Professional Engineering Consultants, P.A.

DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS

BALTHROP 4TH ADDITION

WICHITA, SEDGWICK COUNTY, KANSAS

JANUARY 25, 2002

1263 S.W. TOPEKA BLVD.
TOPEKA, KANSAS
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OFFICES IN:
WICHITA
TOPEKA
LAWRENCE

PREPARED BY:

Professional Engineering Consultants, P.A.
1263 S. W. Topeka Boulevard
Topeka, Kansas 66612

PEC PROJECT NO. 99624-2051

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AND
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DATE: January 25, 2002

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MEMO

TO: Mr. Michael E. Lindebak, P.E.
City Engineer
455 N. Main
Wichita, Kansas 67202

ATTENTION: V. R. Huang, P.E.

REFERENCE: Drainage Plan Computations

FROM: Michael W. Berry, P.E. MWB

PROJECT NO.: 99624-2051

PROJECT: Balthrop 4th Addition

COPIES TO:

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

Attached hereto are the computations for the referenced project. This report supercedes previous reports dated February 29, 1996 and October 13, 1999 for the same subdivision.

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" = 40' topographic map with 1' contours, K-96 record drawings and preliminary plat and drainage plan for KTP Addition.

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.

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. For the Bracken/Tipperrary/White Tail loop, 6-5/8" standard curb with 0.7' walk grade was assumed. For all other streets, 3-5/8" roll curb with 0.4' walk grade was assumed.

Grate inlets were assumed to be Std. 4' x 2' design used by the City of Wichita, except for a special inlet to be utilized at Node 210.

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 overland through streets to discharge in a drainage easement in KTP Addition to a pond.

Nodes 210 to 100 are sized to handle the 100-year flow from K-96 and the off-site area II adajcent.

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. For the major storm, 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 smooth flow 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.

REAR YARD DRAINAGE:

In order to minimize long term drainage problems in rear yard areas, and to accommodate current architectural requirements for single family homes, this plat proposes a series of rear yard drainage systems in public easements. In combination with detailed grade design on the public easements, a comprehensive strategy is provided to deal with drainage of the rear yards.

The general criteria are as follows:

1. Provide 2% or greater longitudinal slope.

2. Provide inlets at low points, with adjacent drainage release points at approximately one foot of depth. Drainage release points are designed to provide a "cascade effect" from one point to another to provide a positive, passive drainage relief system in the event of system failure.

3. On continuous longitudinal grades, inlets will be provided approximately every 300 feet to provide opportunity to intercept flow before it has opportunity to accumulate in significant amounts so as to cause erosion problems.

4. For lots abutting the rear yard drainage system, the four-corner lot grading plan will set low opening criteria above the drainage release point so as to provide freeboard.

DRAINAGE MAP:

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

MWB/ljc
Attachments

ON-SITE HYDROLOGY

HYDROLOGY DATA

BALTHROP ADDITION PEC PROJECT NO. 01545 DWL 1/25/02

BASIN	AREA ACRES	RUNOFF COEFF C2	RUNOFF COEFF C100	TIME OF CONC Tc (MIN)	RAINFALL INTENSITY I2 (in/Hr)	RAINFALL INTENSITY I100 (in/Hr)	2-YEAR DISCHARGE Q2 (CFS)	100-YEAR DISCHARGE Q100 (CFS)
A	1.53	0.5	0.76	15	3.83	7.37	2.93	8.57
B	1.12	0.5	0.76	15	3.83	7.37	2.14	6.27
C	0.81	0.5	0.76	15	3.83	7.37	1.55	4.54
D	1.33	0.5	0.76	15	3.83	7.37	2.55	7.45
E	0.83	0.5	0.76	15	3.83	7.37	1.59	4.65
F1	0.60	0.5	0.76	15	3.83	7.37	1.15	3.36
F2	0.57	0.5	0.76	15	3.83	7.37	1.09	3.19
G	0.45	0.5	0.76	15	3.83	7.37	0.86	2.52
H1	0.46	0.5	0.76	15	3.83	7.37	0.88	2.58
H2	0.51	0.5	0.76	15	3.83	7.37	0.98	2.86
I	0.61	0.5	0.76	15	3.83	7.37	1.17	3.42
J	0.60	0.5	0.76	15	3.83	7.37	1.15	3.36
K	1.25	0.5	0.76	15	3.83	7.37	2.39	7.00
L	0.71	0.5	0.76	15	3.83	7.37	1.36	3.98
M	1.06	0.5	0.76	15	3.83	7.37	2.03	5.94
N	0.83	0.5	0.76	15	3.83	7.37	1.59	4.65
O	1.12	0.5	0.76	15	3.83	7.37	2.14	6.27
P	0.37	0.5	0.76	15	3.83	7.37	0.71	2.07
Q	0.36	0.5	0.76	15	3.83	7.37	0.69	2.02
R	0.37	0.5	0.76	15	3.83	7.37	0.71	2.07
S	0.95	0.5	0.76	15	3.83	7.37	1.81	5.30
T	0.84	0.5	0.76	15	3.83	7.37	1.61	4.72
U	0.62	0.5	0.76	15	3.83	7.37	1.18	3.46
V	0.26	0.5	0.76	15	3.83	7.37	0.50	1.46
W	0.15	0.5	0.76	15	3.83	7.37	0.29	0.84
X	0.70	0.5	0.76	15	3.83	7.37	1.34	3.92
Y	0.25	0.5	0.76	15	3.83	7.37	0.48	1.40
Z	0.96	0.5	0.76	15	3.83	7.37	1.84	5.38
AA	1.52	0.5	0.76	15	3.83	7.37	2.91	8.51
BB	0.26	0.5	0.76	15	3.83	7.37	0.50	1.46
CC	0.53	0.5	0.76	15	3.83	7.37	1.01	2.97
DD	0.78	0.5	0.76	15	3.83	7.37	1.49	4.37
EE	0.54	0.5	0.76	15	3.83	7.37	1.03	3.02
FF	0.93	0.5	0.76	15	3.83	7.37	1.78	5.21
GG	1.22	0.5	0.76	15	3.83	7.37	2.34	6.83
HH	1.62	0.5	0.76	15	3.83	7.37	3.10	9.07
II	15.40	0.5	0.76	15	3.83	7.37	29.49	86.26
JJ	7.06	0.5	0.76	15	3.83	7.37	13.52	39.54
KK	1.70	0.5	0.76	15	3.83	7.37	3.26	9.52
LL	0.65	0.5	0.76	15	3.83	7.37	1.24	3.64
MM	0.80	0.5	0.76	15	3.83	7.37	1.53	4.48
NN	1.80	0.5	0.76	15	3.83	7.37	3.45	10.08
PP	32.00		0.56	27				101.00
QQ	54.00		0.51	30				149.00

OFF-SITE HYDROLOGY

OFF-SITE HYDROLOGY

Off-site areas were analyzed utilizing field reconnaissance for the area north of the plat and west of K-96 (Basin II), and K-96 record drawing information for those areas easterly of K-96 (Basins PP and QQ). The 100-year storm peaks for II and PP were prorated at Tc – 27 min.

Downstream, the Developer has made arrangement with the adjacent landowner to extend the box culvert sewer approximately 140 feet to the detention pond at a flowline elevation of 1351.00. The proposed pond is to be modified to have a static pool elevation of 1351.0 and a 100-year water surface elevation of 1354.5.

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Project BALTHROP 4TH Date 1.25.02
Item INLET END RCB By MB
OFF-SITE DRAINAGE

