

DRAINAGE PLAN  
AND  
SUPPORTING CALCULATIONS

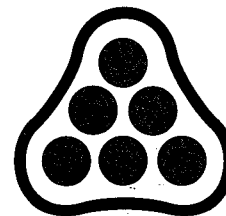
FOR  
NORTHRIDGE LAKES  
AN ADDITION TO WICHITA, SEDGWICK COUNTY, KANSAS

PREPARED BY  
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.

ENGINEERS  
WICHITA, KANSAS

VOLUME II

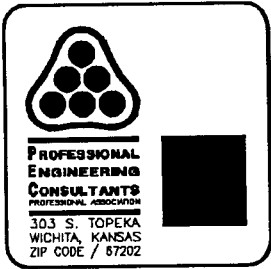
MAY 1, 1995



**P**ROFESSIONAL  
**E**NGINEERING  
**C**ONSULTANTS  
PROFESSIONAL ASSOCIATION

303 S. TOPEKA  
WICHITA, KANSAS 67202  
(316) 262-2691  
FAX (316) 262-3003

# MEMO



TO: Michael E. Lindebak, P.E.  
455 N. Main, 7th Floor  
Wichita, KS 67202  
ATTN: Vicky Huang, P.E.

PROJECT NO. 36-95054-3466  
PROJECT: NorthRidge Lakes  
Drainage Plan  
DATE: 5/1/95

COPIES TO:

Mary Schellenberg  
\_\_\_\_\_  
\_\_\_\_\_

FROM: Michael W. Berry, P.E. *MB*  
REFERENCE: Drainage Plan Computations  
*Michael W. Berry*  
*5/1/95*

PLEASE ADVISE IMMEDIATELY OF ANY MISCONCEPTIONS OR OMISSIONS YOU BELIEVE TO BE CONTAINED HEREIN.

Attached hereto are the computations for the referenced project.

Manual #1, as referenced herein, 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.

The analysis made herein is based on the available site data which includes 1"=100' topographic map with 2' contours, project plans for various improvements on adjacent lands, and the original Drainage Plans for: Sterling Farms Addition (1988) and Sterling Farms 2nd Addition (1993); Sterling Farms 3rd Addition (1993); Reflection Ridge 6th Addition (1991); Reflection Ridge 7th Addition (1991); Reference is also made to Volume I of this report dated Feb. 24, 1995, for detention basin design.

For storm sewer design, the Rational Method was used for hydrologic analysis.

For this development, a uniform assumption of the minimum time of concentration value of 15 minutes was appropriate.

Travel time for flow-through defined channels, pipes, etc., for these basins was estimated on the basis of Manning's Equation.

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

$$Q = 0.56 (Z/n) S^{1/2} d^{8/3} \text{ (Manual #1)}$$

It was assumed that  $t_c$  for street flow was equal to  $t_c$  for pipe flow. This is a conservative assumption, as pipe velocities generally exceed gutter velocities.

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

Inlet capacities were determined by the methods presented in Manual #2, using Chart No. 9 through 12.

In this analysis, City of Wichita Type 1A inlets and 3/8 in./ft. street cross-slope were assumed to be utilized. Minimum walk grade was assumed as 0.3 feet above the top of curb, except as otherwise noted. Local streets are assumed to have 3-5/8" roll curb and gutter unless otherwise noted.

Grate inlets were assumed to be Std. 4' x 2' design.

All storm sewer systems serve residential streets. Therefore, the design minor storm has a recurrence interval of two years, and the major storm one hundred years. Systems are designed for the minor storm, with major storm overflows directed through pipes at sump locations to the ponds.

The following pipe systems are sized to handle the 100-year flow:

- Nodes 206 to 201
- Nodes 303 to 301
- Node 402 to 401
- Nodes 503 to 501
- Nodes 803 to 801

To simplify analysis, the following assumptions were made:

1. The time of concentration is identical for both the major and minor storm.
2. The street conveyance was analyzed using only the street width. Depths above the curb up to the walk grade were used, but the conveyance of the parking was neglected. In general, the parking area conveyance is quite small, due to the relatively higher "n" factor.

Hydraulic computations for the pipe system were performed using Manning's Equation. All pipes were assumed to be reinforced concrete with a Manning's "n" factor of 0.013. It is desirable to keep the hydraulic grade line approximately one foot below the top of curb elevations for the minor storm.

#### HYDRAULIC MODELS FOR DETENTION

The detention basins were analyzed in Volume I of this report.

#### DRAINAGE MAP

A 1"=100' scale drainage map is included in a map pocket at the back of the report.

PROJECT: NORTHRIDGE LAKES  
WICHITA, KS

PROFESSIONAL  
ENGINEERING  
CONSULTANTS, P.A.

# HYDROLOGY DATA

COMP BY : MWB

4/30/95

	BASIN	AREA A (AC)	RUNOFF COEFF. C	TIME OF CONC. Tc (MIN)	RAINFALL INTENSITY I2 (IN/HR)	2-YEAR DISCHARGE Q2 (CFS)	RAINFALL INTENSITY I100(IN/HR)	100-YR DISCHARGE Q100 (CFS)
	A	B	C	D	E	F	G	H
1								
2	A	1.7	0.5	15	3.83	3.26	7.37	6.26
3	B	1.7	0.5	15	3.83	3.26	7.37	6.26
4	C	0.9	0.5	15	3.83	1.72	7.37	3.31
5	D	2.8	0.5	15	3.83	5.36	7.37	10.30
6	E	1.5	0.5	15	3.83	2.87	7.37	5.52
7	F	1.1	0.5	15	3.83	2.11	7.37	4.04
8	G	1.8	0.5	15	3.83	3.45	7.37	6.62
9	H	0.6	0.5	15	3.83	1.15	7.37	2.21
10	J	0.8	0.5	15	3.83	1.53	7.37	2.94
11	K	0.5	0.5	15	3.83	0.96	7.37	1.84
12	L	0.6	0.5	15	3.83	1.15	7.37	2.21
13	M	0.6	0.5	15	3.83	1.15	7.37	2.21
14	N	1.0	0.5	15	3.83	1.91	7.37	3.68
15	P	4.2	0.5	15	3.83	8.04	7.37	15.44
16	Q	3.4	0.5	15	3.83	6.51	7.37	12.50
17	R	9.0	0.5	15	3.83	17.24	7.37	33.09
18	S	4.0	0.5	15	3.83	7.66	7.37	14.71
19	T	0.6	0.5	15	3.83	1.15	7.37	2.21
20	U	0.4	0.5	15	3.83	0.77	7.37	1.47
21	V	0.9	0.5	15	3.83	1.72	7.37	3.31
22	W	1.9	0.5	15	3.83	3.64	7.37	6.99
23	X	1.3	0.5	15	3.83	2.49	7.37	4.78
24	Y	0.6	0.5	15	3.83	1.15	7.37	2.21
25	Z	0.8	0.5	15	3.83	1.53	7.37	2.94
26	AA	2.8 1.7	0.5	15	3.83	3.26 4.98	7.37	6.25 9.58
27	BB	0.8 1.8	0.5	15	3.83	3.44 1.72	7.37	6.02 3.31
28	CC	1.1	0.5	15	3.83	2.11	7.37	4.04
29	DD	1.2	0.5	15	3.83	2.30	7.37	4.41
30	EE	0.9	0.5	15	3.83	1.72	7.37	3.31
31	FF	0.8	0.5	15	3.83	1.53	7.37	2.94
32	GG	0.9	0.5	15	3.83	3.83	7.37	7.35
33	HH	2.0	0.5	15	3.83	3.83	7.37	7.35
34	JJ	1.5	0.5	15	3.83	2.87	7.37	5.52
35	KK	1.1	0.5	15	3.83	2.11	7.37	4.04
36	LL	1.3	0.5	15	3.83	2.49	7.37	4.78
37	MM	1.1	0.5	15	3.83	2.11	7.37	4.04
38	NN	1.4	0.5	15	3.83	2.68	7.37	5.15
39	PP	0.7	0.5	15	3.83	1.34	7.37	2.57
40	QQ	0.9	0.5	15	3.83	1.72	7.37	3.31
41	RR	0.3	0.5	15	3.83	0.57	7.37	1.10





