SCANNED

DRAINAGE REPORT
FOR
~~CENTRAL DEVELOPMENT ADDITION~~ CrestLake

WICHITA, SEDGWICK COUNTY, KANSAS

December 8, 2005

Ruggles & Bohm P.A.

Engineering, Surveying, Land Planning

CENTRAL DEVELOPMENT ADDITION
DRAINAGE ANALYSIS
NOVEMBER 2, 2005

INTRODUCTION

This report contains supporting documentation and calculations for the proposed Central Development Addition. The existing site is an undeveloped 36 acre tract of land located west of the northwest corner of Central Ave. and K-96 highway. The area is currently pasture land with two major drainage ways through the site. The first drainage way crosses the southwest corner of the property and the other is near the easterly side of the property flowing from north to south. Existing off-site drainage enters the site from one location on the west and two locations on the north lines of this property.

The drainage from the north comes from three (3) 8.5 sq. ft. RCPH pipes under K-96 that drain the K-96 right-of-way on the east and a 7' x 4' RCB from Balthrop 4th Addition on the west. The drainage crossing the southwest corner of the property discharges from a pond just west of the subject property and drains approximately 424 acres to the west and north. Both drainage ways are controlled by existing reinforced concrete box culverts (RCB's) under Central Avenue.

The site will be developed into residential lots with on-site detention to be accomplished using the two (2) existing ponds in the center of the property, which will be combined into a single common pond. Detention for this site will also include the required detention for the Balthrop 4th Addition. The pond will also provide detention storage for approximately 7 acres of ground adjacent to and east of the east line of the addition in its fully developed condition as commercial property.

HYDROLOGY

Peak flow rates for the offsite flows were determined from a combination of drainage data from Professional Engineering Consultants, P.A. for the Balthrop 4th Addition and the U.S. Army Corps of Engineers HEC-HMS model. The HY-8 data from the box culverts under Central Ave. was used in the model as downstream controls for this site.
Additional information was obtained from the drainage map and plan and profile sheets of the construction plans for Central Avenue, County Project No. 618-34 dated July 1997.

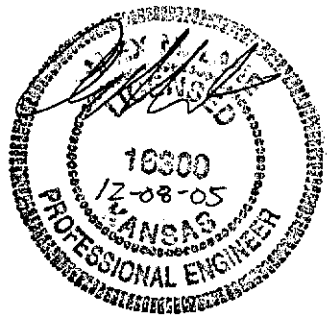
The rational method was used to determine peak flow rates for the basins located within the plat. See the "Hydrology Data" section of this report for calculations and results for this project.

HYDRAULICS

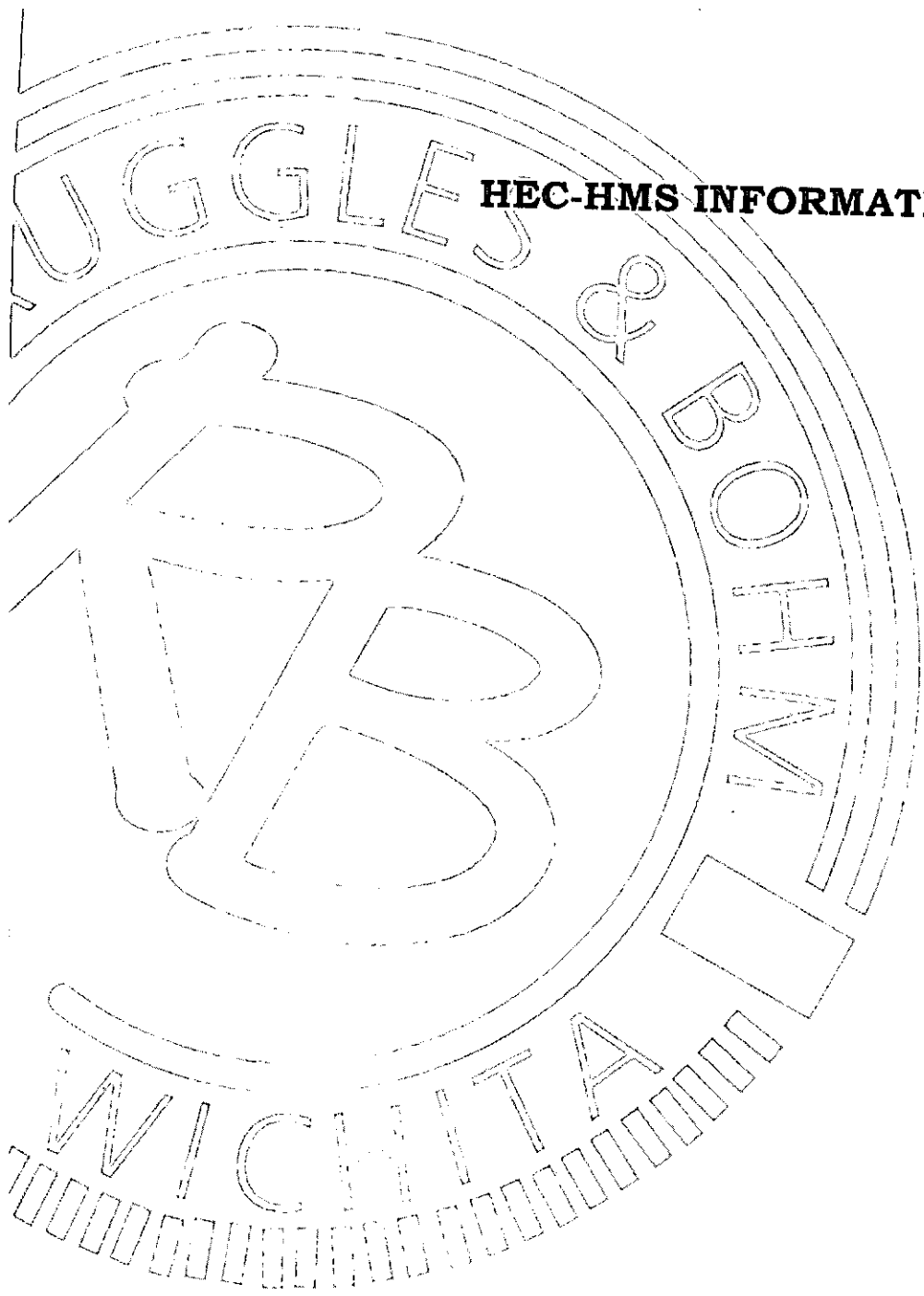
Hydraulic characteristics and design for the channels and outfall structures for the ponds were determined using the Haestad Methods Open Channel Flow Module.

