = 12.48 | 0.53 | 0.50 | 0.55 | OK |
| 110 | 11.08 | 95% (N) = 10.53 | 0.54 | 0.47 | 0.55 | OK |
| | | 5% (S) = 0.55 | 0.35 | 0.17 | 0.55 | OK |
| 109 | 10.66 | 97% (E) = 10.34 | 0.54 | 0.47 | 0.55 | OK |
| | | 3% (S) = 0.32 | 0.35 | 0.14 | 0.55 | OK |
| 108 | 9.70 | 95% (N) = 9.22 | 0.54 | 0.45 | 0.55 | OK |
| | | 5% (S) = 0.48 | 0.35 | 0.16 | 0.55 | OK |
| 107 | 3.38 | 75% (N) = 2.54 | 0.54 | 0.28 | 0.55 | OK |
| | | 25% (S) = 0.84 | 0.35 | 0.20 | 0.55 | OK |
| 106 | 1.67 | 50% (N) = 0.84 | 0.54 | 0.18 | 0.55 | OK |
| | | 50% (S) = 0.83 | 0.35 | 0.20 | 0.55 | OK |
| 105 | 1.88 | 50% (N) = 0.94 | 0.54 | 0.19 | 0.55 | OK |
| | | 50% (S) = 0.94 | 0.35 | 0.21 | 0.55 | OK |
| 104 | 2.17 | 40% (N) = 0.87 | 0.54 | 0.18 | 0.55 | OK |
| | | 60% (S) = 1.30 | 0.35 | 0.24 | 0.55 | OK |
| 103 | - | - | - | - | - | - |
| 102 | 4.90 | 100% (N) = 4.90 | 0.54 | 0.35 | 0.55 | OK |
| 101 | 5.51 | 100% (N) = 5.51 | 0.83 | 0.34 | 0.55 | OK |
| 100 | End System | | | | | |

## EVALUATION OF 100 YR. FLOW IN STREET R/W'S

1. Check street flow approaching Nodes 106 - 109.

Contributing Area

| Node | Acres |
|---|---|
| 108 | 6.93 |
| 107 | 2.23 |
| 106 | 7.62 |
| 109 | 1.00 |
| | 17.78 Ac. |

| $T_c(Q_2)$ | C | $I_{100}$ | A | $Q_{100}$ |
|---|---|---|---|---|
| 22.80 | 0.62 | 6.16 | 17.78 | 67.90 |

$Q_5$ (pipe) 106 - 105 = 31.24 cfs

Street Q = 67.90 - 31.24 = 36.67 cfs

Street Slope = 0.35%

Allowable Q (0.3' wlk gr.) = 52.54 cfs

Actual Q Street (36.67) $<$ Q allowable (52.54) (See Sheet 15)

2. Check street flow approaching Nodes 105 - 110.

Contributing Areas

| Node | Acres |
|---|---|
| 108 | 6.93 |
| 107 | 2.23 |
| 109 | 7.62 |
| 106 | 1.00 |
| 111 | 5.70 |
| 110 | 3.46 |
| 105 | 1.09 |
| | 28.03 Ac. |

| $T_c(Q_2)$ | C | $I_{100}$ | A | $Q_{100}$ |
|---|---|---|---|---|
| 23.98 | 0.62 | 6.01 | 28.03 | 104.44 |

$Q_2$ (pipe) 105 - 104 = 51.47 cfs

Street Q = 104.44 - 51.47 = 52.97 cfs

Street slope = 0.35%

Allowable Q (0.35' wlk. gr.) = 56.51 cfs

Actual street Q (52.97) $<$ allowable Q (56.51)

3. Check Street flow approaching Nodes 104 - 112.

Contributing Areas

| Node | Acres |
|---|---|
| 108 | 6.93 |
| 107 | 2.23 |
| 109 | 7.62 |
| 106 | 1.00 |
| 111 | 5.70 |
| 110 | 3.46 |
| 105 | 1.09 |
| 112 | 5.91 |
| 104 | 1.26 |
| | 35.20 Ac. |

| $T_c(Q_2)$ | C | $I_{100}$ | A | $Q_{100}$ |
|---|---|---|---|---|
| 26.04 | 0.62 | 5.79 | 35.20 | 126.27 |

$Q_5$ (pipe) 104 - 103 = 64.82 cfs

Street Q = 126.27 - 64.82 = 61.45 cfs

Street Slope = 0.35%

Allowable Q (0.4 wlk.gr.) = 71.02 cfs (See Sheet 16)

Actual Q Street (61.45) < Q allowable (71.02)

4. Check street flow approaching Node 102.

Contributing Areas

| Node | Acres |
|---|---|
| 108 | 6.93 |
| 107 | 2.23 |
| 109 | 7.62 |
| 106 | 1.00 |
| 111 | 5.70 |
| 110 | 3.46 |
| 105 | 1.09 |
| 112 | 5.91 |
| 104 | 1.26 |
| 102 | 1.76 |
| | 36.96 Ac. |

| $T_c(Q_2)$ | C | $I_{100}$ | A | $Q_{100}$ |
|---|---|---|---|---|
| 27.95 | 0.62 | 5.60 | 36.96 | 128.33 |

$Q_5$ (pipe) = 90.55 cfs

Street Q = 128.33 - 90.55 = 37.78 cfs

Street slope = 0.35%

Allowable Q (0.3' wlk.gr.) = 52.54 cfs (See Sheet 15)

Actual street Q (37.78) < Q allowable (52.54)

5. Check street flow approaching Nodes 114 - 113.

Contributing Areas

| Node | Acres |
|---|---|
| 114 | 8.70 |
| 113 | 2.01 |
| | 10.71 Ac. |

| $T_c(Q_2)$ | C | $I_{100}$ | A | $Q_{100}$ |
|---|---|---|---|---|
| 15.13 | 0.62 | 7.34 | 10.71 | 48.74 |

$Q_5$ (pipe) 113 - 102 = 22.94 cfs

Street Q = 48.74 - 22.94 = 25.8 cfs

Street slope = 0.90% (Avg.)

Allowable Q (0.3' wlk.gr.) = 84.25 cfs

(See Sheet 15)

Actual Q Street (25.8) < Q allowable (84.25)

Check Flow at Node 101

$Area = 50.13$ Ac.

$T_c = 28.77$ minutes

$I_{100} = 5.51$ in/hr

$C_{100} = 0.62$

$Q_{100} = C_{100} \times I_{100} \times A$

$Q_{100} = 0.62 \times 5.51 \times 50.13 = 171.25$ cfs

$Q_{100} - Q_5$ (pipe) = Q overflow @ South PL into channel

171.25 - 94.43 = 76.82 cfs

Investigate wier flow over south curb in Cul-de-sac, and assume flow width @ South PL = width of 100 yr. flow in street

$Q = CLH^{3/2} = 76.82 = 2.9 \times 64' \times H^{3/2}$

$H^{3/2} = 76.82/2.9 \times 64'$

$H^{3/2} = 0.4139$

$H = 0.55$ (flow depth)

Top elevation of standard curb at South PL = 1305.00

+ Flow Depth 0.55

1305.55

∴ Use walk grade 0.55 above top of curb at cul-de-sac.

STRUCTURE HEAD LOSS COMPUTATIONS - SYSTEM 100 - 2 Yr.