NODE 210
INLET END OF BOX

	DA	Q_{100}	T_c	i_{100}
II	15.4 Ac	86.3	19 min.	6.68
PP	32 Ac	101	27 min	5.69

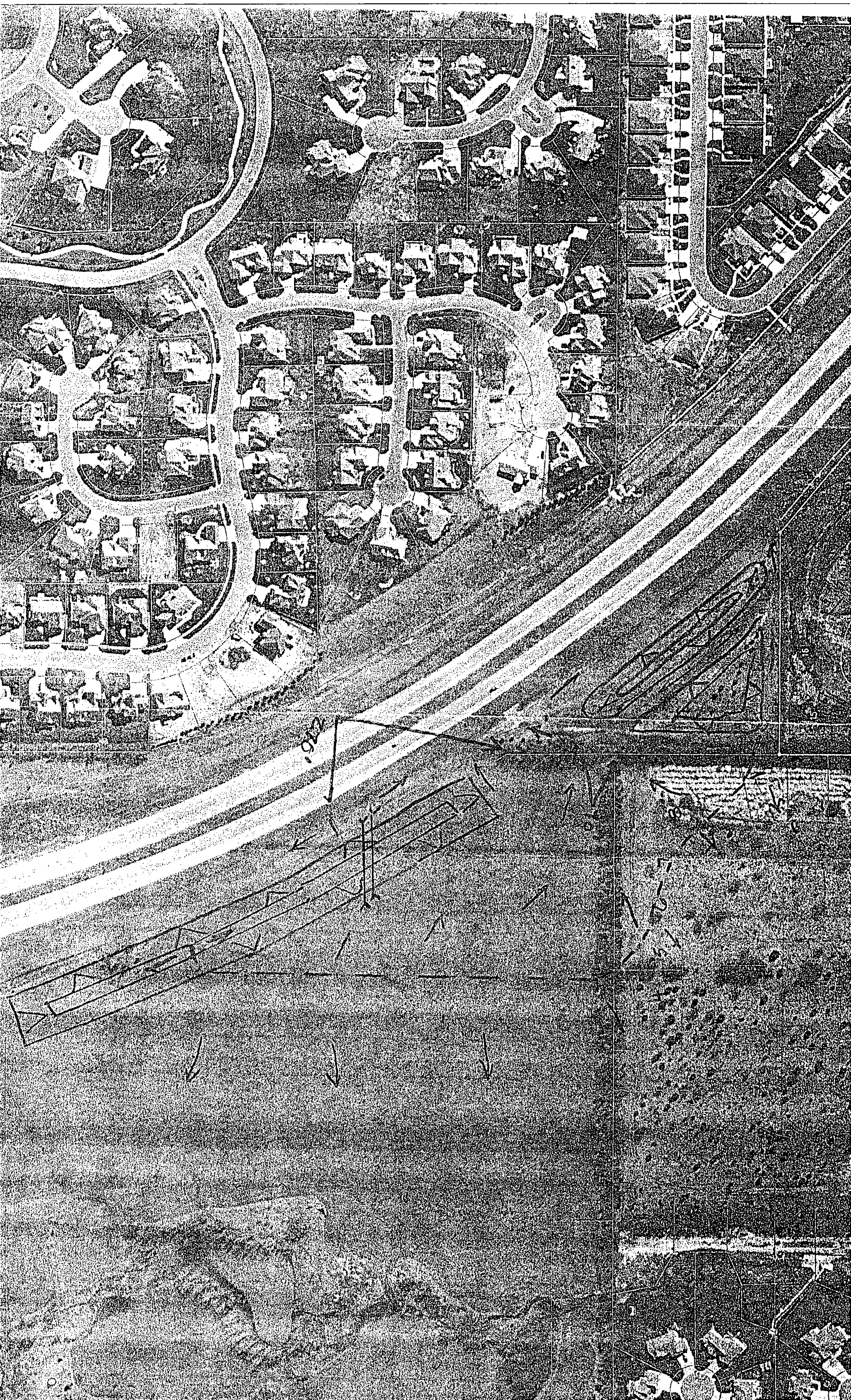
ΣQ @ 19 min

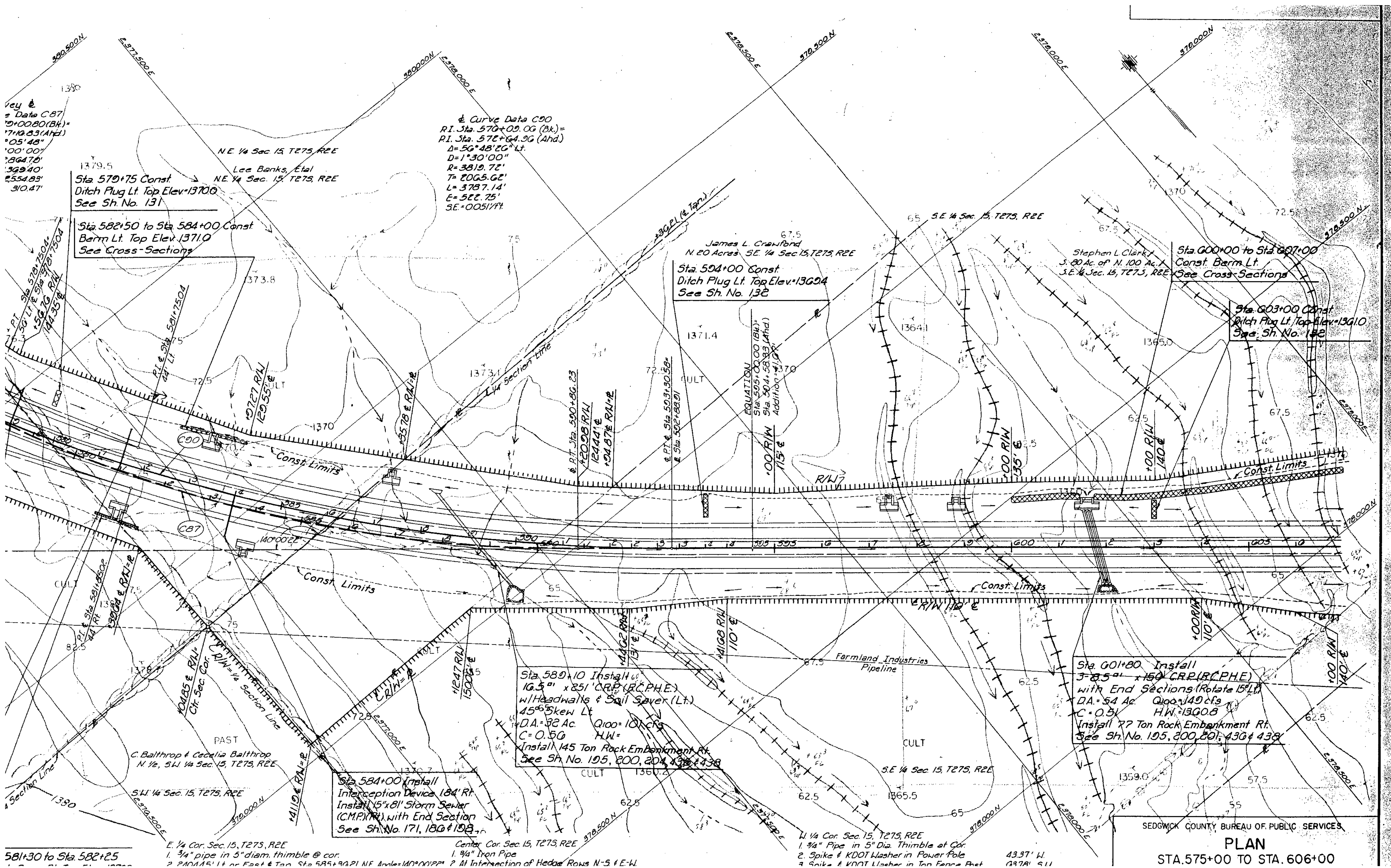
$$86.3 + \frac{19}{27}(101) = 157$$

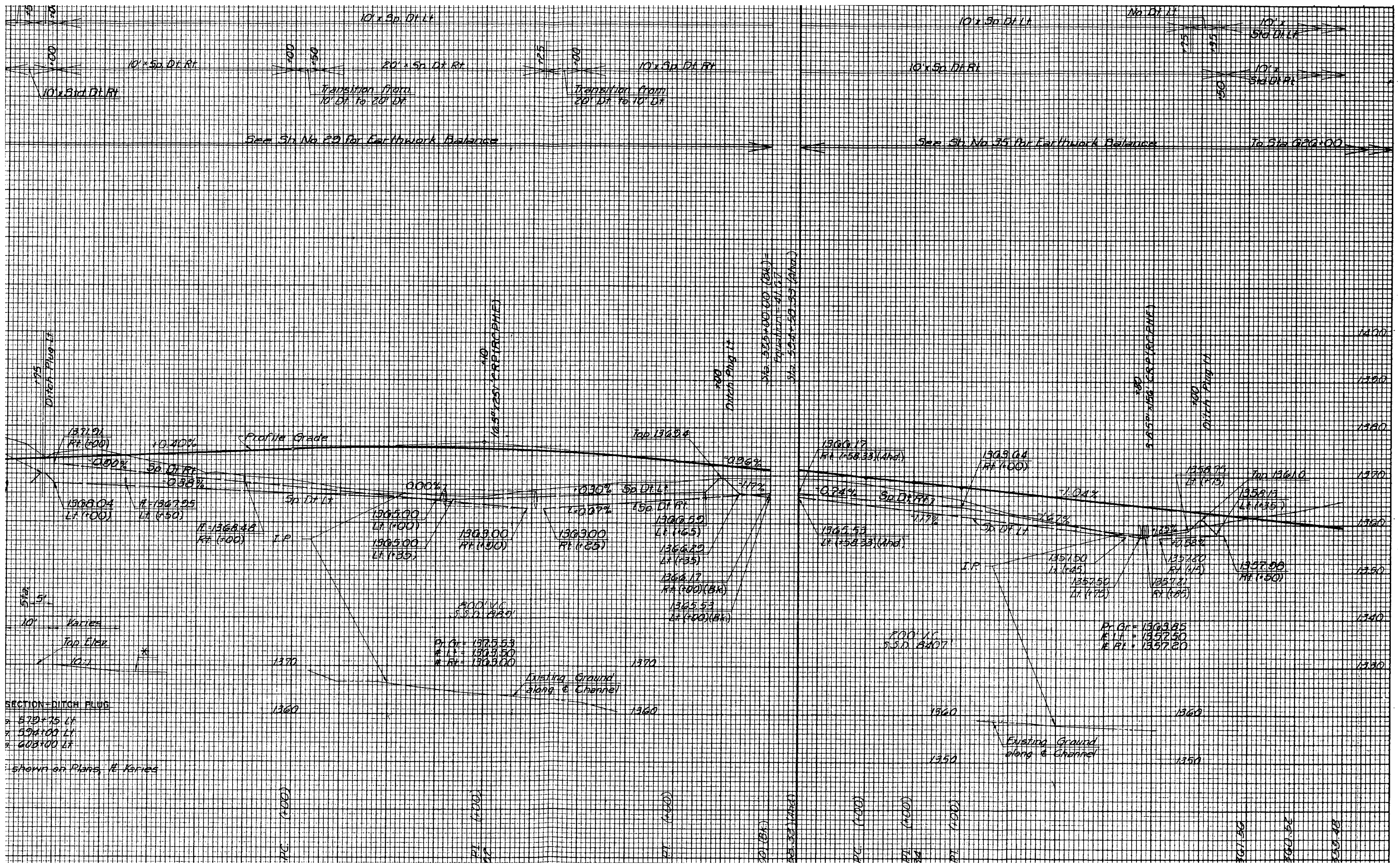
@ 27 min

$$\frac{5.69}{6.68}(86.3) + 101 = 175$$

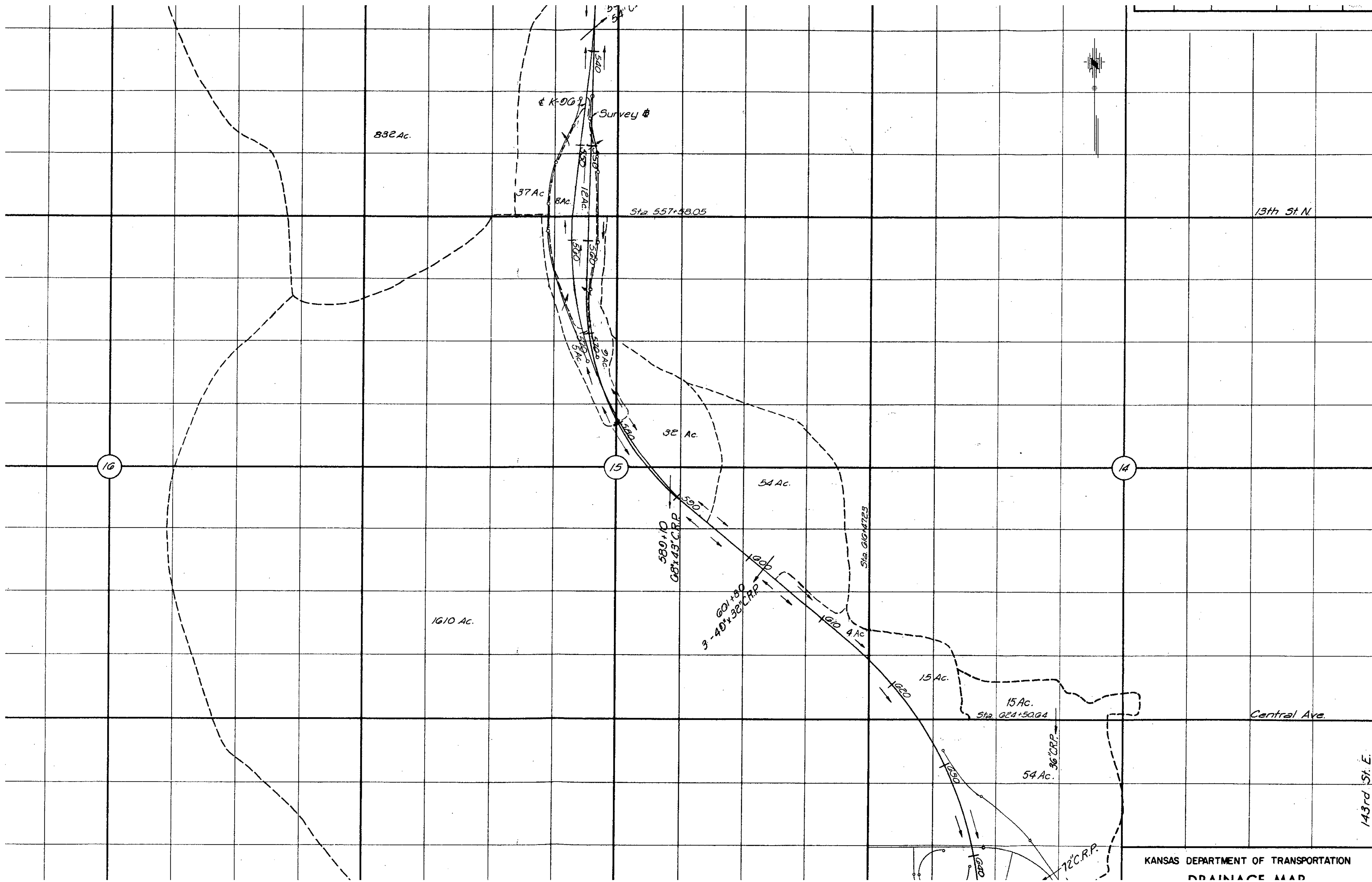
USE 175 cfs @ 27 min




SEDGWICK COUNTY BUREAU OF PUBLIC SERVICES
PLAN
STA.575+00 TO STA.606+00
℄ Curve Data C90
P.I. Sta. 570+09.06 (Bk.)=
P.I. Sta. 572+64.96 (Ahd.)
Δ=56°48'26" Lt.
D=1°30'00"
R=3819.72'
T=2065.62'
L=3787.14'
E=522.75'
SE=.0051/Ft.
N.E. 1/4 Sec. 15, T27S, R2E
Lee Banks, Etal
N.E. 1/4 Sec. 15, T27S, R2E
Sta. 579+75 Const.
Ditch Plug Lt. Top Elev.=1370.0
See Sh. No. 131
Sta. 582+50 to Sta. 584+00 Const.
Berm Lt. Top Elev. 1371.0
See Cross-Sections
James L. Crawford
N. 20 Acres S.E. 1/4 Sec. 15, T27S, R2E
Sta. 594+00 Const.
Ditch Plug Lt. Top Elev.=1369.4
See Sh. No. 132
EQUATION
Sta. 595+00.00 (Bk.)=
Sta. 594+58.93 (Ahd.)
Stephen L. Clark
S. 80 Ac. of N. 100 Ac.
S.E. 1/4 Sec. 15, T27S, R2E
Sta. 600+00 to Sta. 601+00
Const. Berm Lt.
See Cross-Sections
Sta. 603+00 Const.
Ditch Plug Lt. Top Elev.=1361.0
See Sh. No. 132
S.E. 1/4 Sec. 15, T27S, R2E
Const. Limits
R/W
Sta. 589+10 Install
16.5' x 251' C.R.P. (R.C.P.H.E.)
w/Headwalls & Soil Saver (Lt.)
45° Skew Lt.
D.A.=32 Ac. Q100=101 cfs
C=0.50 H.W.=
Install 145 Ton Rock Embankment Rt.
See Sh. No. 195, 200, 204, 436 & 438
Sta. 601+80 Install
3-8.5' x 150' C.R.P. (R.C.P.H.E.)
with End Sections (Rotate 15° Lt.)
D.A.=54 Ac. Q100=149 cfs
C=0.51 H.W.=1360.8
Install 77 Ton Rock Embankment Rt.
See Sh. No. 195, 200, 201, 430 & 438
Sta. 584+00 Install
Interception Device 184' Rt.
Install 15"x81' Storm Sewer
(C.M.P.)(Rt.) with End Section
See Sh. No. 171, 180 & 198
Farmland Industries
Pipeline
C. Balthrop & Cecelia Balthrop
N. 1/2, S.W. 1/4 Sec. 15, T27S, R2E
S.W. 1/4 Sec. 15, T27S, R2E
1/4 Section Line
PAST
CULT
Ctr. Sec. Cor.
E. 1/4 Cor. Sec. 15, T27S, R2E
1. 3/4" pipe in 5" diam. thimble @ cor.
Center Cor. Sec. 15, T27S, R2E
1. 3/4" Iron Pipe
2. At Intersection of Hedge Rows N-S & E-W
W. 1/4 Cor. Sec. 15, T27S, R2E
1. 3/4" Pipe in 5" Dia. Thimble at Cor.
2. Spike & KDOT Washer in Power Pole
581+30 to Sta. 582+25
C87
C90