Date 4.30.95 Page  /  of  /  Comp by M/S

Project NORTH RIDGE LAKES BG 95054 3406

Item Q2 SYSTEM 100

z/n = 2000

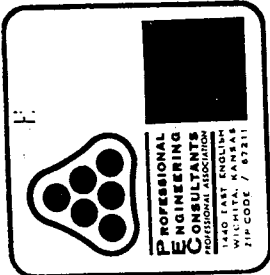
**INLET CAPACITY**

NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP.				SUMP COMP.			
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d ft	T ft	TYPE	L	L <sub>t</sub> ft	L/L <sub>t</sub>	E ft	d <sub>i</sub> ft	d ft	T ft	Q <sub>i</sub> cfs	Q <sub>b</sub> cfs
GG	1.7	-	0.6%	3/8	0.24	7.7	1A	5'				0.17	0	0	1.7	
FF	1.5	-	↓	↓	0.22	7.0	1A	5'				OK	BY	NUSP		
FE	1.7	-			0.24	7.7	1A	5'				OK	BY	NUSP		

Project Northridge Lakes 36.95254 3466

Item Q2 SYSTEM 200

$z/n = \frac{32}{0.016} = 2000$  **INLET CAPACITY**



BASIN NODE No.	HYDROLOGY		APPROACHING FLOW				INLET			ON-GRADE COMP				SUMP COMP.				
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d <sub>1</sub> ft	T <sub>1</sub> ft	TYPE	L	Lt	L/Lt	E	ft	d <sub>1</sub> ft	d	T	ft	Q <sub>1</sub> cfs	Q <sub>b</sub> cfs
S=209	7.7		1%	3/8	0.35	11'	A	5'	—	—	—	—	0.57'	0.40	13'	7.7	0	
R=208	17.2	—	1%		0.48	15.4		10'					0.72'	0.55'	17'	17.7	0	
206-208-204 & 202																		
BG=203	3.4		0.5%		0.23	7.4												
100YK →	6.6		0.5%		0.40	12.8												
4=207	0.8		0.4%		—	OK BY												

REAR YARD GATE INLETS IN SUMP → USE CORN 4' x 2' INLETS

INSPECTION.

NOTE 0.83' OVER CROWN BUT 209 HAS EXCESS CAPACITY

Date 4.30.95

Page 1 of 1

Comp by MBS

Project NORTH RIDGE LAKES

30 95054 3466

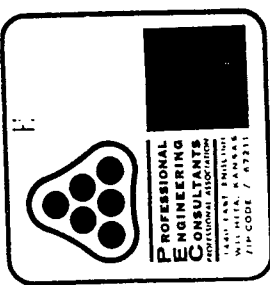
Item Q2 SYSTEM 300

$z/n = 2000$

**INLET CAPACITY**

BASIN/ NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		GN-GRADE COMP			SUMP COMP.			Qb cfs	
	Qo cfs	Qo+Qb cfs	So o/o	Sx in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft		Qi cfs
T	1.2	-	0.6%	3/8	0.19	6.1	OK - NO INLET	NO INLET	70	305	THRU V.G.	THRU V.G.	THRU V.G.	15.4	8.5	-0-
W	3.6	-	0.5%		0.31	9.9	OK - NO INLET	NO INLET	70	305	THRU V.G.	THRU V.G.	THRU V.G.	15.4	8.5	-0-
X	2.5	7.3	2%		0.32	10.2										
Y	1.2	-	0.3%		0.23	7.4										
V	1.7	-	2%		0.25	8'	OK BY INSP.?	INTD 304	5'							
Z	1.5	-	0.3%		0.25	8'			5'							
CC	2.1	-	0.6%		0.24'	7.7		302								
DD	2.3	-	0.6%		0.26'	8.3		303								

THESE INLETS SIZED ON Q100 BASIS



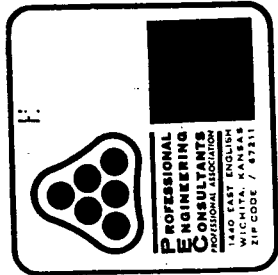




Project NORTH RIDGE LAKES 36 95054 3466

Item Q100 SYSTEM 400

z/n = 2000 **INLET CAPACITY**



NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP.			SUMP COMP.			Q <sub>b</sub> cfs	
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	d <sub>i</sub> ft	d ft	T ft		Q <sub>i</sub> cfs
D	10.3	—	0.5%	3/8	0.45	14.4	1A	10'	—	—	—	0.47	0.30	9.6	10.3	—

Project NORTH RIDGE LAKES

Item R2 SYSTEM 500

36 95054 3466

**INLET CAPACITY**

z/n = 2000



NODE No.	HYDROLOGY		APPROACHING FLOW			INLET		ON-GRADE COMP.				SUMP COMP.				
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	d <sub>i</sub> ft	d ft	T ft	Q <sub>1</sub> cfs	Q <sub>b</sub> cfs
N	1.9	-	0.4%	3/8	0.25	8.0	- NONE, V <sub>G</sub>								0	1.9
M	1.2	-	2.0%	3/8	OK BY MSP		- V <sub>G</sub>								0	1.2
L	1.1	-	2.0%	3/8	OK BY MSP		- V <sub>G</sub>								0	1.1
K	1.0	5.2	0.4%	3/8	0.38	12.2	- V <sub>G</sub>								0	12.2
J	1.5	13.7	0.4%	3/8	0.52	17	IF ON GRADE L=10' USED								0	13.7
H	1.2	14.9	1.5%	3/8	0.43'	13.8	IA	10'	34'	0.29	0.45				6.2	7.5
	W/O INLETS	8.7	1.5%	3/8	0.36'	11.5	IA	10'				0.62	0.45	14.4	14.9	0
	W/ INLETS	8.7	1.5%	3/8			NO INLET REQ'D AT J					0.44	0.27	8.6	8.7	0
Q	6.5	-	0.4%	3/8	0.4	12.8	NONE								0	6.5
P	8.0	14.5	0.4%	3/8	0.55	17	NONE								0	14.5
G	3.4	17.9	1.5%	3/8	0.46	14.7	IA	10'				0.62	0.45	14.4	17.9	0