Node 108 - Curb Inlet, $Q_o$ only

$Q_o$ = 9.70 cfs; $V_o$ = 4.03 fps; $V_o^2/2g$ = 0.25, $D_o$ = 21"

Initial velocity, $H_v$ = 0.25

Entrance loss = 0.5 $H_v$ = 0.13

Total loss = 0.38

Node 107 - Curb Inlet + Lateral Flow

$Q_L$ = 9.70; $V_L$ = 4.03; $V_L^2/2g$ = 0.25; $D_L$ = 21"

$Q_g$ = 3.11

$Q_o$ = 12.81; $V_o$ = 4.07; $V_o^2/2g$ = 0.257; $D_o$ = 24"

$H_L - H_o = V_o^2/2g - Q_L/Q_o\ (0.3\ V_L^2/2g)$

= 0.257 - 0.757 (0.075) = 0.20

Node 109 - Curb Inlet, $Q_o$ only

$Q_o$ = 10.66; $V_o$ = 4.43; $V_o^2/2g$ = 0.30; $D_o$ = 21"

Initial Velocity, $H_v$ = 0.30;

Entrance loss = 0.5 $H_v$ = 0.15

Total loss = 0.45

Node 106 - Curb Inlet + Upstream + Lateral

$Q_u$ = 12.81; $V_u$ = 4.07; $V_u^2/2g$ = 0.257; $D_u$ = 24"

$Q_L$ = 10.66; $V_L$ = 4.43; $V_L^2/2g$ = 0.30; $D_L$ = 21"

$Q_g$ = 1.36; $Q_o$ = 24.83; $V_o$ = 3.51; $V_o^2/2g$ = 0.19; $D_o$ = 36"

$H_u - H_o = V_o^2/2g - (Q_L/Q_o)\ (0.3\ V_L^2/2g) - (Q_u/Q_o)\ (V_u^2/2g)$

= 0.19 - 0.039 - 0.133 = 0.02

<u>Node 111</u> - Curb Inlet, $Q_o$ only

$Q_o = 3.30$; $V_o = 1.87$; $V_o^2/2g = 0.05$; $D_o = 18"$

Initial Velocity, $H_v = 0.05$

Entrance Loss = $0.5\ H_v = 0.025$

Total Loss = 0.08

<u>Node 110</u> - Curb Inlet + Lateral Flow

$Q_L = 3.30$; $V_L = 1.87$; $V_L^2/2g = 0.05$; $D_L = 18"$

$Q_g = 5.88 + 9.18 = 15.06$

$Q_o = 14.72$; $V_o = 4.68$; $V_o^2/2g = 0.34$; $D_o = 24"$

$H_L - H_o = V_o^2/2g - Q_L/Q_o\ (0.53\ V_L^2/2g)$

$= 0.05 - 0.224\ (0.027) = 0.04$

<u>Node 105</u> - Curb Inlet + Upstream + Lateral

$Q_u = 24.83$; $V_u = 3.51$; $V_u^2/2g = 0.19$; $D_u = 36"$

$Q_L = 3.30$; $V_L = 1.87$; $V_L^2/2g = 0.05$; $D_L = 18"$

$Q_g = 1.47$; $Q_o = 41.02$; $V_o = 4.26$; $V_o^2/2g = 0.28$; $D_o = 42"$

$H_u - H_o = V_o^2/2g - (Q_L/Q_o)\ (0.3\ V_L^2/2g) - (Q_u/Q_o)\ (V_u^2/2g)$

$= 0.28 - 0.0012 - 0.115 = 0.16$

<u>Node 112</u> - Curb Inlet, $Q_o$ only

$Q_o = 8.99$; $V_o = 3.74$; $V_o^2/2g = 0.22$; $D_o = 21"$

Initial Velocity $H_v = 0.22$

Entrance loss = $0.5\ H_v = 0.11$

Total loss = 0.33

Node 104 - Curb Inlet + Upstream + Lateral

$Q_L = 8.99$; $V_L = 3.74$; $V_L^2/2g = 0.22$; $D_L = 21"$

$Q_u = 41.02$; $V_u = 4.26$; $V_u^2/2g = 0.28$; $D_u = 42"$

$Q_g = 1.67$

$Q_o = 51.58$; $V_o = 4.11$; $V_o^2/2g = 0.26$; $D_o = 48"$

$H_u - H_o = V_o^2/2g - Q_L/Q_o(0.3\ V_L^2/2g) - Q_u/Q_o(V_u^2/2g)$

$= 0.26 - 0.012 - 0.22 = 0.03$

Node 103 - Manhole + Upstream

$Q_u = 51.68$; $V_u = 4.11$; $V_u^2/2g = 0.26$; $D_u = 48"$

$Q_o = 51.68$; $V_o = 4.11$; $V_o^2/2g = 0.26$; $D_o = 48"$

$H_u - H_o = V_o^2/2g - Q_u/Q_o\ (V_u^2/2g)$

$= 0.26 - 0.26 = 0$

Node 114 - Curb Inlet, $Q_o$ only

$Q_o = 14.99$; $V_o = 4.77$; $V_o^2/2g = 0.35$; $D_o = 24"$

Initial Velocity $H_v = 0.35$

Entrance Loss $= 0.5\ H_v = 0.18$

Total Loss = 0.58

Node 113 - Curb Inlet + Lateral

$Q_L = 14.99$; $V_L = 4.77$; $V_L^2/2g = 0.35$; $D_L = 24"$

$Q_g = 3.45$

$Q_o = 18.44$; $V_o = 3.76$; $V_o^2/2g = 0.22$; $D_o = 30"$

$H_L - H_o = V_o^2/2g - Q_L/Q_o\ (0.3\ V_L^2/2g)$

$= 0.22 - 0.813\ (0.105) = 0.13$

Node 102 - Curb Inlet + Upstream + Lateral

$Q_u = 51.68$; $V_u = 4.11$; $V_u^2/2g = 0.26$; $D_u = 48"$

$Q_L = 18.44$; $V_L = 4.77$; $V_L^2/2g = 0.35$; $D_L = 24"$

$Q_g = 1.27$

$Q_o = 71.39$; $V_o = 5.68$; $V_o^2/2g = 0.50$; $D_o = 48"$

$$H_u - H_o = V_o^2/2g - (Q_L/Q_o)(0.3\ V_L^2/2g) - Q_u/Q_o(V_u^2/2g)$$

$$= 0.50 - 0.027 - 0.188 = 0.29$$

Node 101 - Curb Inlet + Upstream

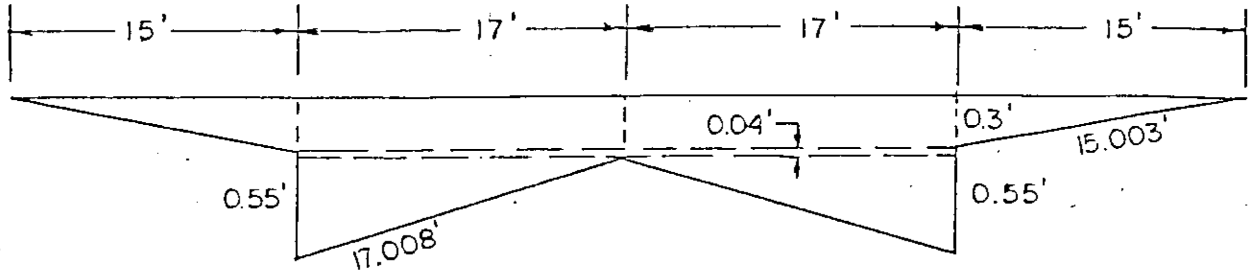
$Q_u = 71.39$; $V_u = 5.68$; $V_u^2/2g = 0.50$; $D_u = 48"$