CONCLUSION

The single detention pond will provide sufficient storage to detain the necessary flow from both this site, Balthrop 4th Addition, and the adjacent 7 acres to the east. A Weir structure must be constructed on the existing pond to provide detention storage. The discharge point from the pond to Central Avenue shall have a twenty-three foot (23') broad-crested weir.



HEC-HMS INFORMATION



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Pond Summary
(2-yr and 5-yr design storm included for information only)

2-year Design Storm
Q_2 Undeveloped = 71 cfs
24-hr Cum. Rainfall = 3.5 in.
Q_2 In = 201 cfs
Q_2 Out = 132.2 cfs
Peak Storage = 6.77 ac-ft.
Peak El. = 1352.4

5-year Design Storm
Q_5 Undeveloped = 155 cfs
24-hr Cum. Rainfall = 4.5 in.
Q_5 In = 283.5 cfs
Q_5 Out = 196 cfs
Peak Storage = 8.9 ac-ft.
Peak El. = 1352.8

100-year Design Storm
Q_{100} Undeveloped = 419 cfs
24-hr Cum. Rainfall = 7.8 in.
Q_{100} In = 567 cfs
Q_{100} Out = 426 cfs 429?
Peak Storage = 15.45 ac-ft.
Peak El. = 1352.8

434 PER PLAN

Weir Discharge Calculations
Central Development Addition

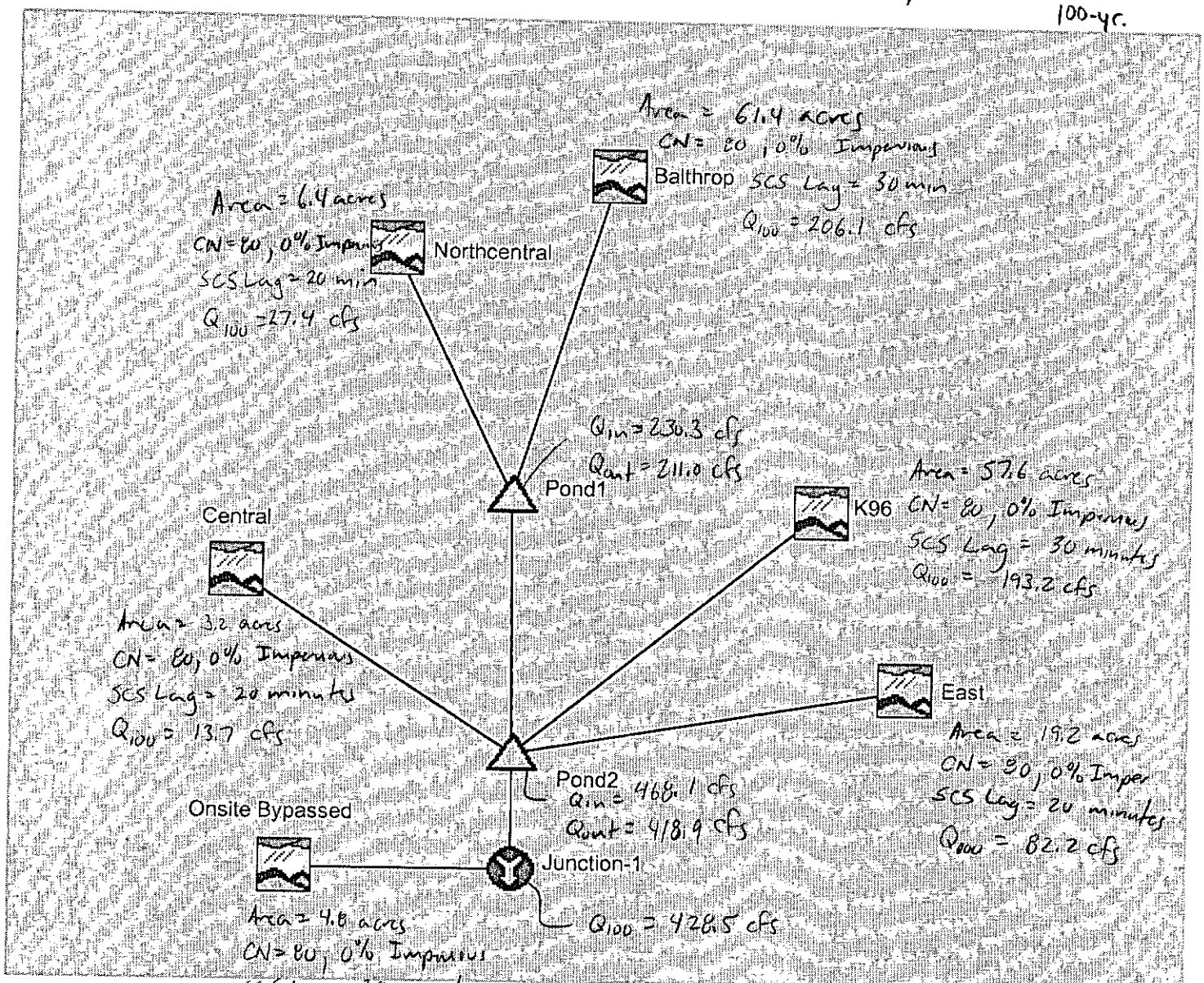
23 foot Wide Broad Crested Weir
Use C = 3.58 (Handbook of Hydraulics, King and Brater)
Note: The HEC-HMS Model models the weir internally
but uses the Broad Crested Weir Equation of Q = CLH**1.5

Elevation	H	C	L	Q	Pond Storage (ac-ft.)
1351	0	3.58	23	0	0.00
1351.5	0.5	3.58	23	29.1	2.43
1352	1	3.58	23	82.3	4.86
1352.5	1.5	3.58	23	151.3	7.44
1353	2	3.58	23	232.9	10.02
1353.5	2.5	3.58	23	325.5	12.76
1354	3	3.58	23	427.9	15.49
1354.5	3.5	3.58	23	539.2	18.38

HEC-HMS Project: ktp Basin Model:

Pre-Development Condition w/ As-Surveyed Conditions Including Unimproved Balthrop 4th Addn.