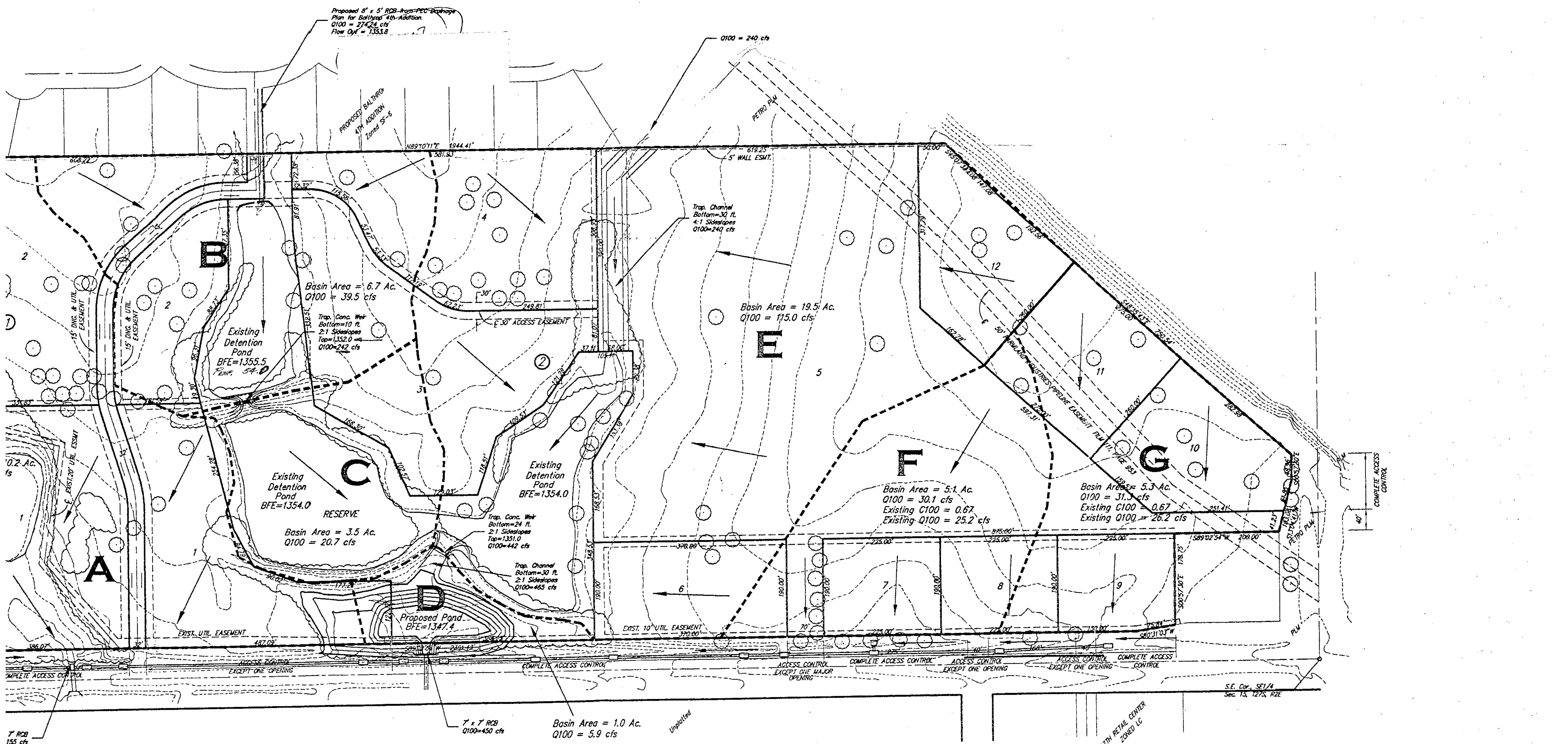


10' x Sp. Dt. Lt.
No Dt. Lt.
10' x Std. Dt. Rt.
10' x Sp. Dt. Rt.
20' x Sp. Dt. Rt.
Transition from 10' Dt. to 20' Dt.
Transition from 20' Dt. to 10' Dt.
10' x Std. Dt. Lt.
See Sh. No. 29 For Earthwork Balance
See Sh. No. 35 For Earthwork Balance
To Sta. 620+00
Ditch Plug Lt.
Ditch Plug Lt.
Profile Grade
+0.40%
-0.80%
Sp. Dt. Rt.
-0.38%
Sp. Dt. Lt.
0.00%
+0.30%
+0.07%
Sp. Dt. Rt.
-0.96%
-1.17%
-0.74%
-1.04%
-1.67%
-1.77%
Top 1365.4
Top 1361.0
1371.91 Rt. (+00)
1368.04 Lt. (+00)
1367.95 Lt. (+50)
1368.48 Rt. (+00)
I.P.
1365.00 Lt. (+00)
1365.00 Lt. (+35)
1363.00 Rt. (+90)
1363.00 Rt. (+25)
1366.52 Lt. (+65)
1366.22 Lt. (+35)
1366.17 Rt. (+00)(Bk.)
1365.53 Lt. (+00)(Bk.)
800' V.C.
S.S.D. 885'
Pr. Gr. = 1375.53
Lt. = 1363.50
Rt. = 1363.00
Existing Ground along Channel
Sta. 525+00.00 (Bk.)
Equation = 41.67
Sta. 524+58.33 (Ahd.)
1366.17 Rt. (+58.33)(Ahd.)
1365.53 Lt. (+58.33)(Ahd.)
1363.04 Rt. (+00)
1358.95 Lt. (+75)
1358.13 Lt. (+35)
1357.50 Lt. (+45)
1357.50 Lt. (+75)
1357.60 Rt. (+15)
1357.21 Rt. (+66)
1357.00 Rt. (+50)
800' V.C.
S.S.D. 8407
Pr. Gr. = 1363.85
Lt. = 1357.50
Rt. = 1357.20
1400
1390
1380
1370
1360
1350
1340
1330
SECTION - DITCH PLUG
Varies
Top Elev.
10:1
579+75 Lt.
594+00 Lt.
603+00 Lt.
shown on Plans, Varies



KANSAS DEPARTMENT OF TRANSPORTATION

DRAINAGE MAP

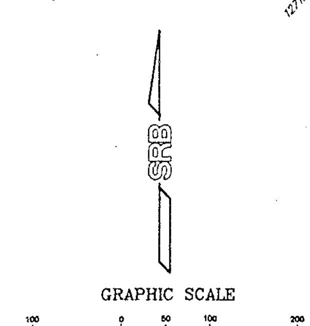


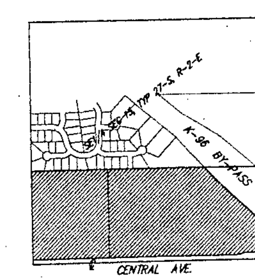
DRAINAGE PLAN

KTP ADDITION

WICHITA, SEDGWICK COUNTY, KANSAS

MINIMUM BUILDING PAD FOR LOWEST OPENING	
LOT 1, BLOCK 1	1351.2
LOT 2, BLOCK 1	1352.2
LOT 1, BLOCK 2	1355.0
LOT 2, BLOCK 2	1356.5
LOT 3, BLOCK 2	1356.5
LOT 5, BLOCK 2	1355.0
LOT 6, BLOCK 2	1355.0



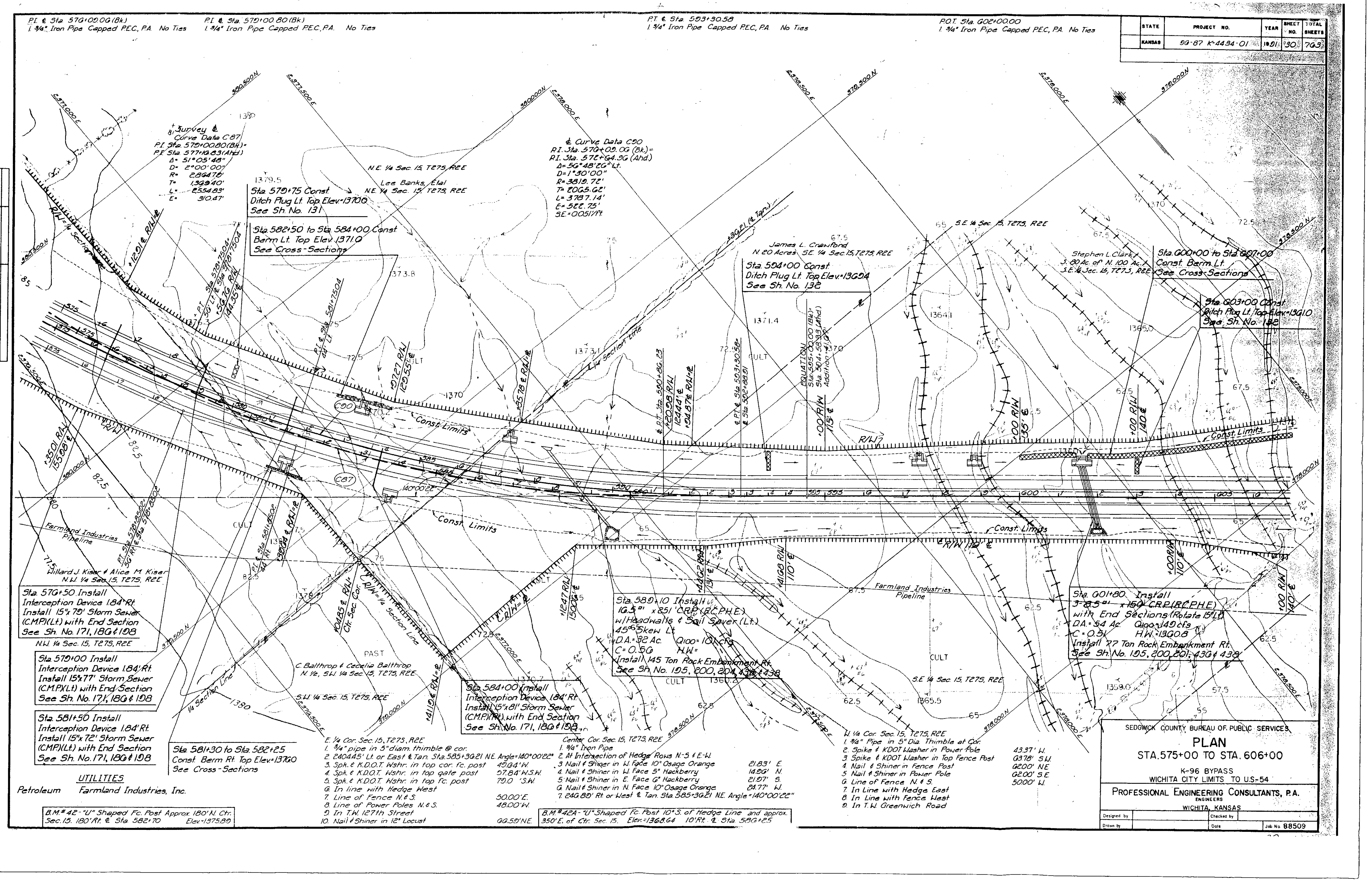


(46)