$Q_g = 3.08$

$Q_o = 74.47$; $V_o = 5.93$; $V_o^2/2g = 0.55$; $D_o = 48"$

$$H_u - H_o = V_o^2/2g - Q_u/Q_o\ (V_u^2/2g)$$

$$= 0.55 - 0.48 = 0.07$$




"N" = 0.030 Grass
"N" = 0.013 Conc. C & G
"N" = 0.016 Asph. Pvm't

64' R/W
0.3' Min. Walk Gr.
34' Fc. to Fc. Pvm't.

$$Q = \frac{1.486}{N} AR^{2/3}S^{1/2}$$

$$\text{Weighted, "N"} = \frac{2(14.5 \times 0.030) + 2(2.5 \times 0.013) + 2(15 \times 0.016)}{65.12}$$

$$\text{"N"} = \frac{1.415}{65.12} = 0.0217$$

Wetted Perimeter, "P" = 65.12

$$\text{Area, "A"} = 2\left[\frac{0.3 \times 15}{2} + \frac{0.51 \times 17}{2} + (0.04 \times 17) + (0.3 \times 17)\right]$$

$$= 2(2.25 + 4.335 + 0.68 + 5.1)$$

"A" = 24.73 sq.ft.

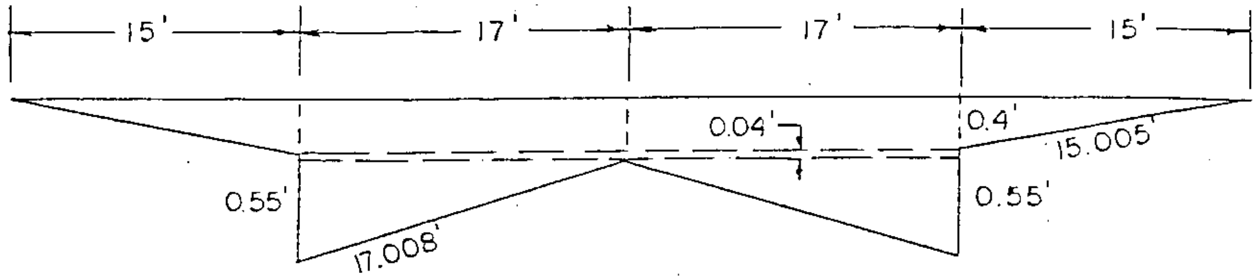
$$R_h = \frac{A}{P} = \frac{24.73}{65.12} = 0.3798; \; R^{2/3} = 0.5244$$

$$\therefore Q = \frac{1.486}{0.0217} (24.73)(0.5244)\, S^{1/2}$$

$$Q = 888.07\, (S^{1/2})$$

Then Q = 52.54 @ 0.35%

84.25 @ 0.90%




"N" = 0.030 Grass

"N" - 0.013 Conc. C & G

"N" = 0.016 Asph. Pvm't.

64' R/W

0.4' Min. Walk Gr.

34' Fc. to Fc. Pvm't

$$Q = \frac{1.486}{N} AR^{2/3}S^{1/2}$$

$$\text{Weighted "N"} = \frac{2(14.5 \times 0.030) + 2(2.5 \times 0.013) + 2(15 \times 0.016)}{65.12}$$

$$\text{"N"} = \frac{1.415}{65.12} = 0.0217$$

Wetted Perimeter, "P" = 65.12

$$\text{Area "A"} = 2\left[\frac{0.4 \times 15}{2} + \frac{0.51 \times 17}{2} + (0.4 \times 17) + (0.04 \times 17)\right]$$

$$= 2(3.00 + 4.335 + 6.8 + 0.68)$$

Area = 29.63 sq. ft.

$$R_h = \frac{A}{P} = \frac{29.63}{65.12} = 0.4550;\ R^{2/3} = 0.5916$$

$$\therefore Q = \frac{1.486}{0.0217} \times 29.63 \times 0.5916 \times S^{1/2}$$