100-yr.



HMS * Summary of Results

Project : ktp Run Name : KTP-UND-New

Start of Run : 28Aug01 1200 Basin Model : KTP-UND-KWL
End of Run : 29Aug01 1200 Met. Model : 100
Execution Time : 30Nov05 1722 Control Specs : 100

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Northcentral	27.413	29 Aug 01 0010	2.8809	0.010
Balthrop	206.11	29 Aug 01 0020	27.566	0.096
Pond1	210.97	29 Aug 01 0030	27.150	0.106
Central	13.706	29 Aug 01 0010	1.4405	0.005
K96	193.22	29 Aug 01 0020	25.843	0.090
East	82.238	29 Aug 01 0010	8.6428	0.030
Pond2	418.92	29 Aug 01 0035	62.570	0.231
Onsite Bypassed	20.834	29 Aug 01 0010	2.1895	0.008
Junction-1	428.51	29 Aug 01 0035	64.759	0.239

HMS * Summary of Results for Junction-1

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Outflow : 428.51 (cfs) Date/Time of Peak Outflow : 29 Aug 01 0035

Total Outflow : 5.09 (in)

HMS * Summary of Results for Pond1

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Inflow	: 230.27 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0020
Peak Outflow	: 210.97 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0030
Total Inflow	: 5.39 (in)	Peak Storage	: 5.7237(ac-ft)
Total Outflow	: 4.80 (in)	Peak Elevation	: 1357.0(ft)

HMS * Summary of Results for Pond2

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Inflow	: 468.05 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0025
Peak Outflow	: 418.92 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0035
Total Inflow	: 5.12 (in)	Peak Storage	: 7.7864(ac-ft)
Total Outflow	: 5.08 (in)	Peak Elevation	: 1354.0(ft)

HMS * Summary of Results for Onsite Bypassed

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Discharge	: 20.834 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.40 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.40 (in)

HMS * Summary of Results for Central

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Discharge	: 13.706 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.40 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.40 (in)

HMS * Summary of Results for Northcentral

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Discharge	: 27.413 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.40 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.40 (in)

HMS * Summary of Results for Balthrop

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Discharge	: 206.11 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0020
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.38 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.38 (in)

HMS * Summary of Results for K96

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

Computed Results

Peak Discharge	: 193.22 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0020
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.38 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.38 (in)

HMS * Summary of Results for East

Project : ktp Run Name : KTP-UND-New

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UND-KWL
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1722	Control Specs	: 100