Drainage Map

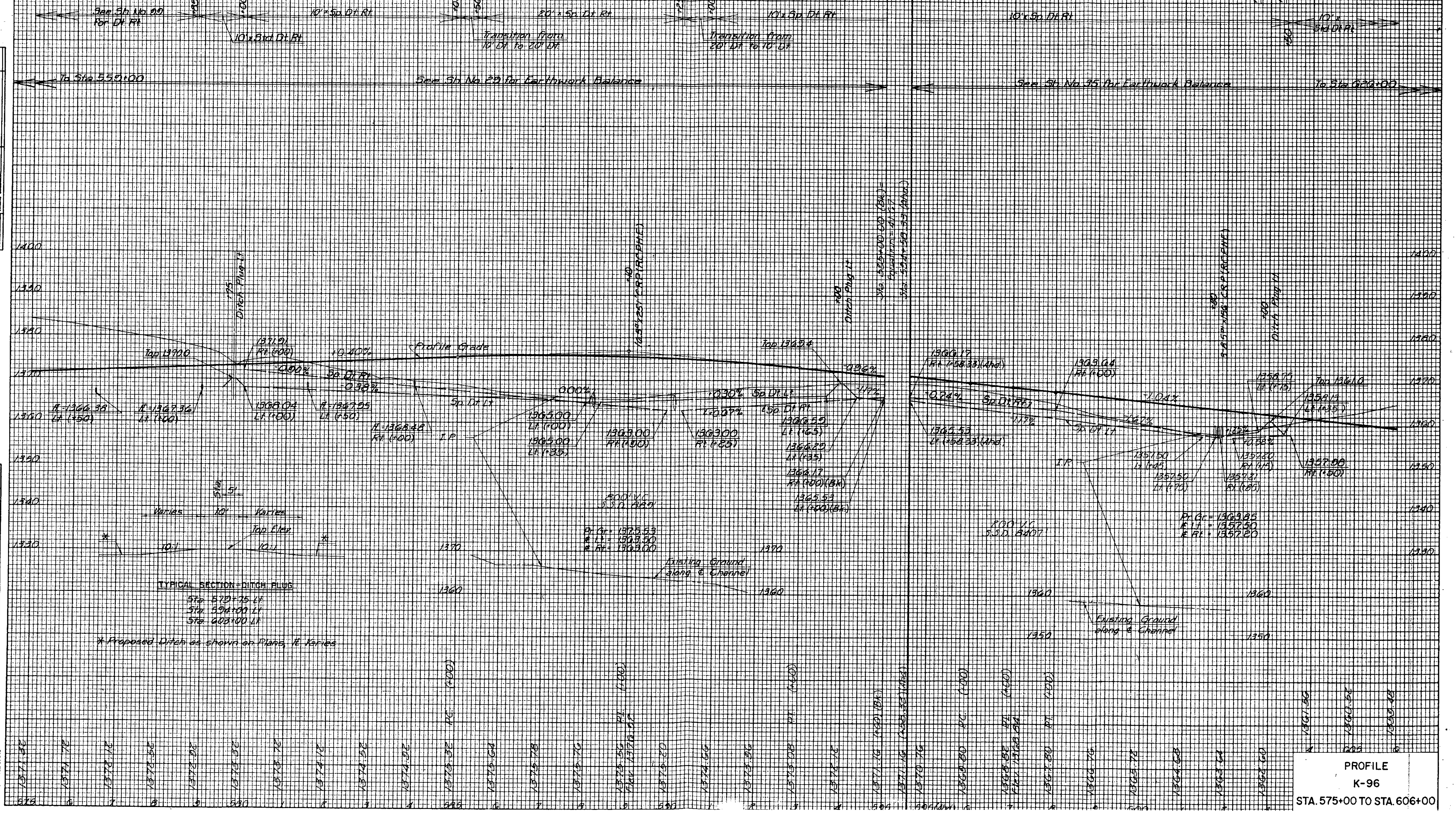
N

1": 200'

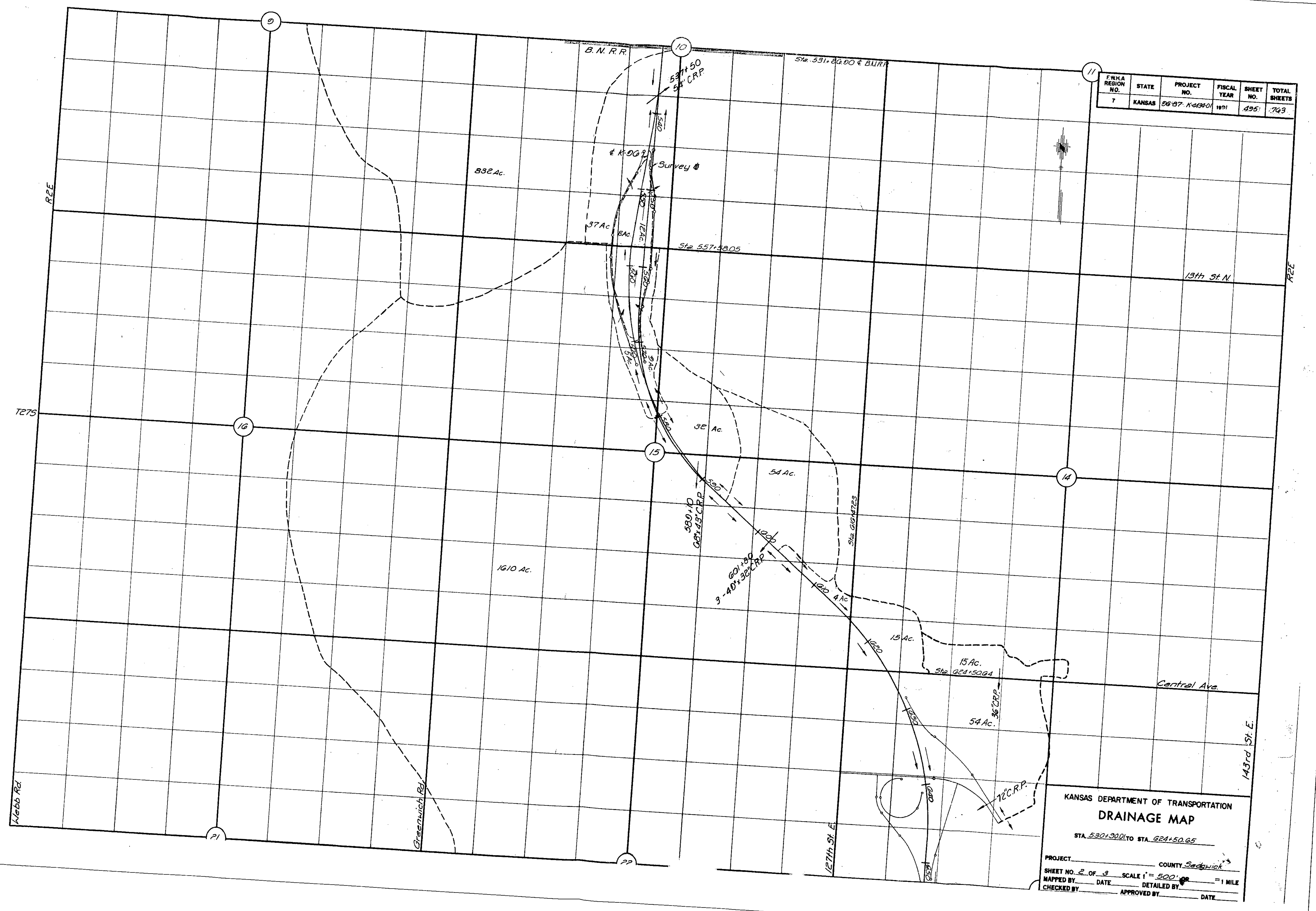


STATE KANSAS PROJECT NO. 59-87 K-4434-01 YEAR 1991 SHEET NO. 30 TOTAL SHEETS 763
Sta 576+30 Install Interception Device 18"Rt Install 15"x78' Storm Sewer (CMP)(Lt) with End Section See Sh. No. 171, 186 & 198
Sta 578+00 Install Interception Device 18"Rt Install 15"x77' Storm Sewer (CMP)(Lt) with End Section See Sh. No. 171, 186 & 198
Sta 581+50 Install Interception Device 18"Rt Install 15"x72' Storm Sewer (CMP)(Lt) with End Section See Sh. No. 171, 186 & 198
UTILITIES
Petroleum Farmland Industries, Inc.
Const Limits
W. 1/4 Cor. Sec. 15, T27S, R2E
1. 3/4" Pipe in 5" Dia. Thimble at Cor.
2. Spike & KDOT Washer in Power Pole 43.37' W.
3. Spike & KDOT Washer in Top Fence Post 63.78' S.W.
4. Nail & Shiner in Fence Post 62.00' N.E.
5. Nail & Shiner in Power Pole 62.00' S.E.
6. Line of Fence N. & S. 50.00' W.
7. In Line with Hedge East
8. In Line with Fence West
9. In T.W. Greenwich Road
SEDGWICK COUNTY BUREAU OF PUBLIC SERVICES
PLAN
STA. 575+00 TO STA. 606+00
K-96 BYPASS
WICHITA CITY LIMITS TO U.S-54
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
ENGINEERS
WICHITA, KANSAS
Designed by
Checked by
Drawn by
Date
Job No. 88509

FHWA NO.	STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
7	KANSAS	96-87 K-4434-01	1991	32	703



PROFILE
K-96
STA. 575+00 TO STA. 606+00



F.W.H.A REGION NO.	STATE	PROJECT NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
7	KANSAS	96-87 K-4434-01	1991	495	763

KANSAS DEPARTMENT OF TRANSPORTATION

DRAINAGE MAP

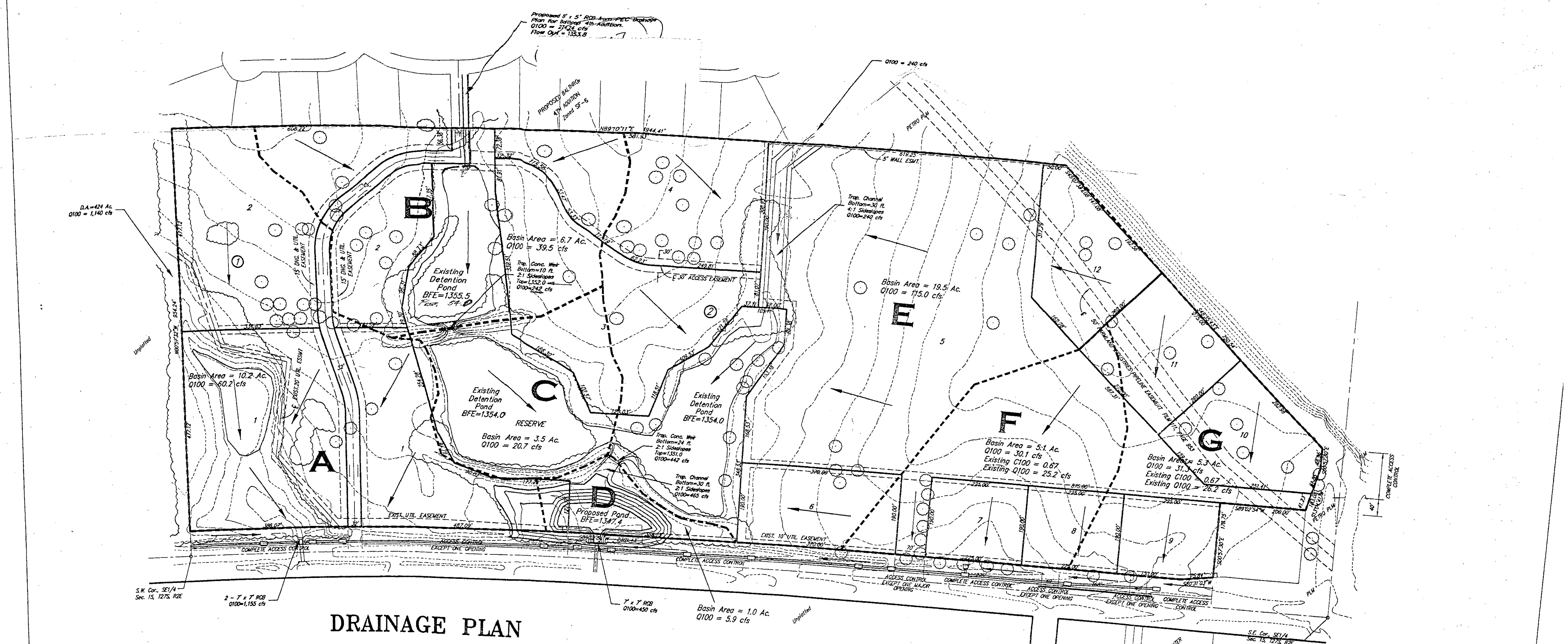
STA. 530+90.01 TO STA. 624+50.65

PROJECT ______ COUNTY Sedgwick

SHEET NO. 2 OF 3 SCALE 1" = 500' OR ______ = 1 MILE

MAPPED BY ______ DATE ______ DETAILED BY ______

CHECKED BY ______ APPROVED BY ______ DATE ______



DRAINAGE PLAN

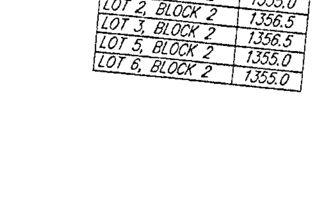
KTP ADDITION

WICHITA, SEDGWICK COUNTY, KANSAS

MINIMUM BUILDING PAD FOR LOWEST OPENING	
LOT 1, BLOCK 1	1351.2
LOT 2, BLOCK 1	1352.2
LOT 1, BLOCK 2	1355.0
LOT 2, BLOCK 2	1356.5
LOT 3, BLOCK 2	1356.5
LOT 5, BLOCK 2	1355.0
LOT 6, BLOCK 2	1355.0

GRAPHIC SCALE

(IN FEET)
1 inch = 100 ft.