$$Q = 1200.38\ (S^{1/2})$$

Then Q = 71.02 @ 0.35%

SAS — SHEET NUMBER 49

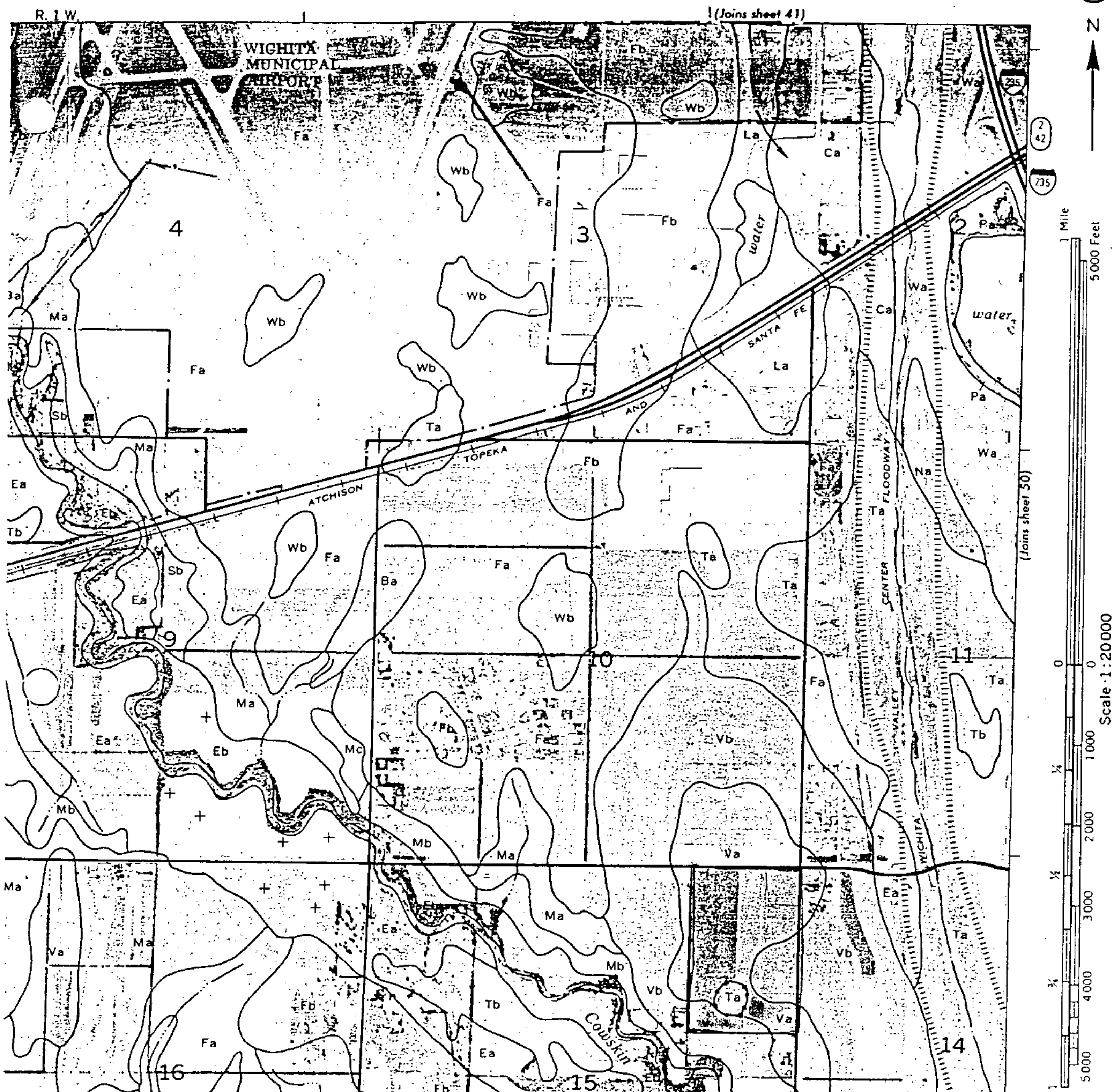


EXHIBIT NO. 1

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 |

## NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

"n" = 0.016
Z = 1/3.125' = 32
Z/n = 2,000

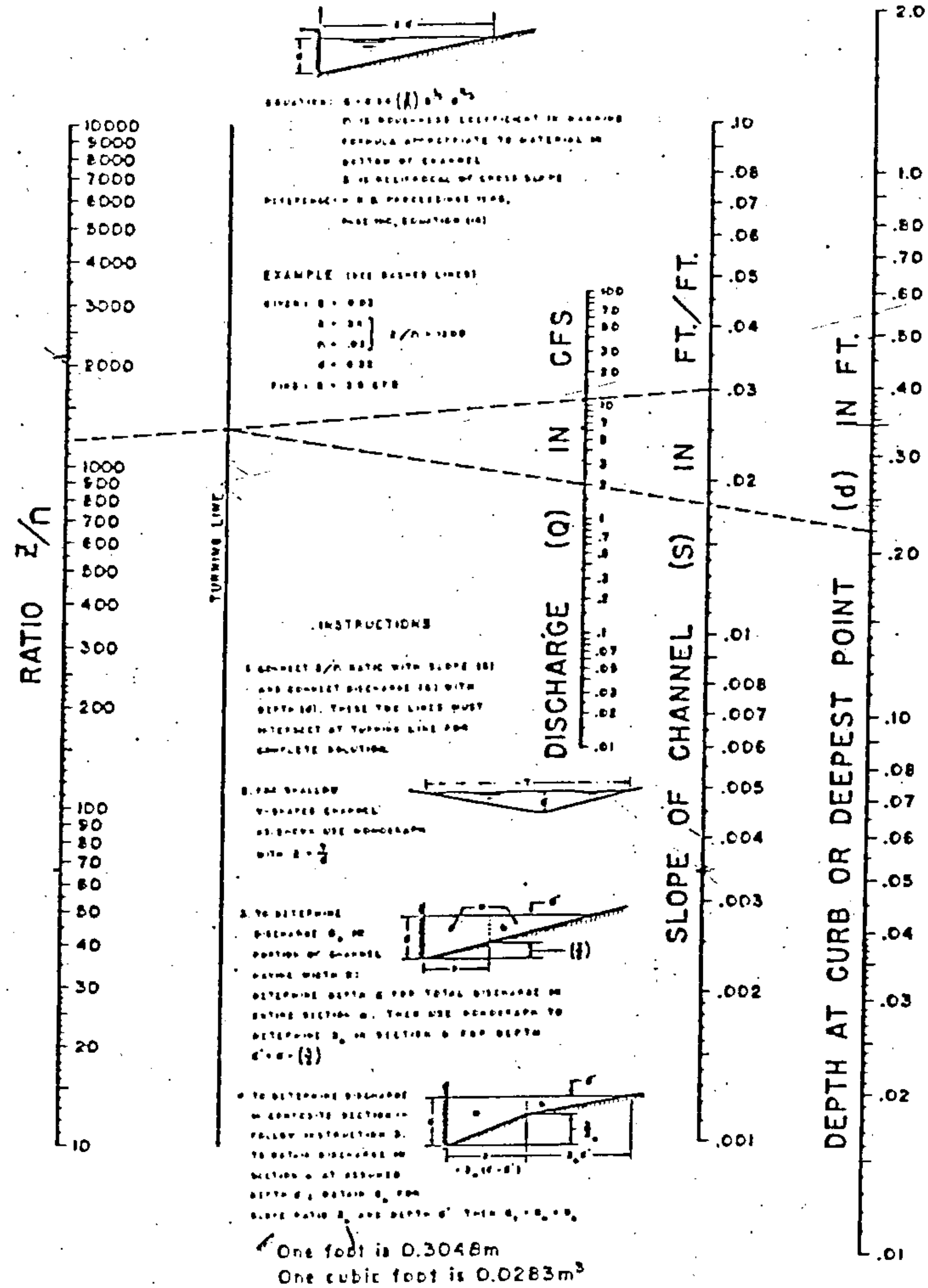
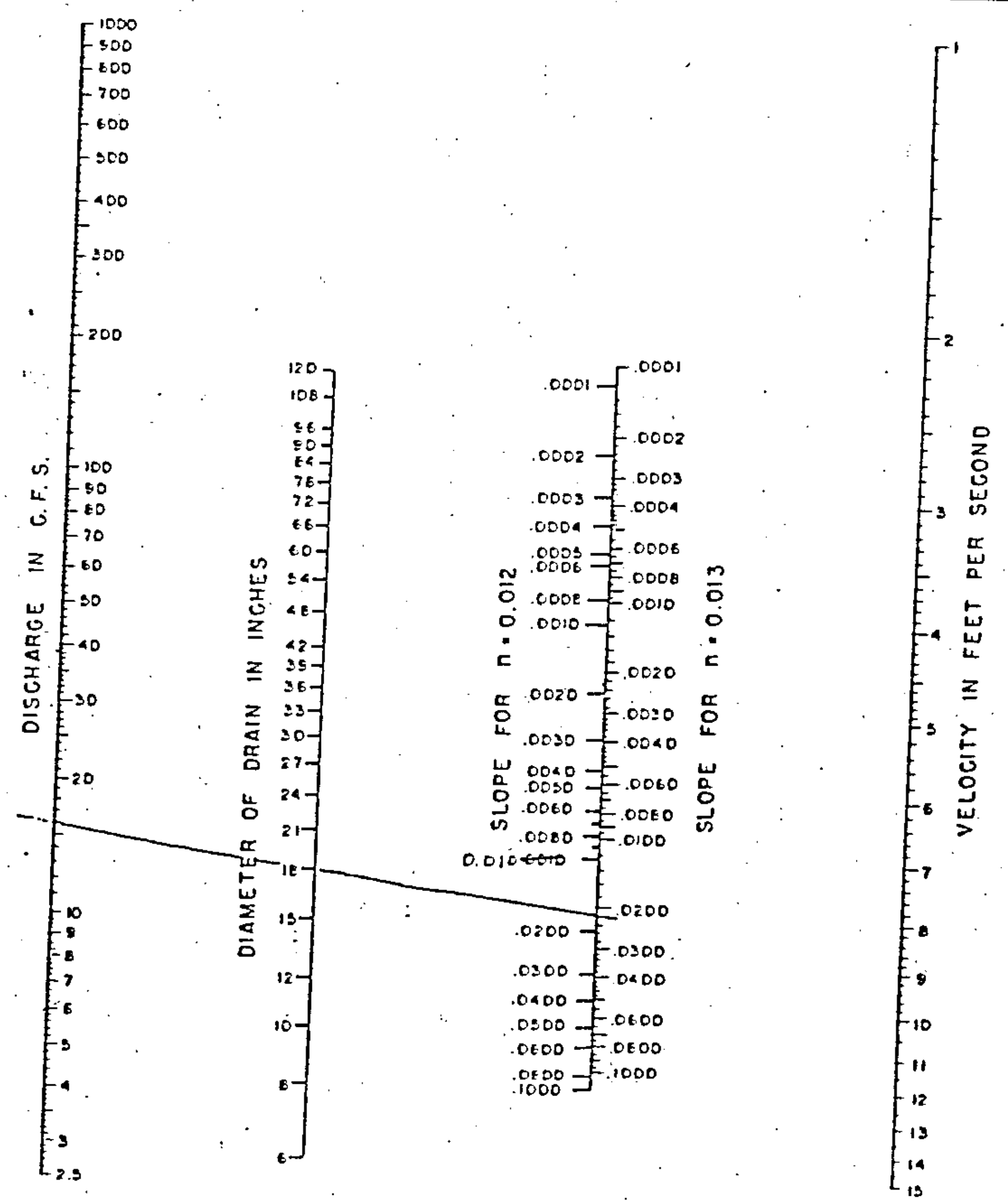