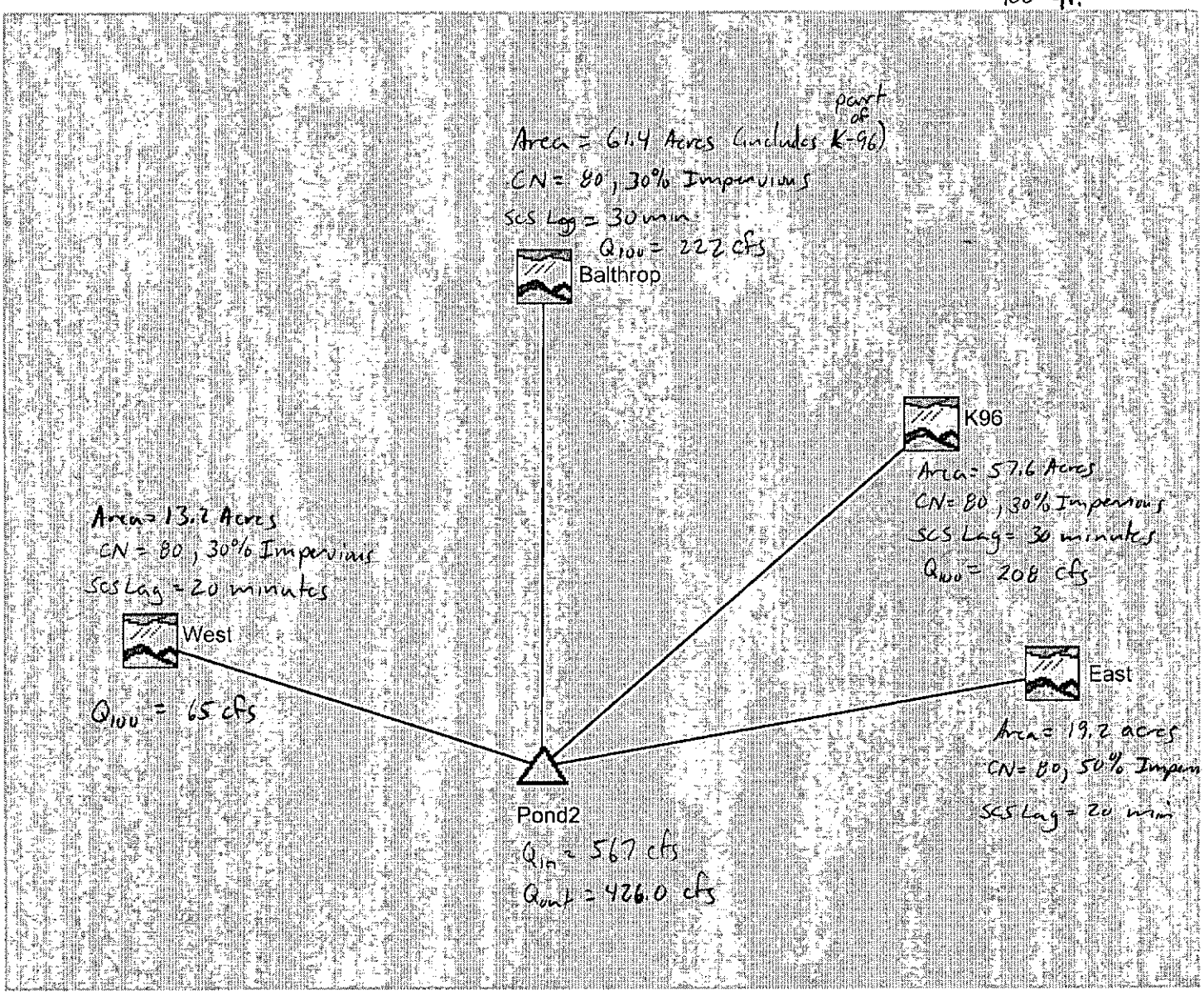
Computed Results

Peak Discharge	: 82.238 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 5.40 (in)
Total Loss	: 2.36 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 5.44 (in)	Total Discharge	: 5.40 (in)

HEC-HMS Project: ktp Basin Model: KTP-East

Developed Model (Balthrop 4th and Central Development) – Check Run.

100-yr.



HMS * Summary of Results

Project : ktp Run Name : KTP East

Start of Run : 28Aug01 1200 Basin Model : KTP-East
End of Run : 29Aug01 1200 Met. Model : 100
Execution Time : 30Nov05 1707 Control Specs : 100

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
West	64.622	29 Aug 01 0010	7.1361	0.022
Balthrop	222.21	29 Aug 01 0020	31.188	0.096
K96	208.32	29 Aug 01 0020	29.239	0.090
East	92.715	29 Aug 01 0010	10.531	0.030
Pond2	425.99	29 Aug 01 0035	76.641	0.238

HMS * Summary of Results for Pond2

Project : ktp Run Name : KTP East

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1707	Control Specs	: 100

Computed Results

Peak Inflow	: 567.33 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0020
Peak Outflow	: 425.99 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0035
Total Inflow	: 6.15 (in)	Peak Storage	: 15.445(ac-ft)
Total Outflow	: 6.04 (in)	Peak Elevation	: 1354.0(ft)

HMS * Summary of Results for West

Project : ktp Run Name : KTP East

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1707	Control Specs	: 100

Computed Results

Peak Discharge	: 64.622 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 6.11 (in)
Total Loss	: 1.65 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.15 (in)	Total Discharge	: 6.11 (in)

HMS * Summary of Results for Balthrop

Project : ktp Run Name : KTP East

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1707	Control Specs	: 100

Computed Results

Peak Discharge	: 222.21 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0020
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 6.09 (in)
Total Loss	: 1.65 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.15 (in)	Total Discharge	: 6.09 (in)

HMS * Summary of Results for K96

Project : ktp Run Name : KTP East

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1707	Control Specs	: 100

Computed Results

Peak Discharge	: 208.32 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0020
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 6.09 (in)
Total Loss	: 1.65 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.15 (in)	Total Discharge	: 6.09 (in)