NO INLETS REQ'D AT J





Date 4.30.95 Page      of      Comp by MB

Project NORTH RIDGE LAKES 36 95054 3466

Item Q2 SYSTEM 600

z/n = 2000 **INLET CAPACITY**

NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP.				SUMP COMP.		Qb cfs	
	Qo cfs	Qo+Qb cfs	So o/o	Sx in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft		Q1 cfs
MM	2.1	-	0.5%	3/8	0.25	8.0	003									
PP	1.3	3.4	0.67%	3/8	0.29	9.3	003									
RR	0.6	-	0.3%	3/8	0.17	5.4	003	5'				0.37	0.20	6.4	4.0	0-
NN	2.7	-	0.5%	3/8	0.28	9.0	002									
QQ	1.7	4.4	0.67%	3/8	0.33	10.6	002									
SS	0.7	-	0.3%	3/8	0.18	5.8	002	5'				0.40	0.23	7.4	5.1	-

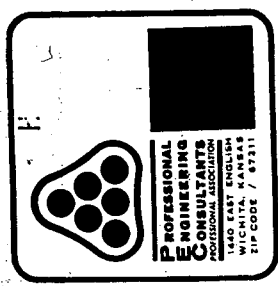


Project NORTH RIDGE LAKES

Item Q2 SYSTEM 700

**INLET CAPACITY**

z/n = 2000



NODE No.	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP.				SUMP COMP.			
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d ft	T ft	TYPE	L	L <sub>t</sub> ft	L/L <sub>t</sub>	E ft	d <sub>i</sub> ft	d ft	T ft	Q <sub>i</sub> cfs	Q <sub>b</sub> cfs
E	2.9	—	1.3%	3/8	0.25	8.0	NONE									
C	1.7	—	1.3%	3/8	0.20	6.4										
B	3.3	7.9	1.5%	3/8	0.35	11.2										
A	3.3	11.2	0.75%	3/8	0.43	13.8	1A	10'				0.5	0.33	10.7	11.2	0
F	2.1	—	0.75%	3/8	0.23	7.4	1A	5'				0.22	0.05	1.6	2.1	0

Date 4.30.95

Page 1 of 1

Comp by MJC

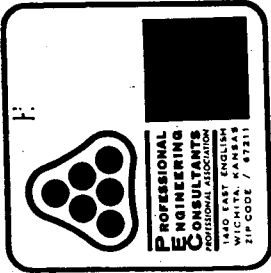
Project NORTH RIDGE LAKES

36 95054 3166

Item SYSTEM 8 Q2 4 Q100

$z/n = 2000$

**INLET CAPACITY**



NODE No:	HYDROLOGY		APPROACHING FLOW			INLET		ON-GRADE COMP.				SUMP COMP.				
	Q <sub>0</sub> cfs	Q <sub>0</sub> +Q <sub>b</sub> cfs	S <sub>0</sub> o/o	S <sub>x</sub> in/ft	d ft	T ft	TYPE	L	L <sub>t</sub> ft	L/L <sub>t</sub>	E ft	d <sub>i</sub> ft	d ft	T ft	Q <sub>i</sub> cfs	Q <sub>b</sub> cfs
LL	2.5	-	0.5%	3/8	0.28	9.0	→	TO JJ	THRU V.G.						0	2.5
KK	2.1	-	0.5%	3/8	0.26	8.3	→	TO JJ	AROUND CURB RETURN						0	2.1
JJ	2.9	7.5	2.0%	3/8	0.33	10.0	1A	→	SIZE FOR Q100							
HH	3.8	-	2.0%	3/8	-	BY INSP										
LL	4.8		0.5%	3/8	0.34	10.9										
KK	4.0		0.5%	3/8	0.32	10.2	1A	10'				0.60'	0.43'	13.5	14.3	-0-
JJ	5.5	14.3	2.0%	3/8	0.42	13.4										
HH	7.4		2.0%	3/8	0.32	10.2	1A	5'				0.52'	0.35'	11.2	7.4	-0-



PROFESSIONAL  
ENGINEERING  
CONSULTANTS  
PROFESSIONAL ASSOCIATION  
303 S. TOPEKA  
WICHITA, KANSAS  
ZIP CODE: 67202

Date 4.30.95 MMB Page \_\_\_\_\_ of \_\_\_\_\_

Project NORTH RIDGE LAKES

Item GRATE INLETS

36 95054 3466

USE 4'x2' C.O.W. GRATES DEETER 2434 GRATE/FRAME

ASSUME 50% CLOGGING;  $A = 0.5 \times 36 \text{ SQ. IN.} / 144 \text{ SQ. IN.} / \text{SQ. FT.} = 1.25 \text{ SQ. FT.}$   
 $P = 4 + 2 + 4 + 2 = 12 \text{ LF}$

BASIN	$Q_2$	$d_2$	FLOW TYPE	$Q_{100}$	$d_{100}$	FLOW TYPE
-------	-------	-------	-----------	-----------	-----------	-----------

AA (3 EQUAL SUB BASINS)				$Q_2 = 3.3$	$Q_{100} = 6.3$	
-------------------------	--	--	--	-------------	-----------------	--

AA	1.1 cfs	0.1'	WEIR	2.1 cfs	0.15'	WEIR
----	---------	------	------	---------	-------	------

WN	1.0 cfs	0.1'	WEIR	1.8 cfs	0.14'	WEIR
----	---------	------	------	---------	-------	------

VV	1.7 cfs	0.14'	WEIR	3.3 cfs	0.21'	WEIR
----	---------	-------	------	---------	-------	------

# HYDROLOGY DATA SHEET

PAGE 1 OF 1

PROJECT: North Ridge Lakes PROJECT NO. 95054 3462

ITEM: SYSTEM 200 DATE: 4.30.95

RETURN PERIOD: 100 YR COMPUTATIONS BY: MMS REVISIONS BY: \_\_\_\_\_



**PROFESSIONAL  
ENGINEERING  
CONSULTANTS**  
PROFESSIONAL ASSOCIATION

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

SCHMATIC DIAGRAM:

SUB-BASIN (1)	TRIBUTARY AREA							HYDROLOGY SUMMATION					CONDUIT DATA				
	C (2)	AREA (acres) (3)	SLOPE (%) (4)	LENGTH (feet) (5)	T <sub>c</sub> (minutes) (6)	I <sub>0</sub> in./hr. (7)	Q <sub>0</sub> (cfs) (8)	T <sub>c</sub> (minutes) (9)	I in./hr. (10)	Q (cfs) (11)	Σ Q (cfs) (12)	PIPE (inches) (13)	SLOPE (%) (14)	VELOCITY (ft./sec.) (15)	LENGTH (feet) (16)	T <sub>t</sub> (minutes) (17)	T <sub>c</sub> + T <sub>t</sub> (minutes) (18)
209								15	7.37		7.7	18"	0.54%	4.3	30	0.1	15.1
208						17.7		15.1	7.35		25.4	36"	0.15%	3.6	30	0.1	15.2
207						0.8					26.2	36"	0.15%	3.7	140	0.6	15.8
206						Q <sub>100</sub> = 1.1					1.1	15"	0.03%	0.9	175	3.3	18.3
205						"		18.3	6.79	1.0	2.1	15"	0.11%	1.7	175	1.7	20.0
204						"		20.0	6.53	1.0	3.1						
203						6.6		15	7.37	6.6		18"	0.40%	3.7	130	0.6	15.6
A+204						T <sub>c</sub> = 15.6 governs											
						Q = 20.2 + $\frac{15.6}{20.0} (3.1) = 28.6$					28.6	36"	0.18%	4.0	200	0.8	16.6
A+202						Q = $\frac{15.6}{16.6} \cdot 6.6 + 20.6 = 34.8$					34.8	42"	0.12%	3.6	200	0.9	17.5

1/40°





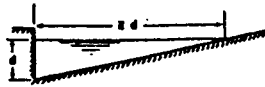








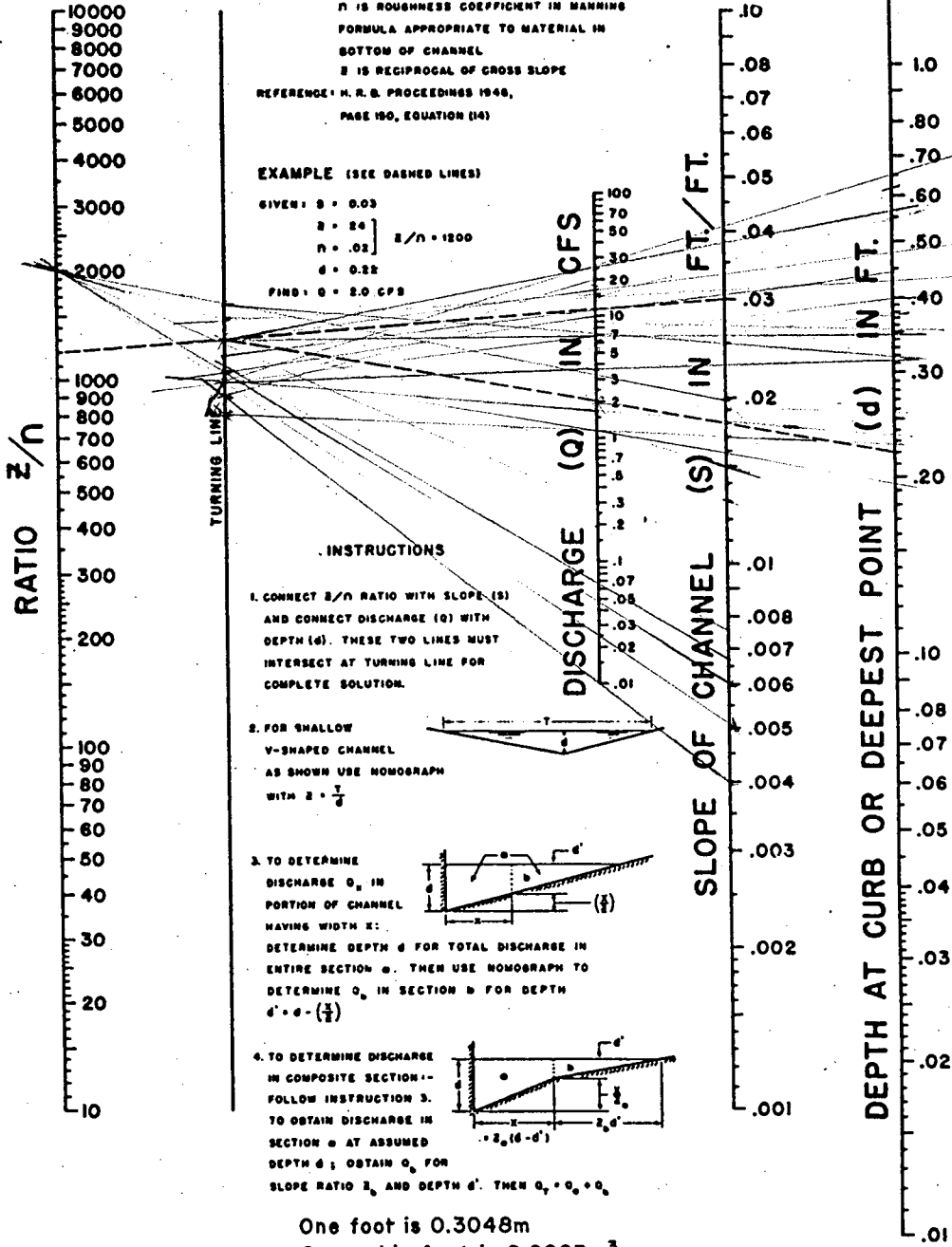
# NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS



EQUATION:  $Q = 0.56 \left(\frac{S}{n}\right)^{1/2} d^{3/2}$   
 $n$  IS ROUGHNESS COEFFICIENT IN MANNING  
 FORMULA APPROPRIATE TO MATERIAL IN  
 BOTTOM OF CHANNEL  
 $S$  IS RECIPROCAL OF CROSS SLOPE  
 REFERENCE: M. R. S. PROCEEDINGS 1948,  
 PAGE 150, EQUATION (14)

**EXAMPLE (SEE DASHED LINES)**

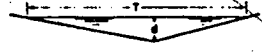
GIVEN:  $S = 0.03$   
 $z = 24$   
 $n = .02$   $S/n = 1200$   
 $d = 0.22$   
 FIND:  $Q = 2.0$  CFS



**INSTRUCTIONS**

1. CONNECT  $S/n$  RATIO WITH SLOPE (S) AND CONNECT DISCHARGE (Q) WITH DEPTH (d). THESE TWO LINES MUST INTERSECT AT TURNING LINE FOR COMPLETE SOLUTION.