FIG. 5-1 *(After FHWA)*




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

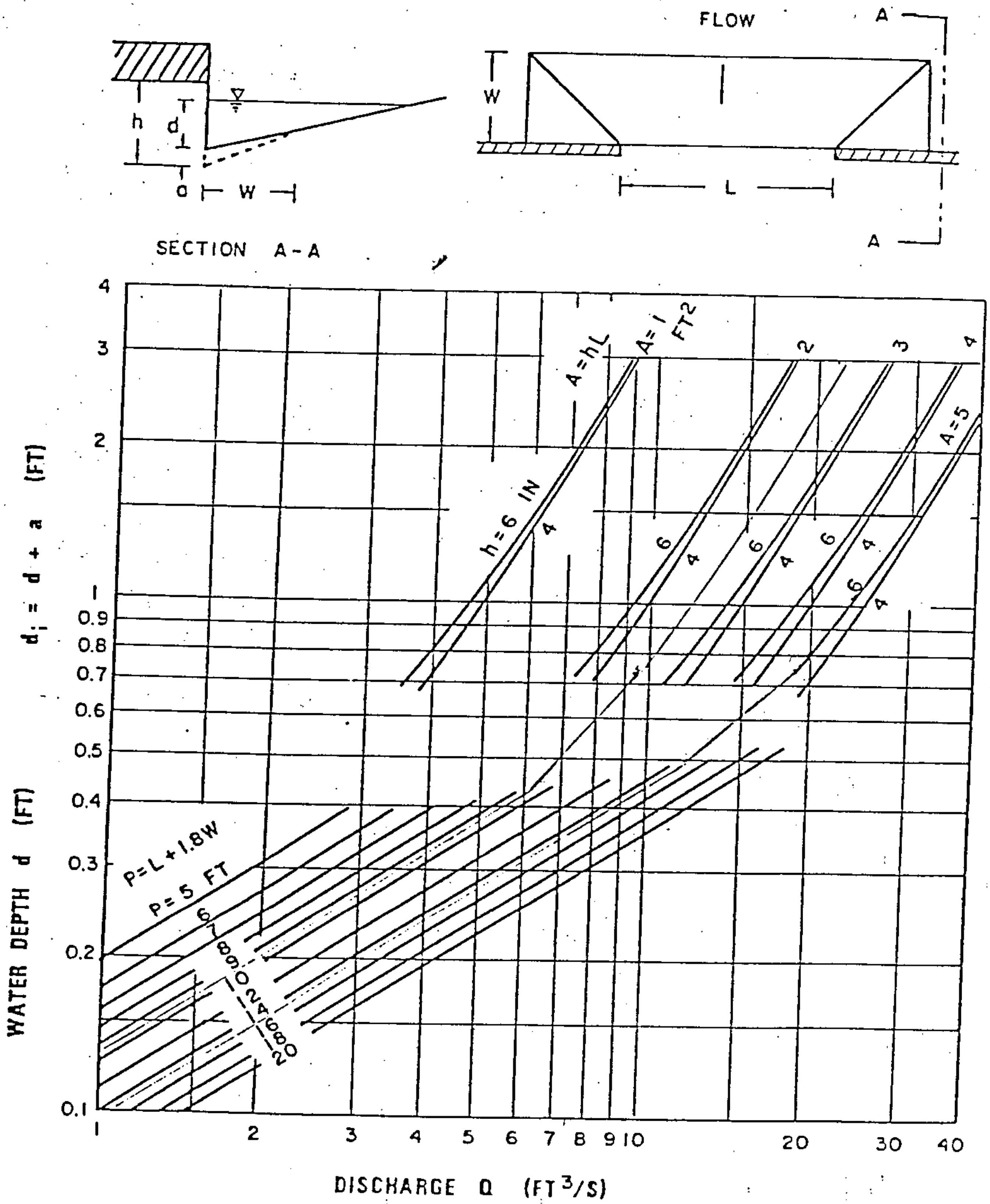



CHART 12. Depressed curb-opening inlet capacity in sump locations.