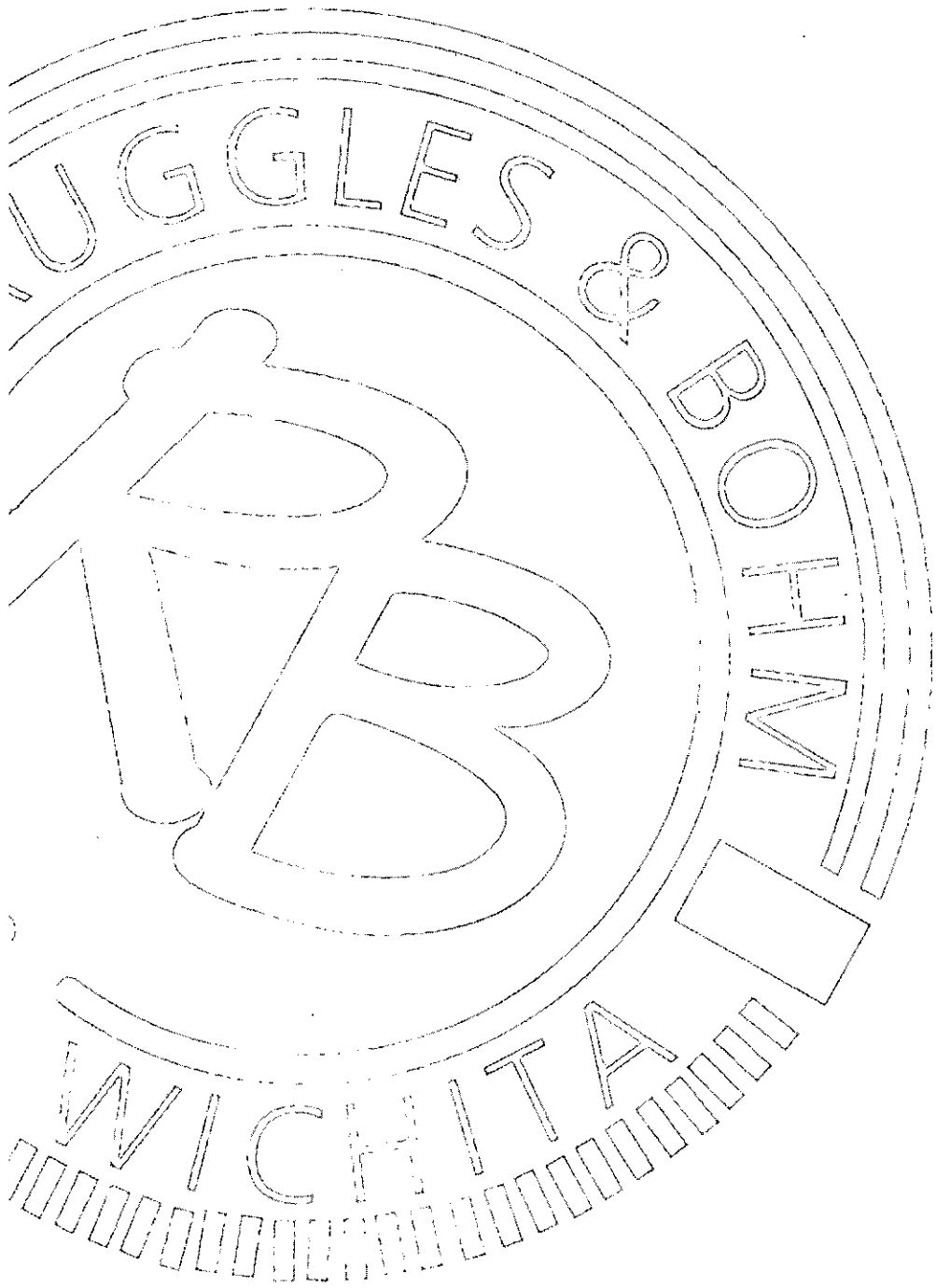
HMS * Summary of Results for East

Project : ktp Run Name : KTP East

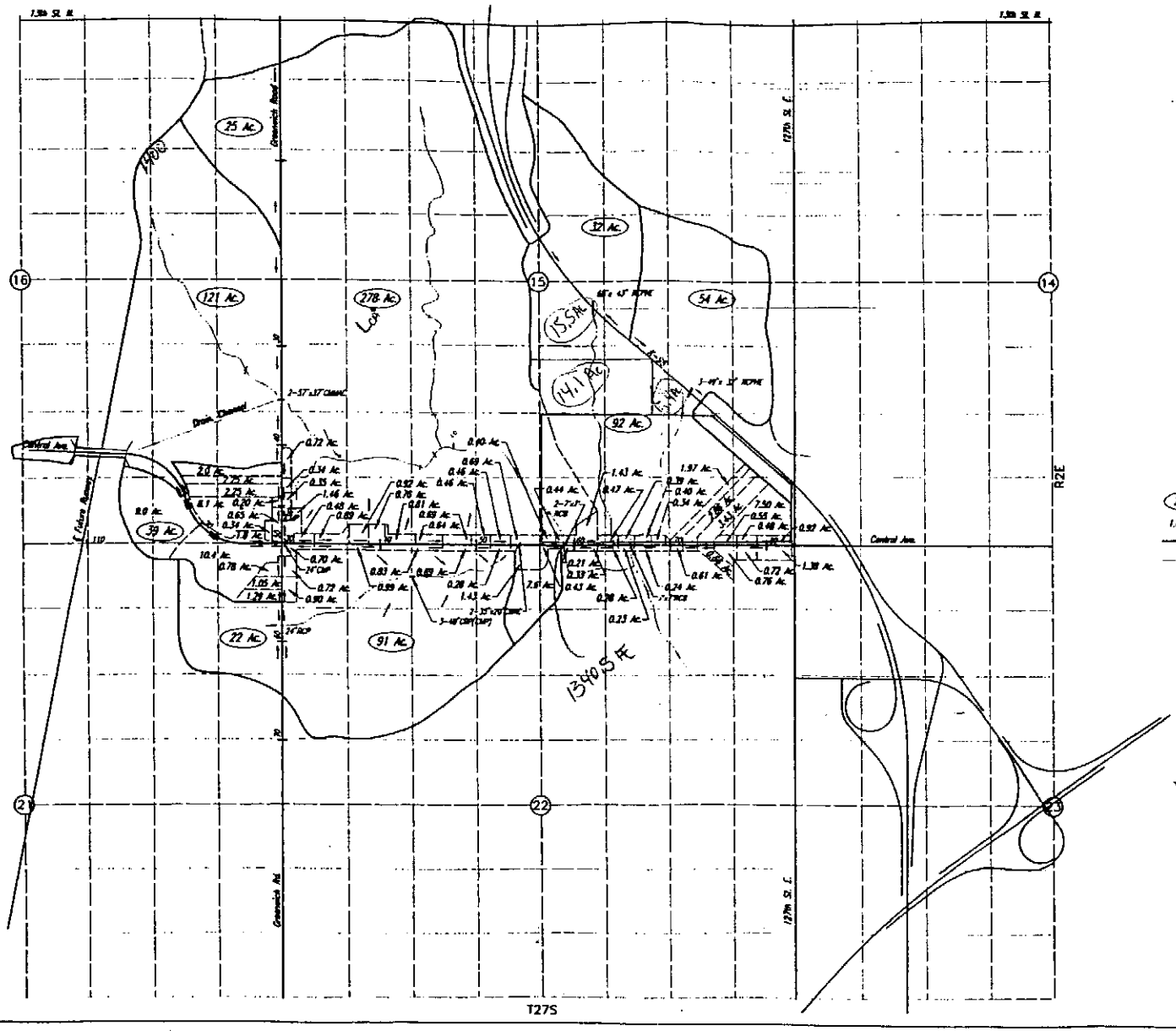
Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 30Nov05 1707	Control Specs	: 100

Computed Results

Peak Discharge	: 92.715 (cfs)	Date/Time of Peak Discharge	: 29 Aug 01 0010
Total Precipitation	: 7.80 (in)	Total Direct Runoff	: 6.58 (in)
Total Loss	: 1.18 (in)	Total Baseflow	: 0.00 (in)
Total Excess	: 6.62 (in)	Total Discharge	: 6.58 (in)



EXISTING CENTRAL AVENUE RCBC ANALYSIS



PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
618-34	1998	#20	#20

SCALE 1"=500'

LEGEND

- (22 Ac.) Total Basin Area to Cross Road Structure
- 1.00 Ac. Sub-basin Area to Storm Sewer Inlet
- Major Basin Divide
- Minor Basin

Note: Cross-road drainage structures shown are those existing prior to project improvements

$L = \frac{5280}{2430} = \frac{x}{3600} = 6,519$ ft.