DWG FILE: 01851P-JDS
PROJECT NO. 01X01851P

SRB
924 NORTH MAIN
WICHITA, KANSAS 67203
http://www.feist.com/~srb
316-264-8008
FAX 264-4621
E-mail: srb@feist.com
SAVOY, RUGGLES & BOHM, P.A.
ENGINEERING & SURVEYING

Sept. 4, 2001

INLET/STREET CAPACITY

Professional Engineering Consultants

Date 24 JAN 02 Page 1 of 6 Comp by MJB

Project BALTHROP 4TH

Item 2-YR

z/n = 32/0.016 = 2000 **INLET CAPACITY**

NODE	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.				
No.	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Q_i cfs	Qb cfs
N/230	1.8	—	0.5	1/32	0.23	7.4	NONE								-0-	1.6
B/250	2.7	—	2.8	"	0.21	6.7	NONE								-0-	2.7
E+F/	2.8	6.5	0.5	"	0.38	12.2	NONE								-0-	6.5
F2+H1	2	(10.1)	0.5	"	0.46	14.7									-	10.1
I+H2	2.2	2.2	1.0	"	0.23	7.4									-	2.2
C	1.6	1.6	2.8	"	0.18	5.8	NONE								-0-	1.6
						Q= 12.3						0.52	0.35	11.2	12.3	-0-
							1A	10'								
			DA= 6.34				(310)									

AT inlet

PROFESSIONAL ENGINEERING CONSULTANTS

Date 25 Jan 2002 Page 2 of 6 Comp by DWL

Project Balthrop 4th

Item 2-YR

z/n = 32/0.016 = 2000 **INLET CAPACITY**

NODE	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.				
No.	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Q_i cfs	Qb cfs
O	2.1		0.5	1/32	0.26	8.3										
P	0.70		1.0	"	0.145	4.6		(180)								
					Q_T =	2.8	1A	5'				0.26	0.09	2.9	2.8	-0-
Q	0.7		0.5	"	0.17	5.4										
R	0.7		0.5	"	0.17	5.4										
V	0.5		0.5	"	0.15	4.8		(110)								
						Q_T =	1.9 1A	5'				0.21	0.04	1.28	1.9	-0-

Professional Engineering Consultants

Date 25 Jan 2002 Page 3 of 6 Comp by DWL

Project Balthrop 4th Add

Item 2-YR

z/n = 32/0.016 = 2000

INLET CAPACITY

	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.				
NODE No.	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Q_i cfs	Qb cfs
J	1.2		3	3/8	0.15	4.8										
K	2.4		2.5	"	0.20	6.4										
L	1.4		1.81	"	0.17	5.4										
						Q_T = 5						0.39	0.22	7.0		
		(120)														
M	2	–	1.81	"	0.22	7.0										
HH	3.1	–	0.50	"	0.29	9.3										
						Q_T = 5.1	1A	5'				0.39	0.22	7.0	5.1	-0-

Date 25 Jan 2002 Page 4 of 6 Comp by DWC

Project Balthrop 4th Add

Item 2-YR Analysis

z/n = 32/0.016 = 2000

INLET CAPACITY

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Qi cfs	Qb cfs
Z	1.8	–	–	–	–	–	4x2	12'					0.14	–	1.8	-0-
G	0.9	–	–	–	–	–	4x2	12'	By Inspection OK							
D	1.5	–	–	–	–	–	4x2	12'	By Inspection OK							
A	1.7	–	–	–	–	–	4x2	12'	By Inspection OK							

PROFESSIONAL ENGINEERING CONSULTANTS

Date 25 Jan 2002 Page 5 of 6 Comp by DWL

Project Balthrop 4th Add

Item 2-YR ANALYSIS

z/n = 3/4 0.016 = 2000

INLET CAPACITY

NODE	HYDROLOGY		APPROACHING FLOW				INLET		ON-GRADE COMP			SUMP COMP.				
No.	Q_o cfs	Q_o+Q_b cfs	S_o o/o	S_x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	di ft	d ft	T ft	Qi cfs	Qb cfs
EE	1	—	—	—	—	—	4x2	12'	—	—	—	—	0.1	—	1	-0-
BB	0.5	—	—	—		—	4x2	17	INSPECTION OK							
AA	1.52	—	—	—	—	—	4x2	12'					0.13	—	1.52	-0-
FF	1.8	—	—	—	—	—	4x2	12'					0.14	—	1.8	-0-
T	1.6	—	—	—	—	—	4x2	12'	Inspection OK							
S	1.8	—	—	—	—	—	4x2	12'	Inspection OK							

PROFESSIONAL ENGINEERING CONSULTANTS

Date 25 Jan 2002 Comp by [illegible]

Project Balthrop 4th Add

Item 2-YR

z/n = 32/0.016 = 2000 **INLET CAPACITY**

NODE No.	HYDROLOGY Q_o cfs	HYDROLOGY Q_o+Q_b cfs	APPROACHING FLOW S_o o/o	APPROACHING FLOW S_x in/ft	APPROACHING FLOW d ft	APPROACHING FLOW T ft	INLET TYPE	INLET L	ON-GRADE COMP Lt ft	ON-GRADE COMP L/Lt	ON-GRADE COMP E ft	SUMP COMP. di ft	SUMP COMP. d ft	SUMP COMP. T ft	Q_i cfs	Q_b cfs
U	1.2			1/32												
W	0.30		0.5	"	0.125	4										
X	1.3		1.28	"	0.17	5.4										
					Q_T = (430)	1.6	1A	5'				0.17	Ø	Ø	1.6	-0-
* GG	2.3		0.5	"	0.27	8.6										
DD	1.5		1.30	"	0.22	7.0										
CC	1		1.36	"	0.275	8.8										
Y	0.5		1.28	"	0.13	4.16										
					Q_T =	5.3	1A	5'				0.40	0.23	7.36	5.3	-0-
			(2.78 Ac)		(440)		1A	10'				0.31	0.14	4.5	5.3	-0-

PROFESSIONAL ENGINEERING CONSULTANTS

Date 1-25-02 Page ___ of ___ Comp by NWB

Project BALTHROP 4TH ADD. CK by ___

Item ___

MAJOR STORM CHECK

NODE	Tc MIN	$i_{100/2}$	Q_2 cfs	Q_{100} cfs	Q_{pipe} cfs	$Q_{100}-Q_p$ cfs	ΣQ cfs	So %	Bk-Bk Street Width	MAX DISCHARGE (cfs) @ d = T.C.	T.C. +0.3'	T.C. +0.41'	T.C. +0.52'	T.C. +0.63'	REMARKS
310	15	1.92	12.3	23.7	12.3	11.4	14.0	0.5	35	32					OK
180	15	"	2.8	5.4	2.8	2.6									
120	15	"	5.1	3.8	5.1	4.7	6.2	0.5	35	32					OK
40	15	"	1.6	3.1	1.6	1.5									
430	15	"	1.4	2.7	1.4	7.3	5.7	0.5	35	32					OK
440	15	"	4.8	9.2	4.8	4.4									

STORM SEWER HYDRAULICS

```
100 j, 1355.0000  100    3   27   26
110 t,BALTHROP 4TH ADDITION DRAINAGE PLAN
120 t,MWB 01-25-02    C:\STORM\BALT4.INP
130 t,2-YR ANALYSIS; EXCEPT 100 YR FOR BASINS Z, II, & PP (K-96)
140 m,  100  1355.00
150 m,  105  1358.50
160 m,  110  1358.50
170 i,  120     0.00     2.70     0.00     0.00     5.10    15.00  1358.50
180 m,  130  1359.30
190 m,  135  1359.80
200 i,  140     0.00     1.85     0.00     0.00     5.00    15.00  1359.80
210 m,  160  1360.20
220 m,  170  1360.20
230 i,  180     0.00     1.50     0.00     0.00     2.80    15.00  1360.20
240 m,  190  1361.30
250 i,  210     0.00    47.40     0.00     0.00   175.00    27.00  1361.00
260 i,  220     0.00     0.96     0.00     0.00     5.40    15.00  1362.50
270 i,  310     0.00     6.30     0.00     0.00    12.30    15.00  1360.20
280 i,  320     0.00     0.45     0.00     0.00     0.90    15.00  1368.00
290 i,  330     0.00     1.33     0.00     0.00     1.50    15.00  1367.50
300 i,  340     0.00     0.90     0.00     0.00     1.70    15.00  1370.00
310 i,  410     0.00     0.99     0.00     0.00     1.90    15.00  1358.50
320 i,  420     0.00     0.62     0.00     0.00     1.20    15.00  1357.50
330 i,  430     0.00     0.85     0.00     0.00     1.60    15.00  1359.50
340 i,  440     0.00     3.04     0.00     0.00     5.30    15.00  1359.50
350 i,  450     0.00     0.54     0.00     0.00     1.00    15.00  1359.50
360 i,  460     0.00     0.26     0.00     0.00     0.50    15.00  1362.00
370 i,  470     0.00     1.52     0.00     0.00     2.20    15.00  1363.00
380 i,  480     0.00     0.93     0.00     0.00     1.80    15.00  1360.00
390 i,  490     0.00     0.84     0.00     0.00     1.60    15.00  1359.00
400 i,  500     0.00     0.95     0.00     0.00     1.80    15.00  1359.00
410 b,  105  100   235.00    8.00    4.00 0.013   0.00    0.00
420 b,  110  105    40.00    8.00    4.00 0.013  70.00    0.00
430 p,  120  110    15.00    30 0.013 110.00    0.00
440 b,  130  110   160.00    8.00    4.00 0.013   0.00    0.00
450 b,  135  130    75.00    8.00    4.00 0.013  50.00    0.00
460 p,  140  135    20.00    18 0.013  90.00    0.00
470 b,  160  135   110.00    8.00    4.00 0.013   0.00    0.00
480 b,  170  160   250.00    7.00    4.00 0.013  20.00    0.00
490 p,  180  170    20.00    18 0.013  90.00    0.00
500 b,  190  170   185.00    7.00    4.00 0.013   0.00    0.00
510 b,  210  190   300.00    7.00    4.00 0.013  45.00    0.00
520 p,  220  210   180.00    18 0.013  90.00    0.00
530 p,  310  170    20.00    24 0.013  90.00    0.00
540 p,  320  310   300.00    15 0.013   0.00    0.00
550 p,  330  320   330.00    15 0.013  90.00    0.00
560 p,  340  330   300.00    15 0.013   0.00    0.00
570 p,  410  110    30.00    30 0.013  70.00    0.00
580 p,  420  410   140.00    30 0.013   0.00    0.00
590 p,  430  420   160.00    24 0.013  90.00    0.00
600 p,  440  430    40.00    24 0.013   0.00    0.00
610 p,  450  440   110.00    18 0.013   0.00    0.00
620 p,  460  450   315.00    15 0.013  90.00    0.00
630 p,  470  460    75.00    15 0.013  45.00    0.00
640 p,  480  450   200.00    15 0.013   0.00    0.00
650 p,  490  420   160.00    18 0.013   0.00    0.00
660 p,  500  490   165.00    15 0.013   0.00    0.00
670 e
```