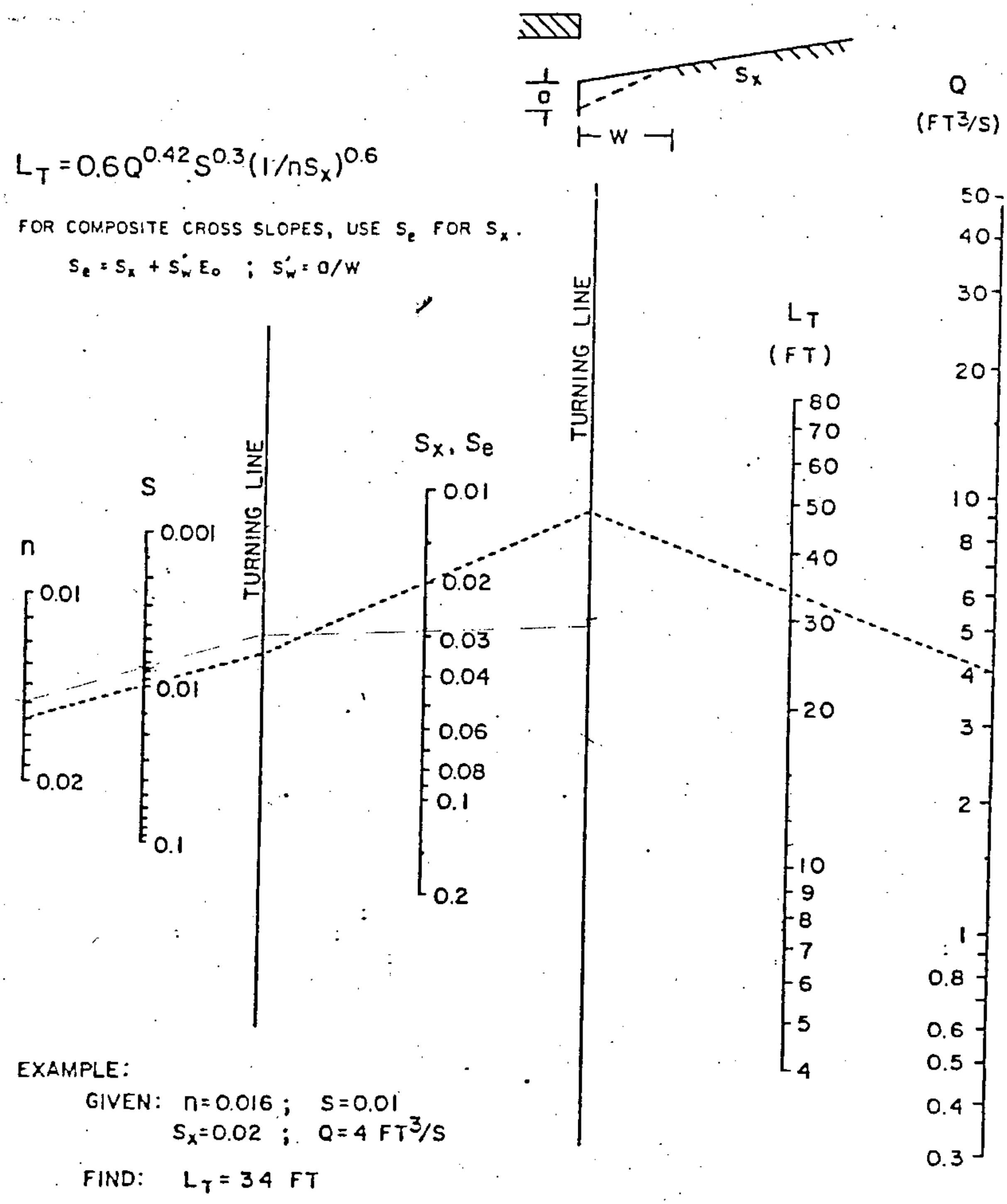



CHART 9. Curb-opening and slotted drain inlet length for total interception.