$L_{CA} = \frac{5280}{2430} = \frac{x}{1660} = 3,911$ ft.

$S = \frac{1400 - 1340.5}{6519} \times 5280 = 48.2$ ft/mi

SEDGWICK COUNTY BUREAU OF PUBLIC SERVICES

DRAINAGE MAP

PROJECT NO. 618-34 SEDGWICK COUNTY

PROFESSIONAL ENGINEERING CONSULTANTS P.A.

WICHITA, KANSAS

Offsite Hydrology

West Offsite Drainage

Area = 424 acres +/- = 0.66 sq. mi
L = 6,519 ft = 1.23 mi
L_{CA} = 3,911 ft = 0.74 mi
Slope = 59.5 ft/ 6519 ft = 0.00913 ft/ft = 48.2 ft/mi

2 of the 4 parameters fit the requirement of the Snyder Unit Hydrograph Equation and the other 2 are close, so the Snyder parameters will be used for the west offsite basin.

See following page for data.

North Offsite Drainage Basins

Balthrop 4th Addition

All proposed flow rates taken from the Professional Engineering Consultants, P.A. Drainage Plan for Balthrop 4th Addition.

K-96 Right-of-Way

Area = 57.4 acres
T_C = 23 min.
I_{100} = 6.13 in/hr
C = 0.69
Q_{100} = 0.69(6.13)(57.4) = 242.8 cfs

Tulsa District Method for Estimating Snyder Parameters

The Tulsa District of the U. S. Army Corps of Engineers has developed the following equation for Snyder's watershed lag for natural watersheds in rural areas of central and norteastern Oklahoma.

$$T = 1.42 \times [(L \times Lca)/\text{sq.rt. } S)]^{0.39}$$

in which:

T = watershed lag in hours
L = watershed length in miles
Lca = length to centroid in miles
S = watershed slope in feet per mile.

The range of hydrologic characteristics of the watersheds studied in developing this equation are as follows:

Watershed Area: From 0.88 sq. mi. to 502 sq. mi.
Watershed Slope: From 4.1 feet per mile to 82.1 feet per mile
Watershed Length: From 1.4 miles to 60.5 miles
Length to Centroid: From 0.6 miles to 33.0 miles

Basin Name	Area (acres)	Area (sq. mi.)	L (mi)	Lca (mi)	S (ft/mi)	T (hr)	qp (cfs/sq.mi.)	Cp (cf/sq.mi.)
KTP Offsite West	*424.00*	*0.6625*	*1.23*	*0.74*	*48*	0.64	*570.53*	0.573

HMS * Summary of Results

Project : KTP Run Name : Run 4

Start of Run	: 28Aug01 1200	Basin Model	: KTP-UndW
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 04Sep01 1432	Control Specs	: 100_West

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Offsite	1136.5	29 Aug 01 0040	221.99	0.663
West	54.528	29 Aug 01 0015	4.9136	0.016
Junction-1	1153.7	29 Aug 01 0040	226.90	0.679

2 - 7'x7' RCB

CURRENT DATE: 08-30-2001
CURRENT TIME: 08:24:46

FILE DATE: 08-30-2001
FILE NAME: ktp_3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CU LV NO	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	1340.80	1340.50	94.00	2 RCB	7.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: ktp_3 DATE: 08-30-2001

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1340.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1344.69	120.0	120.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.18	240.0	240.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.17	360.0	360.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.09	480.0	480.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.94	600.0	600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.73	720.0	720.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1348.48	840.0	840.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1349.33	960.0	960.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1350.07	1080.0	1056.3	0.0	0.0	0.0	0.0	0.0	21.48	6
1350.22	1155.0	1075.8	0.0	0.0	0.0	0.0	0.0	71.26	5
1349.86	1029.3	1029.3	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: ktp_3 DATE: 08-30-2001

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1340.80	0.000	0.00	0.00	0.00
1344.69	0.000	120.00	0.00	0.00
1345.18	0.000	240.00	0.00	0.00
1345.17	0.000	360.00	0.00	0.00
1346.09	0.000	480.00	0.00	0.00
1346.94	0.000	600.00	0.00	0.00
1347.73	0.000	720.00	0.00	0.00
1348.48	0.000	840.00	0.00	0.00
1349.33	0.000	960.00	0.00	0.00
1350.07	-0.004	1080.00	2.22	0.21
1350.22	-0.007	1155.00	7.96	0.69

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

PERFORMANCE CURVE FOR CULVERT 1 - 2(7.00 (ft) BY 7.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1340.80	0.00	-0.30	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
120.00	1344.69	1.96	3.89	1-S2n	1.26	1.32	1.26	1.61	6.79	4.52
240.00	1345.18	3.11	4.38	1-S2n	2.05	2.09	2.05	2.29	8.35	5.47
360.00	1345.17	4.12	4.37	3-M1t	2.75	2.74	2.79	2.79	9.22	6.10
480.00	1346.09	5.06	5.29	2-M2c	3.40	3.32	3.32	3.20	10.31	6.59
600.00	1346.94	5.94	6.14	2-M2c	4.02	3.86	3.86	3.55	11.11	6.98
720.00	1347.73	6.79	6.93	2-M2c	4.62	4.36	4.36	3.86	11.81	7.32
840.00	1348.48	7.65	7.68	2-M2c	5.22	4.83	4.83	4.15	12.43	7.62
960.00	1349.33	8.53	8.39	2-M2c	5.80	5.28	5.28	4.41	12.99	7.89
1056.30	1350.06	9.26	8.95	2-M2c	6.27	5.62	5.62	4.79	13.41	8.27
1075.78	1350.22	9.42	9.06	2-M2c	7.00	5.69	5.69	4.87	13.50	8.36