BALTHROP 4TH ADDITION DRAINAGE PLAN
MWB 01-25-02 C:\STORM\BALT4.INP
2-YR ANALYSIS; EXCEPT 100 YR FOR BASINS Z, II, & PP (K-96)

Storm Frequency = 2-Year

* * * H Y D R O L O G Y * * *

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)
Tributary Area									Hydrology Summation				Conduit Data				
105	100	.00	.00	.00	.0	.00	.00	.00	29.92	2.67	.00	213.28	8.00 X 4.00	6.66	235.00	.59	30.51
110	105	.00	.00	.00	.0	.00	.00	.00	29.82	2.68	.00	213.28	8.00 X 4.00	6.66	40.00	.10	29.92
120	110	.00	2.70	.00	.0	15.00	3.83	5.10	15.00	3.83	5.10	5.10	30"	1.04	15.00	.24	15.24
130	110	.00	.00	.00	.0	.00	.00	.00	29.38	2.70	.00	195.46	8.00 X 4.00	6.11	160.00	.44	29.82
135	130	.00	.00	.00	.0	.00	.00	.00	29.18	2.71	.00	195.46	8.00 X 4.00	6.11	75.00	.20	29.38
140	135	.00	1.85	.00	.0	15.00	3.83	5.00	15.00	3.83	5.00	5.00	18"	2.83	20.00	.12	15.12
160	135	.00	.00	.00	.0	.00	.00	.00	28.87	2.73	.00	191.90	8.00 X 4.00	6.00	110.00	.31	29.18
170	160	.00	.00	.00	.0	.00	.00	.00	28.26	2.76	.00	191.90	7.00 X 4.00	6.85	250.00	.61	28.87
180	170	.00	1.50	.00	.0	15.00	3.83	2.80	15.00	3.83	2.80	2.80	18"	1.58	20.00	.21	15.21
190	170	.00	.00	.00	.0	.00	.00	.00	27.78	2.79	.00	179.12	7.00 X 4.00	6.40	185.00	.48	28.26
210	190	.00	47.40	.00	.0	27.00	2.84	175.00	27.00	2.84	175.00	179.12	7.00 X 4.00	6.40	300.00	.78	27.78
220	210	.00	.96	.00	.0	15.00	3.83	5.40	15.00	3.83	5.40	5.40	18"	3.06	180.00	.98	15.98
310	170	.00	6.30	.00	.0	15.00	3.83	12.30	15.00	3.83	12.30	14.86	24"	4.73	20.00	.07	15.07
320	310	.00	.45	.00	.0	15.00	3.83	.90	20.82	3.27	.77	3.82	15"	3.11	300.00	1.61	22.42
330	320	.00	1.33	.00	.0	15.00	3.83	1.50	18.61	3.46	1.35	3.05	15"	2.49	330.00	2.21	20.82
340	330	.00	.90	.00	.0	15.00	3.83	1.70	15.00	3.83	1.70	1.70	15"	1.39	300.00	3.61	18.61
410	110	.00	.99	.00	.0	15.00	3.83	1.90	20.35	3.30	1.64	17.47	30"	3.56	30.00	.14	20.49
420	410	.00	.62	.00	.0	15.00	3.83	1.20	19.63	3.37	1.05	15.83	30"	3.22	140.00	.72	20.35
430	420	.00	.85	.00	.0	15.00	3.83	1.60	18.90	3.43	1.43	11.57	24"	3.68	160.00	.72	19.63
440	430	.00	3.04	.00	.0	15.00	3.83	5.30	18.70	3.45	4.77	10.14	24"	3.23	40.00	.21	18.90
450	440	.00	.54	.00	.0	15.00	3.83	1.00	18.09	3.50	.92	5.37	18"	3.04	110.00	.60	18.70
460	450	.00	.26	.00	.0	15.00	3.83	.50	15.70	3.75	.49	2.69	15"	2.19	315.00	2.40	18.09
470	460	.00	1.52	.00	.0	15.00	3.83	2.20	15.00	3.83	2.20	2.20	15"	1.79	75.00	.70	15.70
480	450	.00	.93	.00	.0	15.00	3.83	1.80	15.00	3.83	1.80	1.80	15"	1.47	200.00	2.27	17.27
490	420	.00	.84	.00	.0	15.00	3.83	1.60	16.87	3.62	1.51	3.31	18"	1.88	160.00	1.42	18.30
500	490	.00	.95	.00	.0	15.00	3.83	1.80	15.00	3.83	1.80	1.80	15"	1.47	165.00	1.87	16.87

BALTHROP 4TH ADDITION DRAINAGE PLAN
MWB 01-25-02 C:\STORM\BALT4.INP
2-YR ANALYSIS; EXCEPT 100 YR FOR BASINS Z, II, & PP (K-96)

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)
100	.00000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	1355.0000	1355.0000	.00
105	.00232	.5444	.0000	.0000	.0345	.2551	.0058	.8398	1355.8400	1358.5000	2.66
110	.00232	.0927	.0000	.0110	.0000	.0000	.1063	.2100	1356.0500	1358.5000	2.45
120	.00015	.0023	.0000	.0000	.0000	.0000	.0000	.0023	1356.0520	1358.5000	2.45
130	.00195	.3113	.0000	.0000	.0290	.1431	.0049	.4882	1356.5380	1359.3000	2.76
135	.00195	.1459	.0000	.0021	.0000	.0000	.0257	.1737	1356.7120	1359.8000	3.09
140	.00227	.0453	.0000	.0000	.0000	.0000	.0000	.0453	1356.7570	1359.8000	3.04
160	.00188	.2063	.0000	.0342	.0000	.0600	-.0795	.2210	1356.9330	1360.2000	3.27
170	.00261	.6516	.0000	.0094	.0000	.0000	.1000	.7611	1357.6940	1360.2000	2.51
180	.00071	.0142	.0000	.0000	.0000	.0000	.0000	.0142	1357.7080	1360.2000	2.49
190	.00227	.4201	.0000	.0000	.0318	.1383	.0057	.5958	1358.2900	1361.3000	3.01
210	.00227	.6812	.0000	.0490	.0000	.0725	1.4004	2.2031	1360.4930	1361.0000	.51
220	.00264	.4757	.0000	.0000	.0000	.0000	.0000	.4757	1360.9680	1362.5000	1.53
310	.00431	.0863	.0000	.0197	.0000	.0000	.8507	.9566	1358.6500	1360.2000	1.55
320	.00350	1.0502	.0000	.0054	.0000	.0481	.1234	1.2272	1359.8770	1368.0000	8.12
330	.00224	.7377	.0000	.0066	.0000	.0000	.1403	.8847	1360.7620	1367.5000	6.74
340	.00069	.2078	.0000	.0000	.0000	.0000	.0000	.2078	1360.9700	1370.0000	9.03
410	.00181	.0544	.0000	.0035	.0000	.0000	.0788	.1367	1356.1860	1358.5000	2.31
420	.00149	.2085	.0000	.0099	.0000	.1054	.0272	.3509	1356.5370	1357.5000	.96
430	.00262	.4187	.0000	.0049	.0000	.0000	.1097	.5333	1357.0710	1359.5000	2.43
440	.00201	.0804	.0000	.0019	.0000	.0000	.2199	.3021	1357.3730	1359.5000	2.13
450	.00261	.2870	.0000	.0069	.0000	.0373	.1720	.5031	1357.8760	1359.5000	1.62
460	.00173	.5461	.0000	.0025	.0000	.0109	.0567	.6162	1358.4920	1362.0000	3.51
470	.00116	.0870	.0000	.0000	.0000	.0000	.0000	.0870	1358.5790	1363.0000	4.42
480	.00078	.1553	.0000	.0000	.0000	.0000	.0000	.1553	1358.0310	1360.0000	1.97
490	.00100	.1593	.0000	.0021	.0000	.0000	.0788	.2403	1356.7780	1359.0000	2.22
500	.00078	.1281	.0000	.0000	.0000	.0000	.0000	.1281	1356.9060	1359.0000	2.09

Balthrop 4th Addition Q100
Worksheet for Trapezoidal Channel

Project Description	
Project File	g:\haestad\fmw\balthrop.fm2
Worksheet	Balthrop 4th Addition
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	50.00	ft
Discharge	152.50	cfs

Results		
Depth	0.79	ft
Flow Area	41.52	ft²
Wetted Perimeter	55.01	ft
Top Width	54.76	ft
Critical Depth	0.65	ft
Critical Slope	0.015388	ft/ft
Velocity	3.67	ft/s
Velocity Head	0.21	ft
Specific Energy	1.00	ft
Froude Number	0.74	
Flow is subcritical.		

* For Channel across Lot Nos 38 & 39

Balthrop 4th Addition Q10
Worksheet for Trapezoidal Channel

Project Description	
Project File	g:\haestad\fmw\balthrop.fm2
Worksheet	Balthrop 4th Addition
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

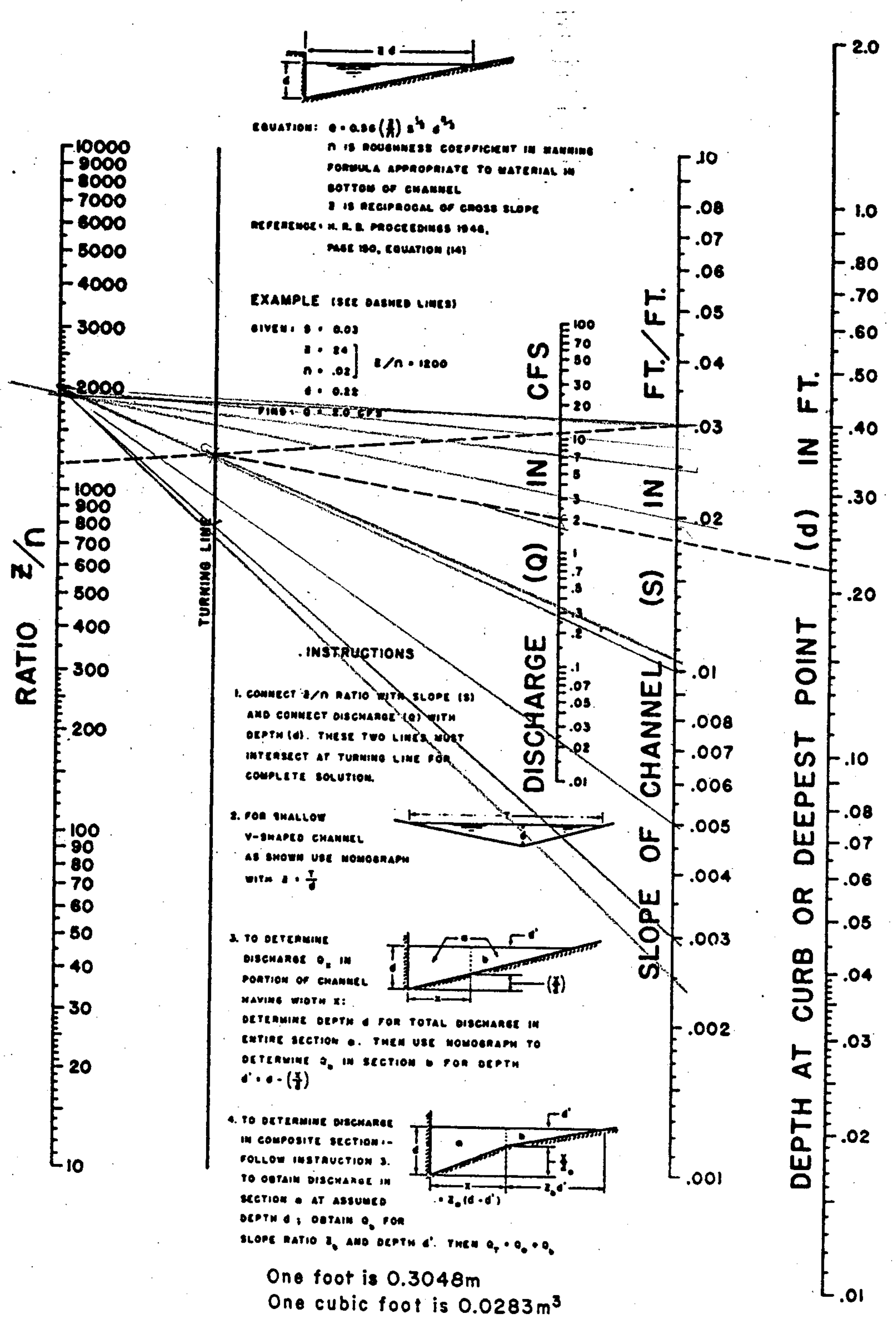
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	50.00	ft
Discharge	102.00	cfs

Results		
Depth	0.62	ft
Flow Area	32.37	ft²
Wetted Perimeter	53.95	ft
Top Width	53.74	ft
Critical Depth	0.50	ft
Critical Slope	0.016744	ft/ft
Velocity	3.15	ft/s
Velocity Head	0.15	ft
Specific Energy	0.78	ft
Froude Number	0.72	
Flow is subcritical.		