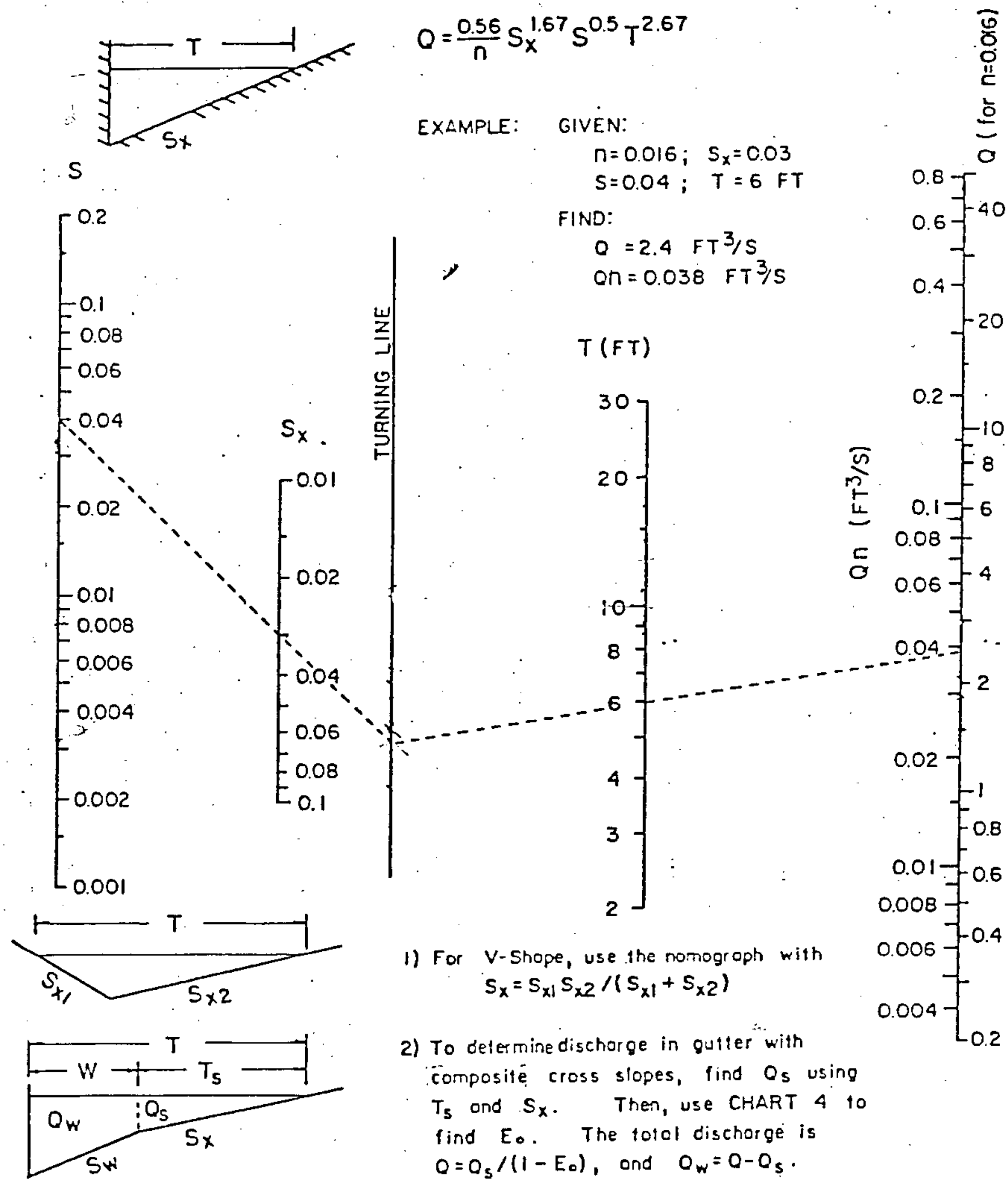



**CHART 3. Flow in triangular gutter sections.**

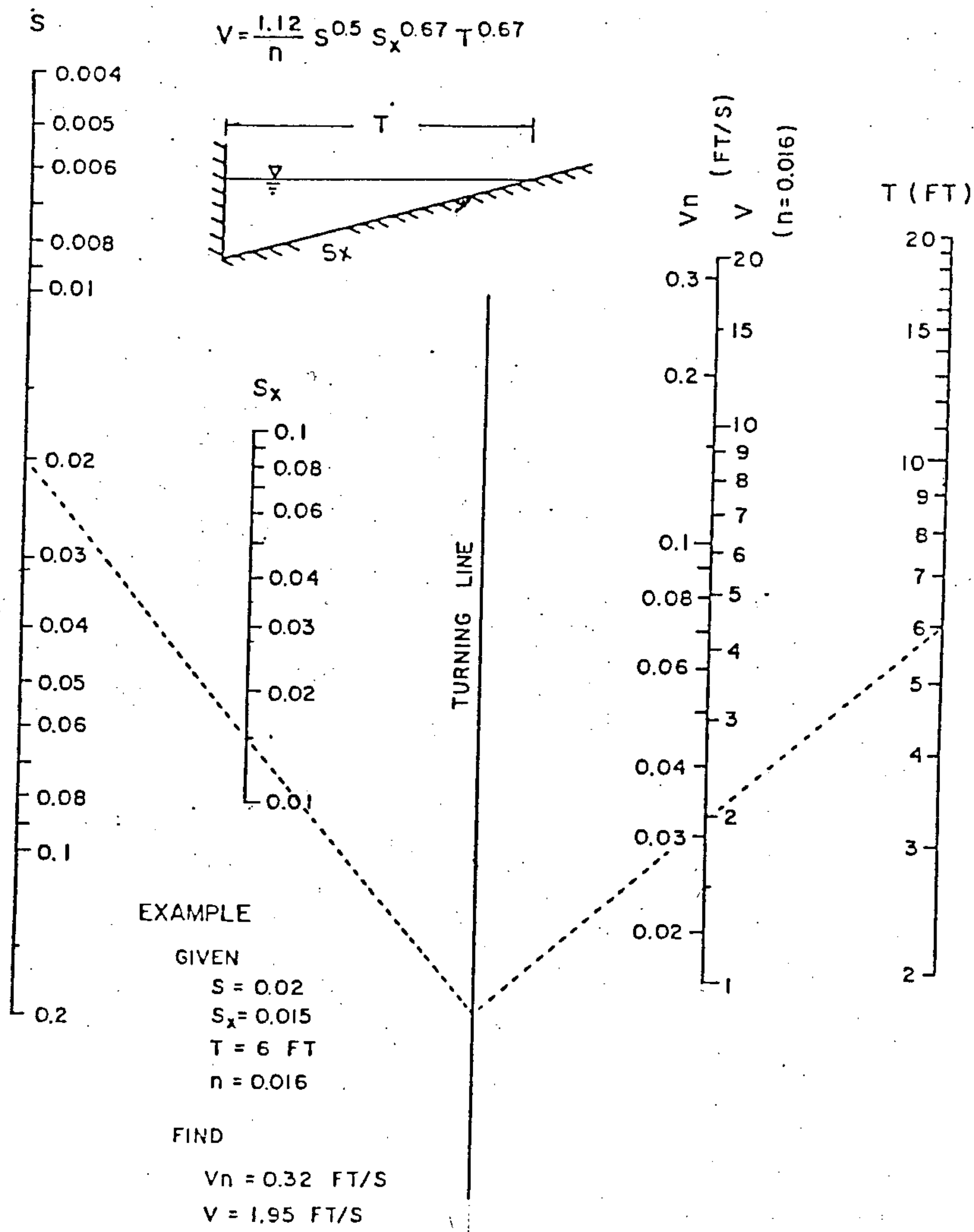



**CHART 2. Velocity in triangular gutter sections.**

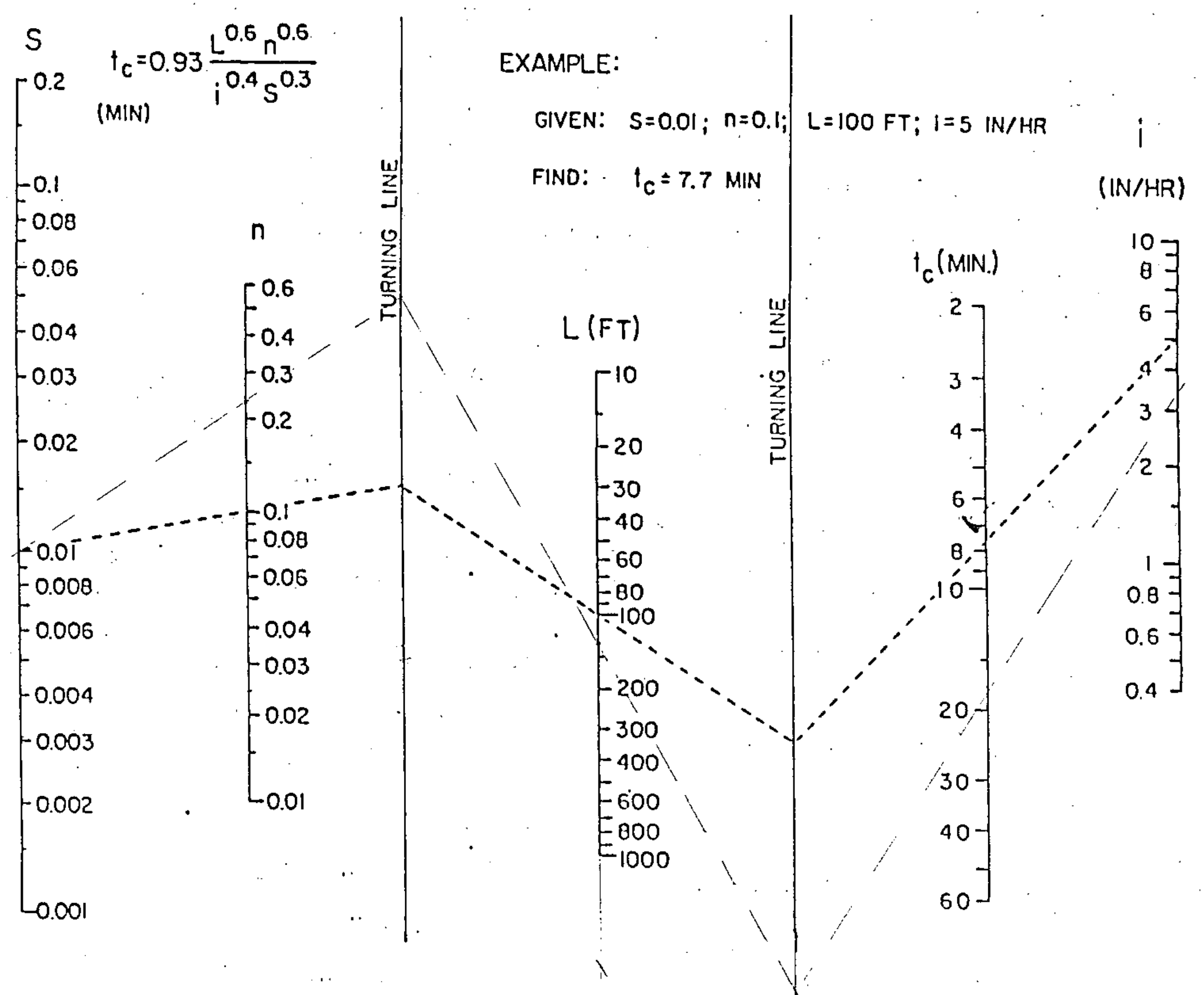



CHART 1. Kinematic wave formulation for determining time of concentration.

ATTACHMENT E

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

| Surface Type | VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 20.0 |
| Forest with Heavy Ground Litter or Meadow | 0.03 | 0.04 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.16 | 0.21 | 0.28 | 0.33 | 0.39 | 0.46 | 0.53 | 0.60 | 0.72 | 1.10 |
| Fallow or Minimum Tillage Cultivation | 0.06 | 0.08 | 0.10 | 0.12 | 0.13 | 0.14 | 0.16 | 0.17 | 0.18 | 0.19 | 0.29 | 0.40 | 0.51 | 0.66 | 0.78 | 0.91 | 1.05 | 1.20 | 1.44 | 2.10 |
| Short Grass Pasture or Lawns | 0.09 | 0.13 | 0.15 | 0.18 | 0.20 | 0.21 | 0.23 | 0.25 | 0.26 | 0.28 | 0.45 | 0.60 | 0.77 | 0.96 | 1.17 | 1.33 | 1.50 | 1.68 | 1.98 | 3.20 |
| Almost Bare Ground | 0.16 | 0.22 | 0.28 | 0.31 | 0.35 | 0.38 | 0.41 | 0.44 | 0.46 | 0.49 | 0.70 | 0.85 | 1.05 | 1.26 | 1.50 | 1.75 | 2.03 | 2.32 | 2.79 | 4.40 |
| Grassed Waterway | 0.35 | 0.48 | 0.58 | 0.67 | 0.77 | 0.84 | 0.91 | 0.98 | 1.05 | 1.12 | 1.54 | 1.82 | 2.10 | 2.38 | 2.78 | 3.20 | 3.66 | 4.14 | 4.56 | 7.00 |
| Paved Areas (Sheet Flow) or Shallow Gutter Flow | 0.44 | 0.62 | 0.77 | 0.91 | 1.05 | 1.12 | 1.19 | 1.26 | 1.33 | 1.40 | 2.00 | 2.55 | 3.20 | 3.83 | 4.41 | 5.04 | 5.70 | 6.00 | 6.20 | 9.00 |