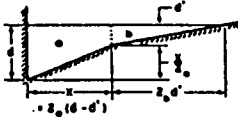
2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH WITH  $z = \frac{1}{2}$



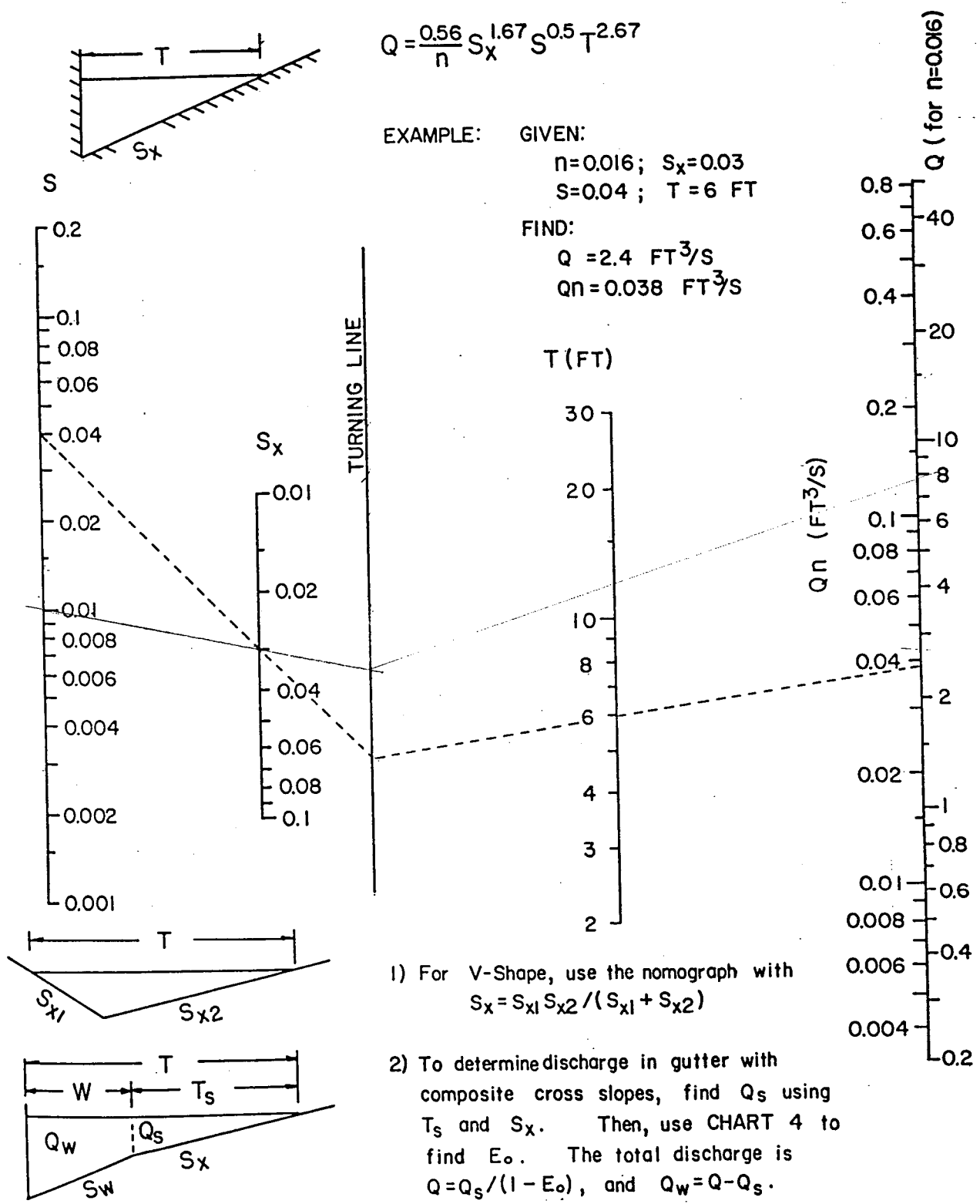
3. TO DETERMINE DISCHARGE  $Q_1$  IN PORTION OF CHANNEL HAVING WIDTH  $x$ : DETERMINE DEPTH  $d$  FOR TOTAL DISCHARGE IN ENTIRE SECTION  $a$ . THEN USE NOMOGRAPH TO DETERMINE  $Q_2$  IN SECTION  $b$  FOR DEPTH  $d' = d \cdot \left(\frac{x}{a}\right)$



4. TO DETERMINE DISCHARGE IN COMPOSITE SECTION -- FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE IN SECTION  $a$  AT ASSUMED DEPTH  $d$ ; OBTAIN  $Q_2$  FOR SLOPE RATIO  $S_2$  AND DEPTH  $d'$ . THEN  $Q_1 = Q_2 \cdot \frac{a}{x}$



One foot is 0.3048m  
 One cubic foot is 0.0283m<sup>3</sup>



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

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



PROFESSIONAL  
ENGINEERING  
LICENSED  
1400 EAST ENGLISH  
WICHITA, KANSAS  
ZIP CODE 67211

Date 5/30/85 MWB Page \_\_\_\_\_ of \_\_\_\_\_

Project \_\_\_\_\_

Item STREET FLOW EQUATIONS

35' BK-BK STREET (1/2 STREET CAPACITY)

$$15' \times \frac{3}{8}''/1' = 0.46875'$$

$$\# \text{ to } \epsilon = 0.47 + 0.05 = 0.52$$

Curb deep flow is 0.03' above crown.

$$T = (\text{depth above } \#) / S_x$$

$$n = 0.016$$

$$S_x = \frac{3}{16} \text{ in / ft} = 0.03125 \text{ ft / ft}$$

$$B = T - 16.6' \quad (\text{See I Below})$$

I. At d = 0.52' (Crown deep)

$$T = 0.52 / 0.03125 = 16.6'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(16.6')^{8/3} - 1^{8/3}]$$

$$= 194.58 \sqrt{S}$$

II At d = 0.55' (Curb deep)

$$T = 17.6'$$

$$B = 1.0'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(17.6')^{8/3} - 1^{8/3}]$$

$$= 227.32 \sqrt{S}$$

III. At d = 0.85' (T.C. + 0.302') (14'-6" Pkg.) (1/4" / 1' Sl.)

$$d = 0.85$$

$$T = 27.26$$

$$B = 10.66$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(27.26)^{8/3} - (10.66)^{8/3}]$$

$$= 670.66 \sqrt{S}$$

IV At T.C. + 0.41' (14'-6" Pkg., 3/8" / 1' Sl.)

$$d = 0.96'$$

$$T = 30.72'$$

$$B = 14.12'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(30.72)^{8/3} - (14.12)^{8/3}]$$

$$= 878.09 \sqrt{S}$$

V At T.C. + 0.52' (14'-6" Pkg., 1/2" / 1' Sl.)