* For Channel across Lot Nos 38 & 39

DESIGN CHARTS

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS



One foot is 0.3048m

One cubic foot is $0.0283 m^3$

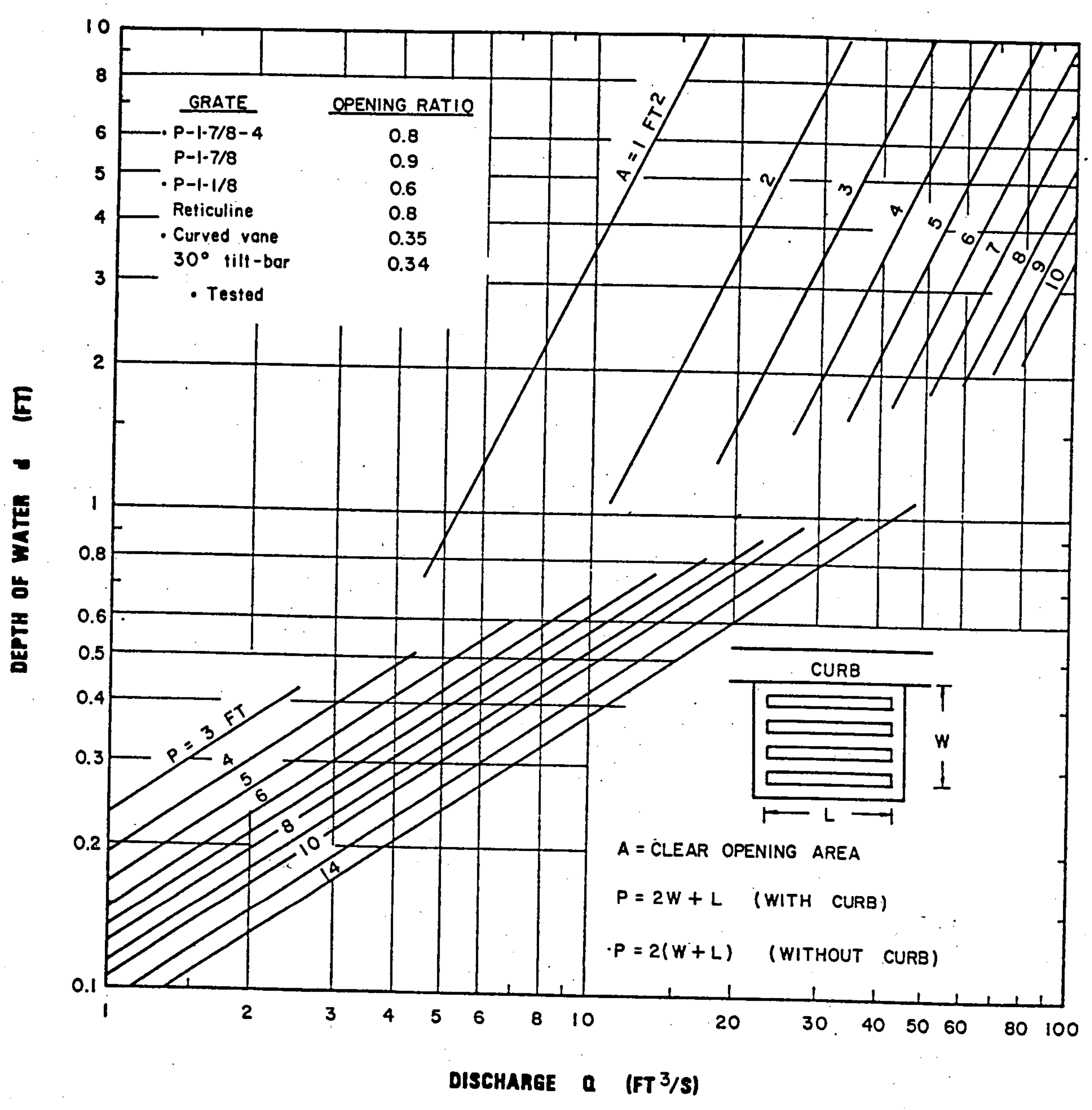


CHART 11. Grate inlet capacity in sump conditions.

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

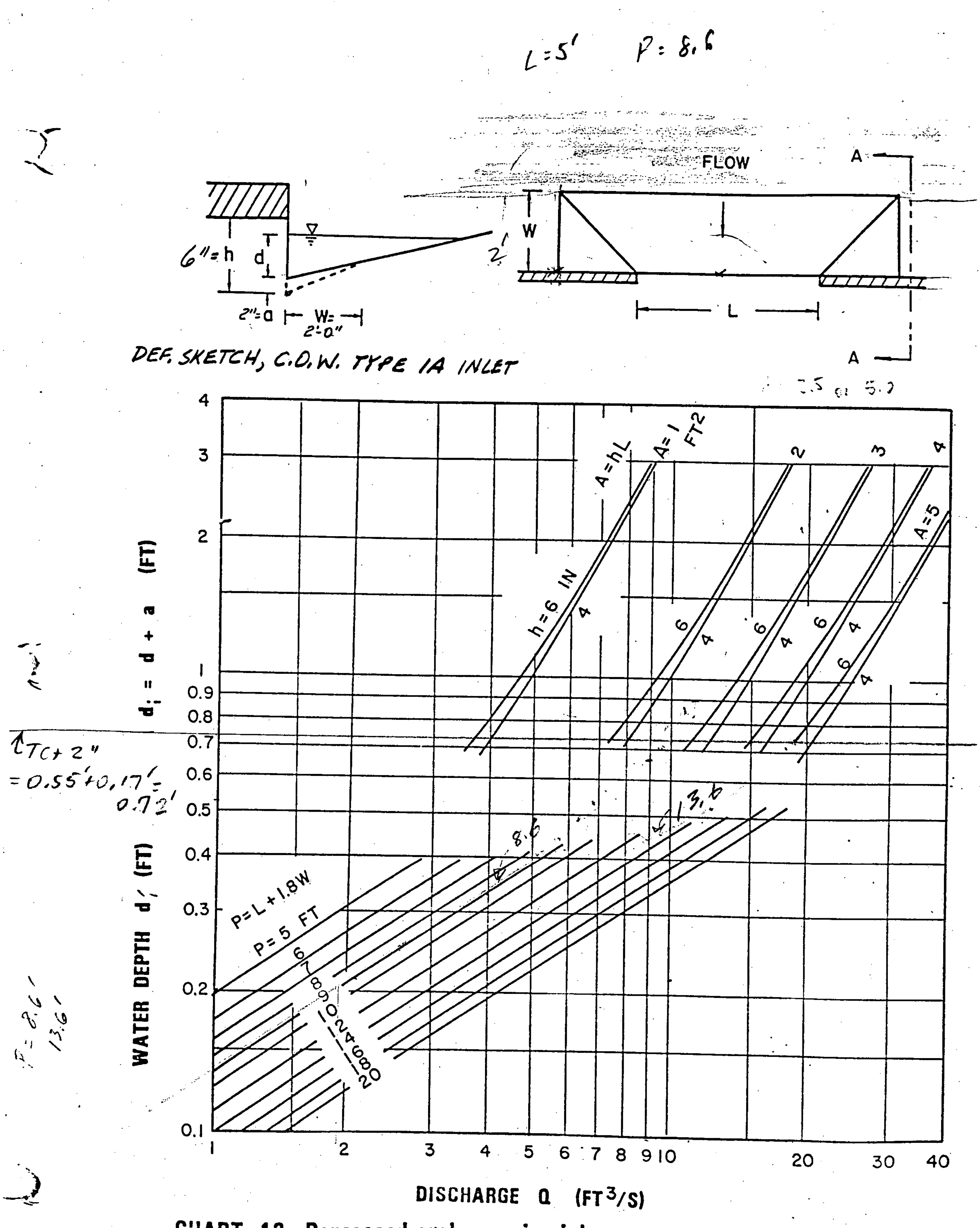


CHART 12. Depressed curb-opening inlet capacity in sump locations.

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

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Date: 3/13/85 MJB Page: 1 of

Project:

Item: STREET FLOW EQUATIONS

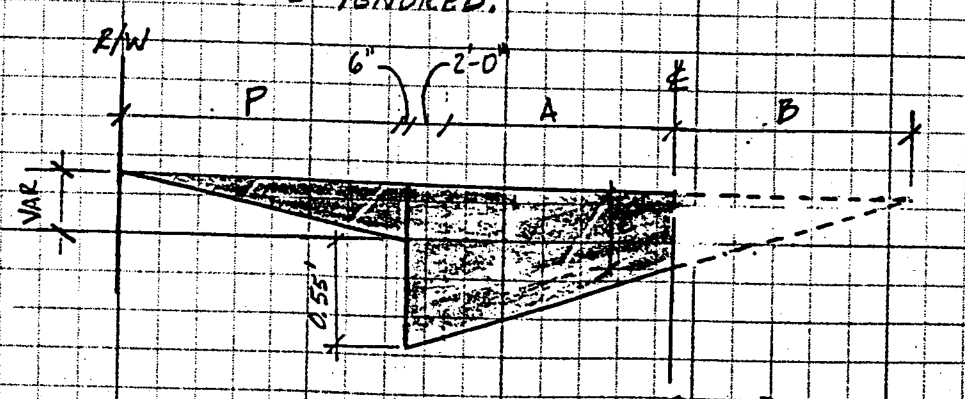
PROBLEM STATEMENT

DETERMINE CONVEYANCE CAPACITY OF STREET RIGHTS-OF-WAY, INCLUDING PARKING, AS A FUNCTION OF LONGITUDINAL GRADE.

SH No ATTACHED IS COPIED FROM HEC-12, "DRAINAGE OF HIGHWAY PAVEMENTS", FHWA, Mar. 1984. EQUATION (4) IS VALID FOR CROSS SLOPES OF 10% OR LESS, WHICH INCLUDES THE ENTIRE "NORMAL" RANGE FOR STREET & PARKING X-SLOPES. NOTE THAT THE RESISTANCE OF THE VERTICAL CURB FACE IS IGNORED IN THE DERIVATION. THUS, THE EQUATION MAY BE SUITABLY UTILIZED FOR COMPOSITE CROSS-SECTIONS WITH ADJACENT VERTICAL PLANES OF WATER WHICH SHOULD NOT BE INCLUDED IN THE WETTED PERIMETER (SEE SKETCH BELOW)

THE ANALYSIS WILL BASED ON STD. C.O.W. CRITERIA:

1. STREET WIDTHS: 29', 35', 37', 41'
2. STD. COMB. C+G (SEE SH No :)
3. PARKING WIDTH = 14'-6".
4. PARKING SLOPE MIN = 1/4 IN/FT (0.02083)
   PARKING SLOPE MAX = 5/8 IN/FT (0.05208) (FOR UNDEVELOPED AREAS)
5. STREET X-SLOPE = 3/8 IN/FT (0.03125). 1/8" ROUNDING AT ℄ IGNORED.