El. inlet face invert 1340.80 ft El. outlet invert 1340.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1340.80 ft
OUTLET STATION	94.00 ft
OUTLET ELEVATION	1340.50 ft
NUMBER OF BARRELS	2
SLOPE (V/H)	0.0032
CULVERT LENGTH ALONG SLOPE	94.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	7.00 ft
BARREL RISE	7.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL (45 DEG. FLARE)
INLET DEPRESSION	NONE

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	10.00 ft
SIDE SLOPE H/V (X:1)	4.0
CHANNEL SLOPE V/H (ft/ft)	0.007
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	1340.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1340.50 ft

****** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1340.50	0.000	0.00	0.00	0.00
120.00	1342.11	0.630	1.61	4.52	0.70
240.00	1342.79	0.640	2.29	5.47	1.00
360.00	1343.29	0.640	2.79	6.10	1.22
480.00	1343.70	0.650	3.20	6.59	1.40
600.00	1344.05	0.650	3.55	6.98	1.55
720.00	1344.36	0.660	3.86	7.32	1.69
840.00	1344.65	0.660	4.15	7.62	1.81
960.00	1344.91	0.660	4.41	7.89	1.92
1080.00	1345.29	0.670	4.79	8.27	2.09
1155.00	1345.37	0.670	4.87	8.36	2.13

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	49.00 ft

***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	5700.00	1350.56
2	5800.00	1350.24
3	5900.00	1349.92
4	5950.00	1349.86
5	6000.00	1350.00
6	6050.00	1350.24

7'x7' RCB

CURRENT DATE: 08-30-2001
CURRENT TIME: 08:32:05

FILE DATE: 08-30-2001
FILE NAME: ktp_1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

C U L V	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
NO. 1	1339.55	1339.50	93.50	1 RCB	7.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: ktp_1 DATE: 08-30-2001

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1339.55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1341.48	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1342.57	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1343.49	150.0	150.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1344.31	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.07	250.0	250.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1345.76	300.0	300.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1346.44	350.0	350.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.05	400.0	400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1347.68	450.0	450.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1348.39	500.0	500.0	0.0	0.0	0.0	0.0	0.0	0.00	1
1349.24	554.4	554.4	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: ktp_1 DATE: 08-30-2001

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
1339.55	0.000	0.00	0.00	0.00
1341.48	0.000	50.00	0.00	0.00
1342.57	0.000	100.00	0.00	0.00
1343.49	0.000	150.00	0.00	0.00
1344.31	0.000	200.00	0.00	0.00
1345.07	0.000	250.00	0.00	0.00
1345.76	0.000	300.00	0.00	0.00
1346.44	0.000	350.00	0.00	0.00
1347.05	0.000	400.00	0.00	0.00
1347.68	0.000	450.00	0.00	0.00
1348.39	0.000	500.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

PERFORMANCE CURVE FOR CULVERT 1 - 1(7.00 (ft) BY 7.00 (ft)) RCB

DISCHARGE FLOW (cfs)	HEADWATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	1339.55	0.00	-0.05	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
50.00	1341.48	1.74	1.93	2-M2c	2.13	1.17	1.17	1.02	6.11	3.50
100.00	1342.57	2.77	3.02	2-M2c	3.53	1.85	1.85	1.47	7.70	4.29
150.00	1343.49	3.63	3.94	2-M2c	4.82	2.43	2.43	1.81	8.82	4.81
200.00	1344.31	4.45	4.76	2-M2c	6.05	2.94	2.94	2.09	9.71	5.21
250.00	1345.07	5.22	5.52	2-M2c	7.00	3.42	3.42	2.33	10.45	5.54
300.00	1345.76	5.95	6.21	2-M2c	7.00	3.86	3.86	2.55	11.11	5.82
350.00	1346.44	6.66	6.89	2-M2c	7.00	4.28	4.28	2.75	11.70	6.06
400.00	1347.05	7.37	7.50	2-M2c	7.00	4.67	4.67	2.93	12.23	6.28
450.00	1347.68	8.09	8.13	2-M2c	7.00	5.05	5.05	3.10	12.72	6.48
500.00	1348.39	8.84	8.73	2-M2c	7.00	5.42	5.42	3.26	13.17	6.66

El. inlet face invert 1339.55 ft El. outlet invert 1339.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	1339.55 ft
OUTLET STATION	93.50 ft
OUTLET ELEVATION	1339.50 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0005
CULVERT LENGTH ALONG SLOPE	93.50 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	7.00 ft
BARREL RISE	7.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL (45 DEG. FLARE)
INLET DEPRESSION	NONE

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH	10.00 ft
SIDE SLOPE H/V (X:1)	4.0
CHANNEL SLOPE V/H (ft/ft)	0.007
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	1339.50 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	1339.50 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	1339.50	0.000	0.00	0.00	0.00
50.00	1340.52	0.613	1.02	3.50	0.44
100.00	1340.97	0.624	1.47	4.29	0.64
150.00	1341.31	0.630	1.81	4.81	0.79
200.00	1341.59	0.635	2.09	5.21	0.91
250.00	1341.83	0.638	2.33	5.54	1.02
300.00	1342.05	0.641	2.55	5.82	1.12
350.00	1342.25	0.644	2.75	6.06	1.20
400.00	1342.43	0.646	2.93	6.28	1.28
450.00	1342.60	0.648	3.10	6.48	1.36
500.00	1342.76	0.650	3.26	6.66	1.42

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	49.00 ft

***** USER DEFINED ROADWAY PROFILE

CROSS-SECTION COORD. NO.	X ft	Y ft
1	6050.00	1350.24
2	6300.00	1349.60
3	6400.00	1349.34
4	6500.00	1349.24
5	6600.00	1350.06
6	6700.00	1351.06

STORMCAD OUTPUT

Ruggles & Bohm P.A.
Engineering, Surveying, Land Planning

Onsite Hydrology

Proposed Runoff Data (All Basins)

Hydrologic Soil Group D
Assume single family residential development for all basins (1/4 Acre Lots).
$C_2 = 0.50$
$C_{100} = 0.76$
Assume all drainage areas have a T_C of 15 minutes, which is the minimum per the City of Wichita Design Criteria.
$I_5 = 3.83$ in/hr
$I_{100} = 7.37$ in/hr

Storm water sewer design and flow capacities are calculated with Haestad Methods STORM Cad program. Output from this program is included with this report. All starting hydraulic grade line elevations are calculated using the 100 year water surface of the detention pond = 1354.0 MSL (conservative).