$$d = 1.07'$$

$$T = 34.24'$$

$$B = 17.64'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(34.24)^{8/3} - (17.64)^{8/3}]$$

$$= 1112.64 \sqrt{S}$$

VI At T.C. + 0.63' (14'-6" Pkg., 5/8" / 1' Sl.)

$$d = 1.18'$$

$$T = 37.76'$$

$$B = 21.16'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(37.76)^{8/3} - (21.16)^{8/3}]$$

$$Q = 1369.72 \sqrt{S}$$

VII At d = 0.30' TC Roll Curb

$$d = 0.3' \quad T = 9.6 \text{ ft}$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} (9.6)^{8/3} \sqrt{S}$$

$$Q = 45.17 \sqrt{S}$$



PROFESSIONAL  
ENGINEERING  
SULTANTS  
ONAL ASSOCIATION  
1440 EAST ENGLISH  
WICHITA, KANSAS  
ZIP CODE 67211

Date 3/14/85 MWB Page \_\_\_\_\_ of \_\_\_\_\_

Project \_\_\_\_\_

Item STREET FLOW EQUATIONS

29' BK-BK STREET (1/2 STREET CAPACITY)

$$12 \times \frac{3}{8} \text{ " } = 0.375'$$

$$H \text{ to } E = 0.375 + 0.05 = 0.425'$$

Curb deep flow does is 0.125' above crown.  
Above  $d = 0.375'$ , deduction of area B req'd.

$$T = (\text{depth above } H) / S_x$$

$$n = 0.016$$

$$S_x = \frac{3}{8} \text{ " } / \text{ft} = 0.03125$$

$$B = T - 13.6$$

I. At  $d = 0.425'$  (crown deep)

$$d = 0.425$$

$$T = 13.6'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} (13.6)^{8/3} \sqrt{S}$$

$$Q = 114.36 \sqrt{S}$$

II. At  $d = T.C.$

$$d = 0.55'$$

$$T = 17.6$$

$$B = 4.0$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(17.6)^{8/3} - (4)^{8/3}]$$

$$= 223.06 \sqrt{S}$$

III. At  $T.C. + 0.302'$  (4'-6" Plug, 1/4" Sl.)

$$d = 0.852'$$

$$T = 27.264$$

$$B = 13.664$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} (\sqrt{S}) [(27.264)^{8/3} - (13.664)^{8/3}]$$

$$= 614.878 \sqrt{S}$$

IV. At  $T.C. + 0.41'$  (14'-6" Pkg, 3/8" Sl.)

$$d = 0.96'$$

$$T = 30.72'$$

$$B = 17.12'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(30.72)^{8/3} - (17.12)^{8/3}]$$

$$Q = 793.215 \sqrt{S}$$

V. At  $T.C. + 0.52'$  (14'-6" Pkg, 1/2" Sl.)

$$d = 1.07'$$

$$T = 34.24'$$

$$B = 20.64'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(34.24)^{8/3} - (20.64)^{8/3}]$$

$$Q = 993.613 \sqrt{S}$$

VI. At  $T.C. + 0.63'$  (14'-6" Pkg, 5/8" Sl.)

$$d = 1.18'$$

$$T = 37.76'$$

$$B = 24.16'$$

$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} \sqrt{S} [(37.76)^{8/3} - (24.16)^{8/3}]$$

$$Q = 1212.07 \sqrt{S}$$

VII. At 3 3/8" Roll  $T.C. = 0.30' = d.$

$$d = 0.3$$

$$T = 9.6 \text{ ft}$$

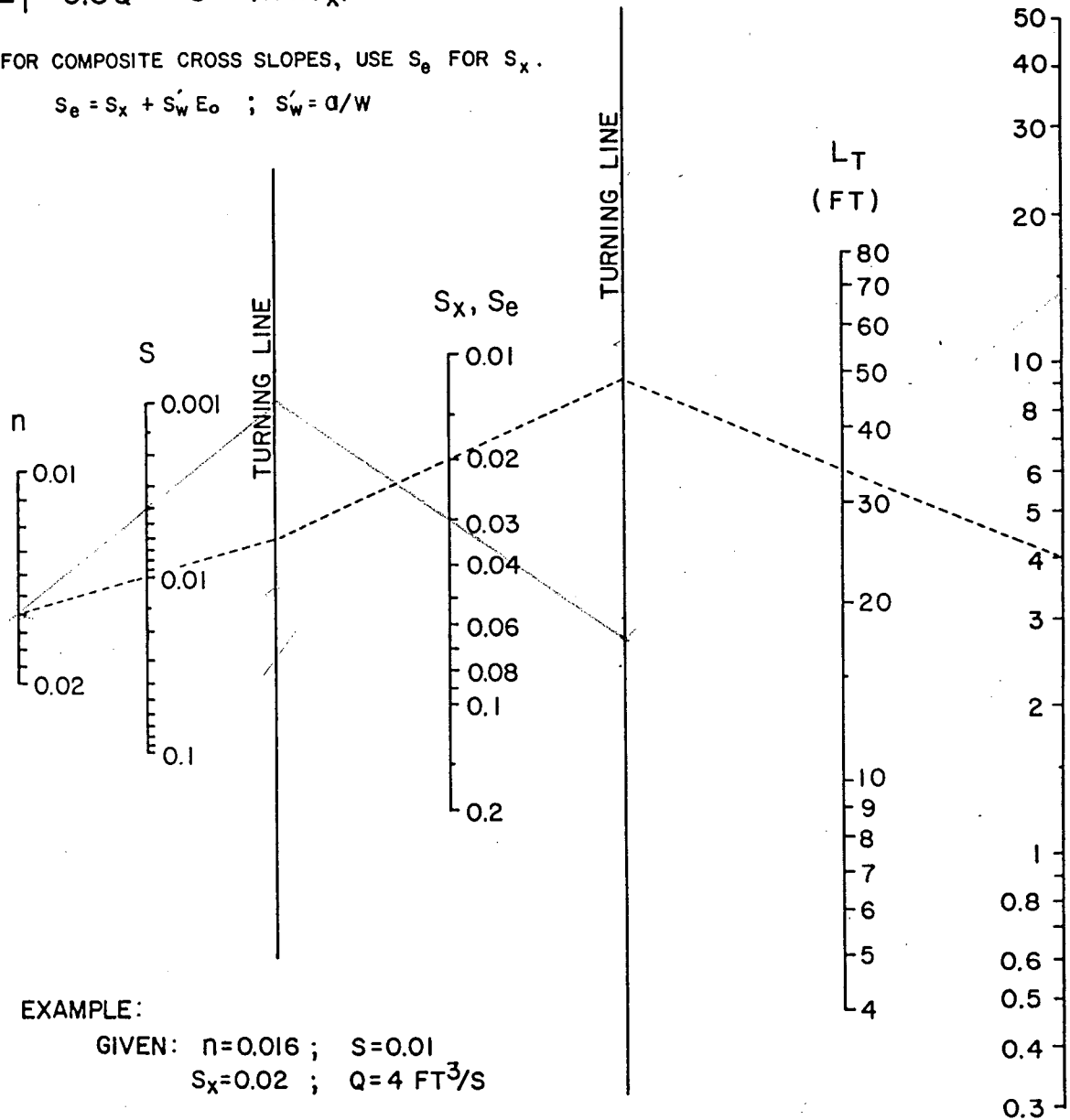
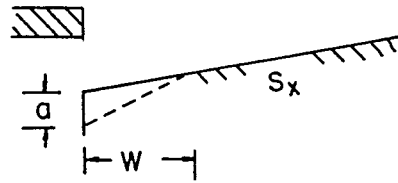
$$Q = \frac{0.56}{0.016} (0.03125)^{5/3} (9.6)^{8/3} \sqrt{S}$$