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 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 |

WHEATLAND ADDITION — HYDROLOGY - SYSTEM 100 — 2 YR. FREQUENCY

| TRIBUTARY AREA | | | | | | SUMMATION | | | | CONDUIT DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node to Node | "C" | Area Ac. | Tc Min. | I 2 | $Q_2$ cfs | Tc Min. | I 2 | $Q_2$ cfs | $\Sigma Q_2$ | Pipe Size | Vel. fps | Length | T.T. | T.T. + Tc |
| 108 - 107 | 0.45 | 6.93 | 22.91 | 3.11 | 9.70 | 22.91 | 3.11 | 9.70 | 9.70 | 21" | 4.03 | 40 | 0.17 | 23.08 |
| 107 - 106 | 0.45 | 2.23 | 19.52 | 3.37 | 3.38 | 23.08 | 3.09 | 3.11 | 12.81 | 24" | 4.07 | 290 | 1.19 | 24.27 |
| 109 - 106 | 0.45 | 7.62 | 22.80 | 3.11 | 10.66 | 22.80 | 3.11 | 10.66 | 10.66 | 21" | 4.43 | 40 | 0.15 | 22.95 |
| 106 - 105 | 0.45 | 1.00 | 16.21 | 3.70 | 1.67 | 24.27 | 3.01 | 1.36 | 24.83 | 36" | 3.51 | 300 | 1.42 | 24.37 |
| 111 - 110 | 0.45 | 5.70 | 17.27 | 3.58 | 9.18 | 17.27 | 3.58 | 9.18 | 3.30 (by pass=5.88) | 18" | 1.87 | 30 | 0.27 | 17.54 |
| 110 - 105 | 0.45 | 3.46 | 19.95 | 3.34 | 5.20 | 17.54 | 3.56 | 5.54 | 14.72 | 24" | 4.68 | 40 | 0.14 | 17.68 |
| 105 - 104 | 0.45 | 1.09 | 15.00 | 3.83 | 1.88 | 24.37 | 3.00 | 1.47 | 41.02 | 42" | 4.26 | 300 | 0.85 | 25.22 |
| 112 - 104 | 0.45 | 5.91 | 19.43 | 3.38 | 8.99 | 19.43 | 3.38 | 8.99 | 8.99 | 21" | 3.74 | 40 | 0.18 | 19.61 |
| 104 - 103 | 0.45 | 1.26 | 15.00 | 3.83 | 2.17 | 25.22 | 2.95 | 1.67 | 51.68 | 48" | 4.11 | 290 | 1.18 | 26.40 |
| 103 - 102 | - | - | - | - | - | 26.40 | - | - | 51.68 | 48" | 4.11 | 300 | 1.22 | 27.62 |
| 114 - 113 | 0.45 | 8.70 | 15.02 | 3.83 | 14.99 | 15.02 | 3.83 | 14.99 | 14.99 | 24" | 4.77 | 40 | 0.14 | 15.16 |
| 113 - 102 | 0.45 | 2.01 | 15.00 | 3.83 | 3.46 | 15.16 | 3.81 | 3.45 | 18.44 | 30" | 3.76 | 270 | 1.20 | 16.36 |
| 102 - 101 | 0.45 | 1.76 | 19.44 | 3.38 | 2.68 | 27.62 | 2.80 | =2.22 -0.95 by pass | 71.39 | 48" | 5.68 | 125 | 0.37 | 27.99 |
| 101 - 100 | 0.45 | 2.46 | 15.00 | 3.83 | 4.24 | 27.99 | 2.78 | 3.08 | 74.47 | 48" | 5.93 | 240 | 0.68 | 28.67 |
| | | | | | | | | | | | | | | |

WHEATLAND ADDITION

5 YEAR

| TRIBUTARY AREA | | | | | | SUMMATION | | | | CONDUIT DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node to Node | "C" | Area Ac. | Tc Min. | $I_5$ | $Q_5$ cfs | Tc Min. | $I_5$ | $Q_5$ cfs | $\Sigma Q_5$ | Pipe Size | Vel. fps | Length | T.T. | T.T. + Tc |
| 108 - 107 | 0.47 | 6.93 | 22.91 | 3.74 | 12.18 | 22.91 | 3.74 | 12.18 | 12.18 | 21" | 5.06 | 40 | 0.13 | 23.04 |
| 107 - 106 | 0.47 | 2.23 | 19.52 | 4.05 | 4.24 | 23.04 | 3.73 | 3.91 | 16.09 | 24" | 5.12 | 290 | 0.94 | 23.98 |
| 109 - 106 | 0.47 | 7.62 | 22.80 | 3.75 | 13.43 | 22.80 | 3.75 | 13.43 | 13.43 | 21" | 5.58 | 40 | 0.12 | 22.91 |
| 106 - 105 | 0.47 | 1.00 | 16.21 | 4.41 | 2.07 | 23.98 | 3.65 | 1.72 | 31.24 | 36" | 4.42 | 300 | 1.13 | 25.11 |
| 111 - 110 | 0.47 | 5.70 | 17.27 | 4.28 | 11.48 | 17.27 | 4.28 | 11.48 | 4.13 by-pass=7.35 | 18" | 2.34 | 30 | 0.21 | 17.48 |
| 110 - 105 | 0.47 | 3.46 | 19.95 | 4.01 | 6.52 | 17.48 | 4.26 | 6.92 | 18.40 | 24" | 5.86 | 40 | 0.11 | 17.59 |
| 105 - 104 | 0.47 | 1.09 | 15.00 | 4.56 | 2.34 | 25.11 | 3.56 | 1.83 | 51.47 | 42" | 5.35 | 300 | 0.93 | 26.04 |
| 112 - 104 | 0.47 | 5.91 | 19.43 | 4.06 | 11.28 | 19.43 | 4.06 | 11.28 | 11.28 | 21" | 4.69 | 40 | 0.14 | 19.57 |
| 104 - 103 | 0.47 | 1.26 | 15.00 | 4.56 | 2.70 | 26.04 | 3.50 | 2.07 | 64.82 | 48" | 5.16 | 290 | 0.94 | 26.98 |
| 103 - 102 | - | - | - | - | - | 26.98 | - | - | 64.82 | 48" | 5.16 | 300 | 0.97 | 27.95 |
| 114 - 113 | 0.47 | 8.70 | 15.02 | 4.56 | 18.65 | 15.02 | 4.56 | 18.65 | 18.65 | 24" | 5.94 | 40 | 0.11 | 15.13 |
| 113 - 102 | 0.47 | 2.01 | 15.00 | 4.56 | 4.31 | 15.13 | 4.54 | 4.29 | 22.94 | 30" | 4.67 | 270 | 0.96 | 16.09 |
| 102 - 101 | 0.47 | 1.76 | 19.44 | 4.06 | 3.36 | 27.95 | 3.37 | 2.79 | 90.55 | 48" | 7.21 | 125 | 0.29 | 28.24 |
| 101 - 100 | 0.47 | 2.46 | 15.00 | 4.56 | 5.27 | 28.24 | 3.35 | 3.88 | 94.43 | 48" | 7.51 | 240 | 0.53 | 28.77 |