TOTAL FLOW = {FLOW IN P+6"} + {FLOW IN A+2'} − {FLOW IN B}

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Date: 3-13-85 MWB Page ____ of ____

Project: ____

Item: STREET FLOW EQUATIONS

STREET PARKING

I. 14'-6" PARKING, 1/4"/1 SLOPE

(Depth above TC = 0.302')

$T = 14.5 + 0.5 = 15$

$S_x = 0.02083$

$n = 0.055$ (Neglect sidewalk)

$$Q = \frac{0.56}{n} S_x^{5/3} T^{8/3} \sqrt{S}$$

$$= \frac{0.56}{0.055} (0.02083)^{5/3} (15)^{8/3} \sqrt{S}$$

$$= 21.973 \sqrt{S}$$

II. 14'-6" PARKING, 3/8"/1 SLOPE

(Depth above T.C = 10.5 x 0.03125 + 0.08 = 0.41'

$T = 15$

$S_x = 0.03125$

$n = 0.055$

$$Q = \frac{0.56}{0.055} (0.03125)^{5/3} (15)^{8/3} \sqrt{S}$$

$$Q = 43.200 \sqrt{S}$$

III. 14'-6" PARKING, 1/2"/1 SLOPE

(Depth above T.C. = (10.5)(0.04166) + 0.08 = 0.52'

$T = 15$

$S_x = 0.04166$

$n = 0.055$

$$Q = \frac{0.56}{0.055} (0.04166)^{5/3} (15)^{8/3} \sqrt{S}$$

$$Q = 69.759 \sqrt{S}$$

IV. 14'-6" PARKING, 5/8"/1 SLOPE

(Depth above T.C. = (10.5)(0.05208) + 0.08 = [illegible]

$T = 15$

$n = 0.055$

$S_x = 0.05208$

$$Q = \frac{0.56}{0.055} (0.05208)^{5/3} (15)^{8/3} \sqrt{S}$$

$$= 101.202 \sqrt{S}$$

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Date 3/13/85 MWB Page ____ of ____

Project ____

Item STREET FLOW EQUATIONS

41' Bk - Bk Street (½ Street Capacity)

$18' \times \frac{3}{8}"/_1 = 0.5625'$

∴ ℄ to ℄ = 0.05 + .5625 = 0.6125'

Curb deep flow does not cross crown.
Above d = 0.6125', deduction of area B req'd.

$T = \frac{\text{depth above ℄}}{S_x}$

$n = 0.016$
$S_x = 3/8"/ft = 0.03125$
$B = T - 19.6'$ (See II. below)

I. At T.C.

$d = 0.55$
$T = 0.55/0.03125 = 17.6'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}(17.6)^{8/3}\sqrt{S}$$
$$= 227.43\sqrt{S}$$

II At T.C + 0.0625' (Flooded to ℄)

$d = 0.6125'$
$T = 19.6'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}(19.6)^{8/3}\sqrt{S}$$
$$Q = 303.04\sqrt{S}$$

III. At T.C. + 0.302' (14'-6" Pkg, ¼"/1 Sl.)

$d = 0.852'$
$T = 27.264'$
$B = 7.664$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\sqrt{S}\left[(27.264)^{8/3} - (7.664)^{8/3}\right]$$
$$= 705.90\sqrt{S}$$

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

$d = 0.96'$
$T = 30.72'$
$B = 11.12'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\left[(30.72)^{8/3} - (11.12)^{8/3}\right]\sqrt{S}$$
$$= 937.63\sqrt{S}$$

V. At T.C. + 0.52' (14'-6" Pkg, ½"/1 Sl.)

$d = 1.07'$
$T = 34.24'$
$B = 14.64'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\left[(34.24)^{8/3} - (14.64)^{8/3}\right]\sqrt{S}$$
$$= 1202.27\sqrt{S}$$

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

$d = 1.18'$
$T = 37.76'$
$B = 18.16'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\left[(37.76)^{8/3} - (18.16)^{8/3}\right]$$
$$= 1494.17\sqrt{S}$$

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Date 11-4-91 MWB Page ____ of ____

Project ____

Item STREET FLOW EQUATIONS

25' BACK-BACK STREET (1/2 STREET CAPACITY)

ASSUMPTIONS:

C.O.W. Std. Curb c 6 5/8" high
X-Slope 3/8"/ft = 1/32
Ignore conveyance of turb area behind curb

$10' \times \frac{1}{32} = 0.3125'$ E.P to Crown

$0.3125' + 0.05 = 0.3625'$ ℄ to Cr.

Curb deep is 0.55' d is higher than crown; deduction of B is req'd.

$T = (\text{Depth above ℄}) / S_x$
$n = 0.016$
$S_x = 1/32 = 0.03125$
$B = T - 11.6$

I. At $d = 0.3625'$ (Crown Deep)

$d = 0.3625$
$T = 11.6$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}(11.6)^{8/3}\sqrt{S}$$

$Q = 74.8\sqrt{S}$

II. At $d = T.C = 0.55'$

$d = 0.55'$
$T = 17.6$
$B = 17.6 - 11.6 = 6.0$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\sqrt{S}\left[(17.6)^{8/3} - (6)^{8/3}\right]$$

$Q = 214.5\sqrt{S}$

III. At T.C. + 0.302' (14'-6" Pkg; 1/4"/, Sl.

$d = 0.852'$
$T = 27.264'$
$B = 15.664'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\sqrt{S}\left[(27.264)^{8/3} - (15.66\ldots\right.$$

$Q = 564\sqrt{S}$

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

$d = 0.96'$
$T = 30.72'$
$B = 19.12'$

$$Q = \frac{0.56}{0.016}(0.03125)^{5/3}\sqrt{S}\left[(30.72)^{8/3} - (19.12)^{8/3}\right]$$

$Q = 721\sqrt{S}$

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

$d = 1.07'$
$T = 34.24'$
$B = 20.64'$

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

$Q = 994\sqrt{S}$

VI At T.C + 0.63' (14-6 Pkg; 5/8 in/ft Sl

$d = 1.18'$
$T = 37.76'$
$B = 24.16'$

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

$Q = 1212\sqrt{S}$

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Date 3/14/85 MMB Page ______ of ______

Project ______

Item STREET FLOW EQUATIONS

29' Bk-Bk Street (1/2 Street Capacity)

$12 \times 3/8 "/' = 0.375'$

℄ to ℄ = 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.

$T = (\text{depth above ℄}) / S_x$
$n = 0.016$
$S_x = 3/8 "/ft = 0.03125$
$B = T - 13.6$

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

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

$= 223.06 \sqrt{S}$

III. At TC + 0.302' (14'-6" Pkg, 1/4"/' Sl.)

d = 0.852'
T = 27.264
B = 13.664

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

$= 614.878 \sqrt{S}$

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

d = 0.96'
T = 30.72'
B = 17.12'

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

$Q = 793.215 \sqrt{S}$

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

d = 1.07'
T = 34.24'
B = 20.64'

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

$Q = 993.613 \sqrt{S}$

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

d = 1.18'
T = 37.76'
B = 24.16'

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

$Q = 1212.07 \sqrt{S}$

VII At 3 5/8" Roll TC = 0.30' = d.

d = 0.3
T = 9.6 ft

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

$= 45.17 \sqrt{S}$

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Date 5/30/85 MWB Page ____ of ____

Project ____

Item STREET FLOW EQUATIONS

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

15' x 3/8"/1 = 0.46875'

FL to ℄ = 0.47 + 0.05 = 0.52

Curb deep flow is 0.03' above crown.

T = (depth above FL)/S_x
n = 0.016
S_x = 3/8 in/ft = 0.03125 ft/ft
B = T − 16.6' (See I Below)

I. At d = 0.52' (Crown deep)

T = 0.52/0.03125 = 16.6'

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

$= 194.58\sqrt{S}$

II At d = 0.55' (Curb deep)

T = 17.6'
B = 1.0'

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

$= 227.32\sqrt{S}$

III. At d = 0.85' (TC + 0.302') (14'-6" Pkg.) (1/4"/1 Sl.)

d = 0.85
T = 27.26
B = 10.66

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

$= 670.66\sqrt{S}$

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

d = 0.96'
T = 30.72'
B = 14.12'

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

$= 878.09\sqrt{S}$

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

d = 1.07'
T = 34.24'
B = 17.64'

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

$= 1112.64\sqrt{S}$

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

d = 1.18'
T = 37.76'
B = 21.16'

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

$Q = 1369.72\sqrt{S}$

VII At d = 0.30' TC Roll Curb

d = 0.3' T = 9.6 ft

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

$Q = 45.17\sqrt{S}$

Date 3-8-90 MB Page 1 of 2

Project

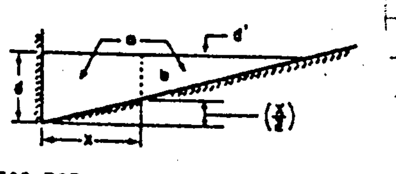
Item STREET FLOW EQUATION

49' BK-BK STREET (HALF STREET CAPACITY)

Use 3/8 in/ft X-Slope = 1/32

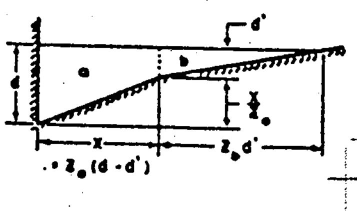
Use KDOT Type I C+G, which is a compound section. See solution method below

3. TO DETERMINE DISCHARGE Q_x IN PORTION OF CHANNEL HAVING WIDTH X:



DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION a. THEN USE NOMOGRAPH TO DETERMINE Q_b IN SECTION b FOR DEPTH $d' = d - \left(\frac{x}{z}\right)$

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



$$Q = 0.56 \frac{z}{n} \sqrt{S}\, d^{8/3}$$

Let $n = 0.016$
$z = 32$ for 3/8"/ft
$z = 12$ gutter pan

Ignore conveyance over turf area in parking

(I) At $d = 0.15'$ = Full gutter pan

$$Q = \frac{0.56(12)}{0.016}(0.15)^{8/3}\sqrt{S} = 2.67\sqrt{S}$$

(II) At $d = 0.50'$ = Top of curb
≈ one eleven foot lane flooded

a) Gutter pan

$$Q_a = \frac{0.56(12)}{0.016}(0.50)^{8/3}\sqrt{S} - \frac{0.56(12)}{0.016}(0.35)^{8/3}\sqrt{S}$$

$$= 66.15\sqrt{S} - 25.55\sqrt{S} = 40.6\sqrt{S}$$

b) street

$$Q_b = \frac{0.56(32)}{0.016}(0.35)^{8/3}\sqrt{S}$$

$$= 68.1\sqrt{S}$$

$$Q_T = Q_a + Q_b = 109\sqrt{S}$$

(III) At $d = 0.8375'$ = Cr. Gr = T.C + 0.34'

a) Gutter pan

$$Q_a = \frac{0.56(12)}{0.016}(0.8375)^{8/3}\sqrt{S} - \frac{0.56(12)}{0.016}(0.69)^{8/3}\sqrt{S}$$

$$= 261.7\sqrt{S} - 156\sqrt{S} = 105\sqrt{S}$$

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Item STREET FLOW EQUATIONS

49' BK-BK STREET (HALF-STREET CAPACITY)

III con't

b) Street

$$Q_b = \frac{0.56(32)(0.19)^{8/3}}{0.016}\sqrt{S} = 416\sqrt{S}$$

$$Q_T = Q_a + Q_b = 105\sqrt{S} + 416\sqrt{S} = 521\sqrt{S}$$

IV At T.C + 0.53'

(25'-6" Parking 1/4"/ft X-Slope)

$$\frac{25.5}{48} = 0.53 \qquad d = 0.53 + 0.5 = 1.03'$$

a) Gutter pan

$$Q_a = \frac{0.56(12)(1.03)^{8/3}}{0.016}\sqrt{S} - \frac{0.56(12)(0.88)^{8/3}}{0.016}\sqrt{S}$$

$$= 454\sqrt{S} - 299\sqrt{S} = 155\sqrt{S}$$

$$Q_b = \frac{0.56(32)(0.88)^{8/3}}{0.016}\sqrt{S} - \frac{0.56(32)(0.19)^{8/3}}{0.016}\sqrt{S}$$

$$= 796\sqrt{S} - 13\sqrt{S} = 783\sqrt{S}$$

$$Q_T = 155 + 783 = 938\sqrt{S}$$

V At T.C + 0.98' ≠ Cr Gr + 8" ±

(21'-6" Parking @ 1/2"/1 + 4' SW @ 1/4"/1)

$$\frac{21.5}{24} + \frac{4}{48} = 0.98'$$

$$d = 0.98 + 0.5 = 1.48'$$

a) Gutter Pan

$$Q_a = \frac{0.56(12)(1.48)^{8/3}\sqrt{S}}{0.016} - \frac{0.56(12)(1.33)^{8/3}\sqrt{S}}{0.016}$$

$$= 1195\sqrt{S} - 899\sqrt{S} = 296\sqrt{S}$$

$$Q_b = \frac{0.56(32)(1.33)^{8/3}\sqrt{S}}{0.016} - \frac{0.56(32)(0.49)^{8/3}\sqrt{S}}{0.016}$$

$$= 2396\sqrt{S} - 167\sqrt{S} = 2229\sqrt{S}$$

$$Q_T = 296\sqrt{S} + 2229\sqrt{S} = 2525\sqrt{S}$$

MAP POCKET