$$= 45.17 \sqrt{S}$$

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

FOR COMPOSITE CROSS SLOPES, USE  $S_e$  FOR  $S_x$ .

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



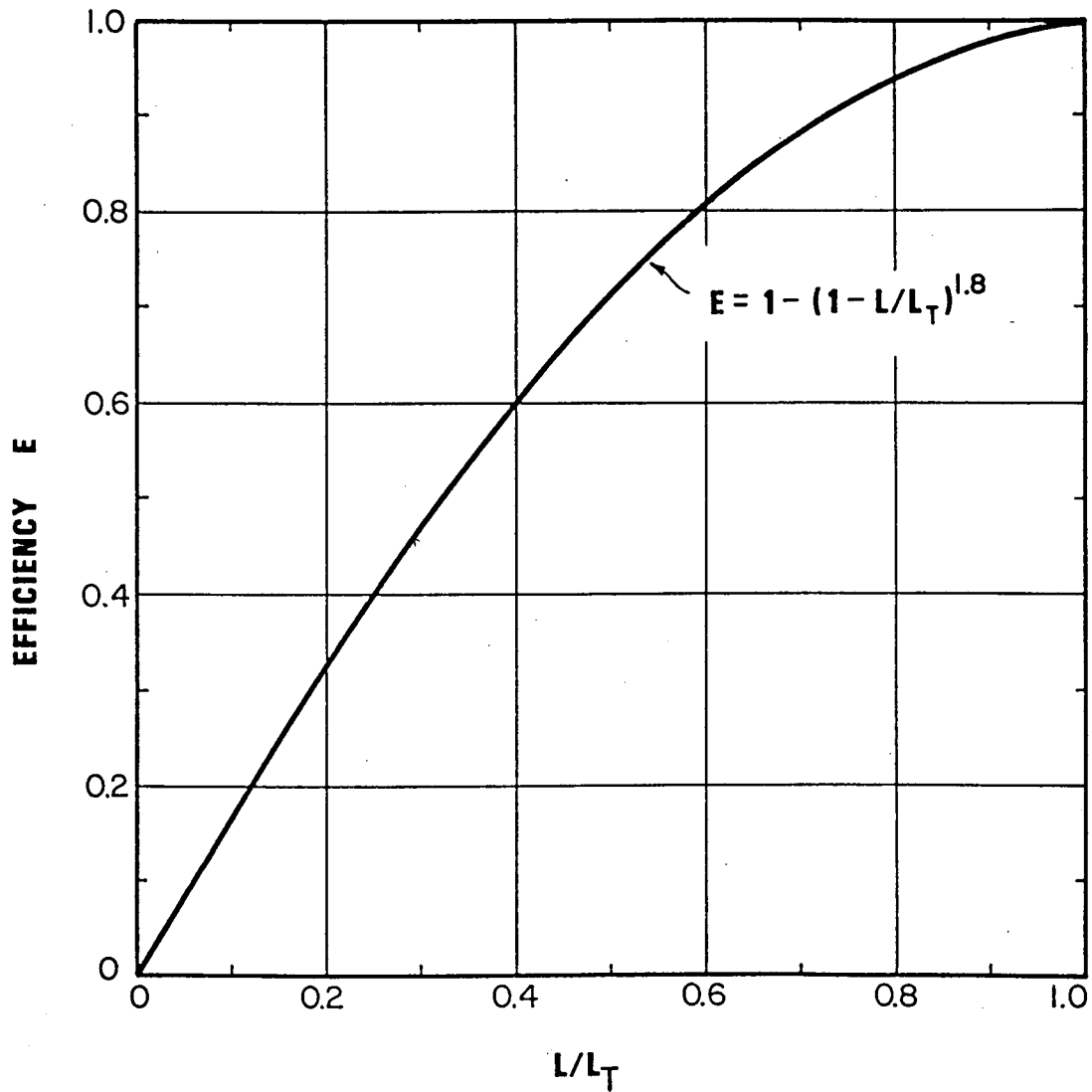
EXAMPLE:

GIVEN:  $n=0.016$  ;  $S=0.01$   
 $S_x=0.02$  ;  $Q=4 \text{ FT}^3/\text{S}$

FIND:  $L_T = 34 \text{ FT}$

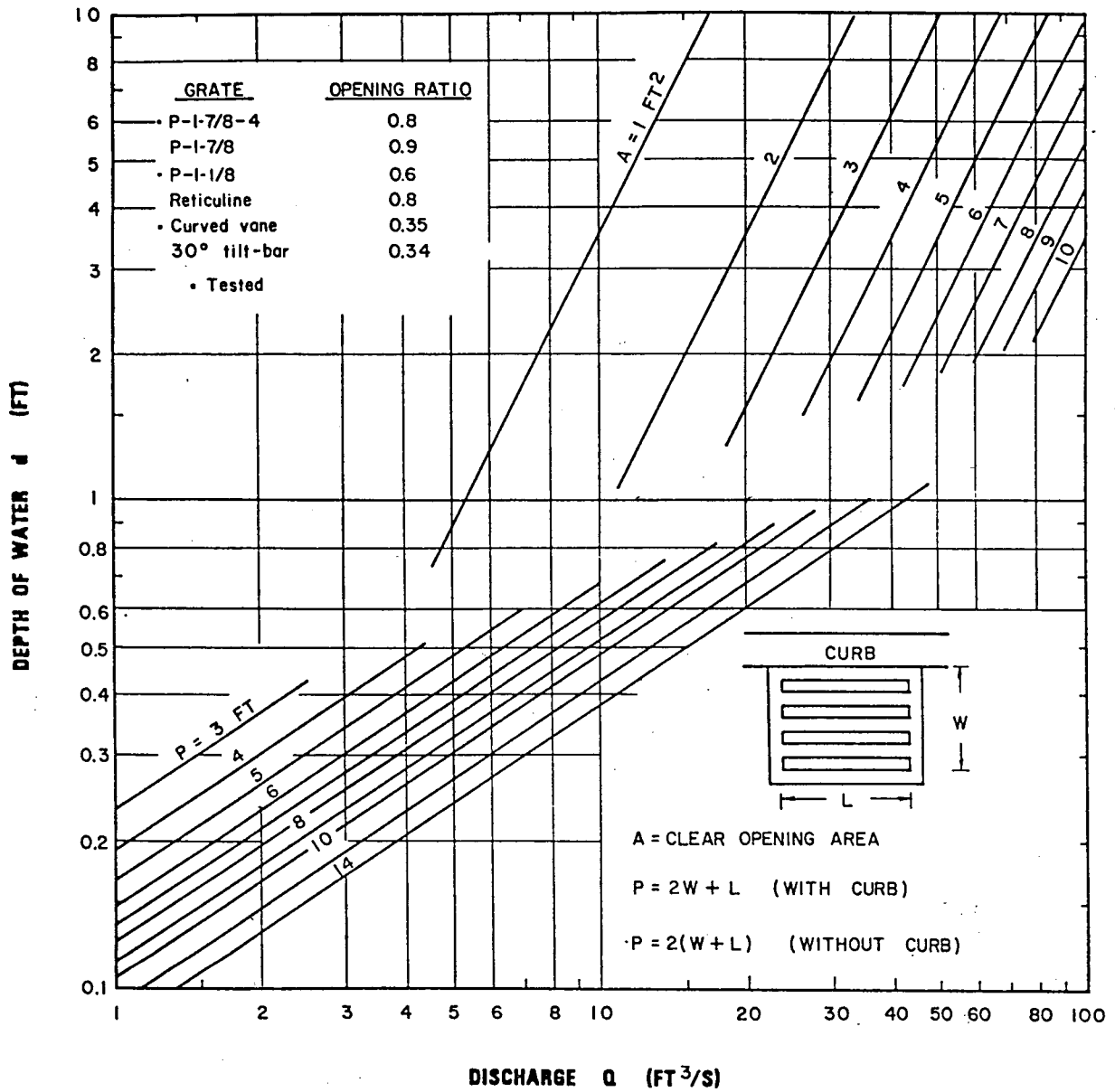
### CHART 9. Curb-opening and slotted drain inlet length for total interception.

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



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

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



**CHART 11. Grate inlet capacity in sump conditions.**

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

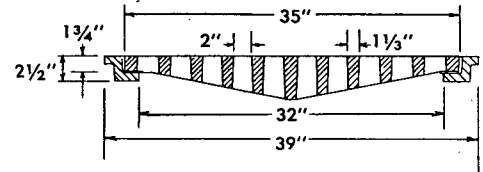
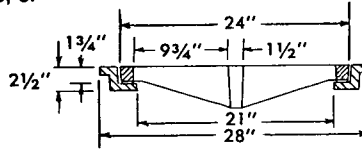
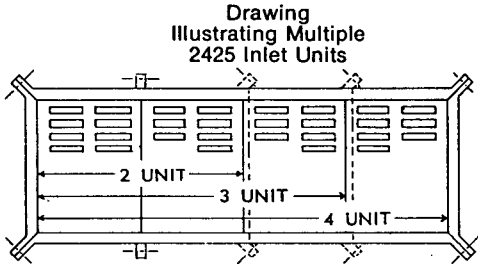
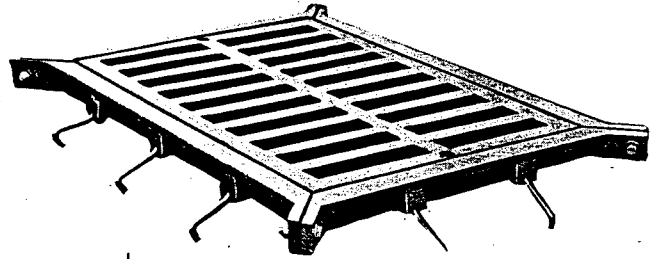
## 2425 Inlet Grate & Sectional Frame

**Heavy Duty**

Total Wt. for single unit — 380#

Open Area for single unit — 390 Sq. In.

1. Grates can be bolted to frames with  $\frac{3}{8}$ " x 2" brass bolts.
2. Frequently used for airport installations.
3. If multiple units are desired specify double, triple, or quadruple units.



## Also: Western Iron & Fdy Co. 400G Grate 2433-2434 Catch Basin Inlet Grate & Frame

**Heavy Duty**

**Open Area**

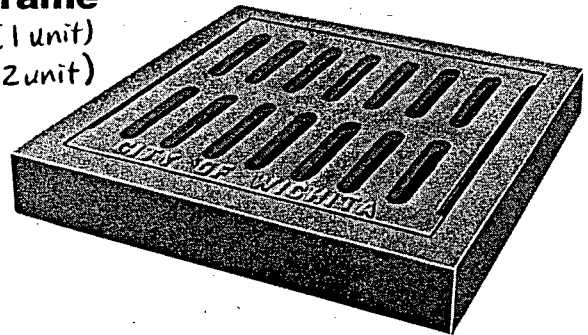
Total Wt. — 2433 — 520# — 184 Sq. In.

2434 — 890# — 368 Sq. In.

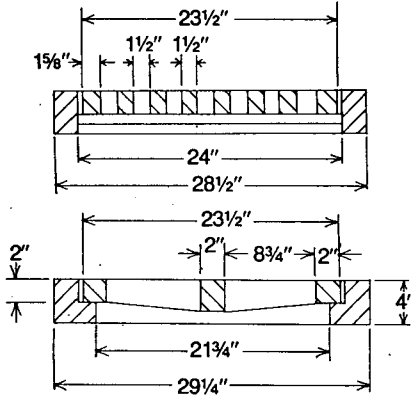
1. 2434 frame requires two grates.

400F Frame (1 unit)

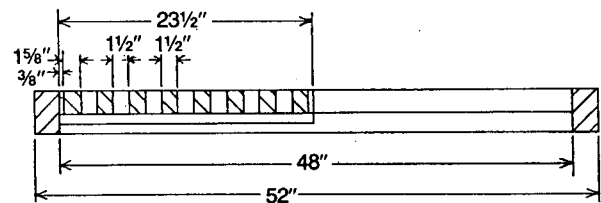
408F Frame (2 unit)



Illustrating 2433  
Catch Basin Grate & Frame



Drawing  
Illustrating 2433 Catch  
Basin Grate & Frame



Drawing  
Illustrating 2434 Catch  
Basin Grate & Frame

## 2435 Catch Basin Inlet Grate & Frame

**Heavy Duty**

Total Wt. — 1105#

Open Area — 473 Sq. In.

1. Frame requires two grates.