Area A

Area = 3.8 acres
$Q_2 = 0.50(3.83)(3.8) = 7.3$ cfs
$Q_{100} = 0.76(7.37)(3.8) = 21.3$ cfs

Area A drains to a sump with two, 10' long type 1A Inlets, Inlet capacity at top of full curb for a 5' wide inlet = 7.0 cfs, for a 10' inlet = 14.0 cfs, therefore two 10' long inlet provide 28 cfs of capacity at top of curb elevation, which is greater than 21.3 cfs, OK.

Pipe system: Assume the west inlet will carry full inlet capacity (larger basin to this point), so Q = 14 cfs, cross street pipe should carry 14 cfs. See STORM Cad output for pipe sizes and HGL Information. STMC/Central Development/profileA.*

Area B

Area = 3.2 acres
$Q_2 = 0.50(3.83)(3.2) = 6.1$ cfs
$Q_{100} = 0.76(7.37)(3.2) = 17.9$ cfs

Area B will connect to the extension of the 4' x 7' RCBC from Balthrop North Addition. Proposed are three inlets, two of which will be 5' type 1A inlets, and the third, an inlet casting directly over the box. The combined inlet capacity at the sump will exceed 21.0 cfs, which is greater than the 17.9 cfs approach flow.

Upstream (match) flowline = 1351.52, length of extension to pond = 250 feet. Use a slope of 0.5% on the extension, resulting in a downstream flow line elevation of 1350.20.

From the PEC Drainage plan from Balthrop Addition, the flow in the 4' x 7' RCBC is 274 cfs. The HEC-RAS model included with this report indicates a flow of 226 cfs from the

same area. Check capacity of the 4' x 7' RCBC extension with STORM Cad with a total 100 year flow of 294 cfs. Result – HGL is < 1355.0 MSL, low sump = 1358.30, OK. Use connecting pipes of 18" RCP at 0.8%.

Area C

Area = 1.4 acres

$Q_2 = 0.50(3.83)(1.4) = 2.7$ cfs

$Q_{100} = 0.76(7.37)(1.4) = 7.8$ cfs

Assume no 100 year overspill available at this location. Inlet capacity, 10' inlet at sump at top of curb elevation will provide 14 cfs of capacity, OK.

From STORM-Cad, use 15" RCP to drain to pond.

Area D

Area = 3.9 acres

$Q_2 = 0.50(3.83)(3.9) = 7.5$ cfs

$Q_{100} = 0.76(7.37)(3.9) = 21.8$ cfs

This sump is served by two dual inlet grates over the top of a proposed 3'x10' RCBC under the roadway. As before, check capacity of a 3'x10' RCBC with the full 100 year flow. From the HEC-RAS model in this report, Q100 = 212 cfs from the K-96 area, combined with the local flow of 21.8 cfs, totaling 234 cfs. From the original KTP Drainage plan, the 100 year flow at this location is 240 cfs, therefore, use 240 cfs for analysis (conservative). Using the Land Development Desktop Culvert Calculator, the following input and output are calculated:

```
                Culvert Calculator – East 10'x3' RCBC Under Plymouth
Entered Data:
     Shape ..........................  Rectangular
     Number of Barrels ..............  1
     Solving for ....................  Headwater
     Chart Number ...................  10
     Scale Number ...................  1
     Chart Description ..............  BOX CULVERT; 90-DEGREE HEADWALL; CHAMFERED
OR BEVELED INLET EDGES
     Scale Decsription ..............  INLET EDGES CHAMFERED 3/4-INCH
     Overtopping ....................  Off
     Flowrate .......................  240.0000 cfs
     Manning's n ....................  0.0130
     Roadway Elevation ..............  1358.0000 ft
     Inlet Elevation ................  1352.0000 ft
     Outlet Elevation ...............  1351.0000 ft
     Height .........................  36.0000 in
     Width ..........................  120.0000 in
     Length .........................  60.0000 ft
     Entrance Loss ..................  0.5000
     Tailwater ......................  1354.0000 ft

Computed Results:
     Headwater ......................  1355.5365 ft
     Slope ..........................  0.0167 ft/ft
     Velocity .......................  8.8889 fps
```

This RCBC has an upstream tailwater elevation of 1355.6, which confines the flow within the drainage easement situated on the Balthrop North addition to the north. OK.

Inlet Grates: Neenah R-3077 Double Inlet Frame and Grate, at 0.6 feet of head, Q = 11.2 cfs per inlet, with two inlet, Q = 22.4 cfs in sump condition, without curb hood units. This exceeds the 100 year sump flow of 21.8 cfs without the companion curb opening hoods.

Inlet Hoods, R-3076-6B will add capacity, but not calculated given the grate capacity exceeds the inflow.

DO NOT WANT ! USE STD.

Area E
Area = 0.8 acres
$Q_2 = 0.50(3.83)(0.8) = 1.5$ cfs
$Q_{100} = 0.76(7.37)(0.8) = 4.5$ cfs

Use a 5' Type 1A inlet on each side of the street to intercept the flow.

Area F (Future Commercial Assumed)
Area = 6.1 acres
$Q_5 = 0.69(4.56)(6.1) = 19.2$ cfs
$Q_{100} = 0.80(7.37)(6.1) = 36.0$ cfs

For the undeveloped condition, the flow rate from Area F = 22.5 cfs (0.5 runoff coefficient). Need inlet and/or inlet/open pipe capacity to provide this flow. As the property develops, connections will be made to facilitate the site.

The Neenah R-2561 Beehive Frame and Gate in a sump condition can discharge 9.6 cfs, so for the undeveloped condition, use 3 Beehive Inlets, or a combination of Inlets and open pipe to collect the stormwater.

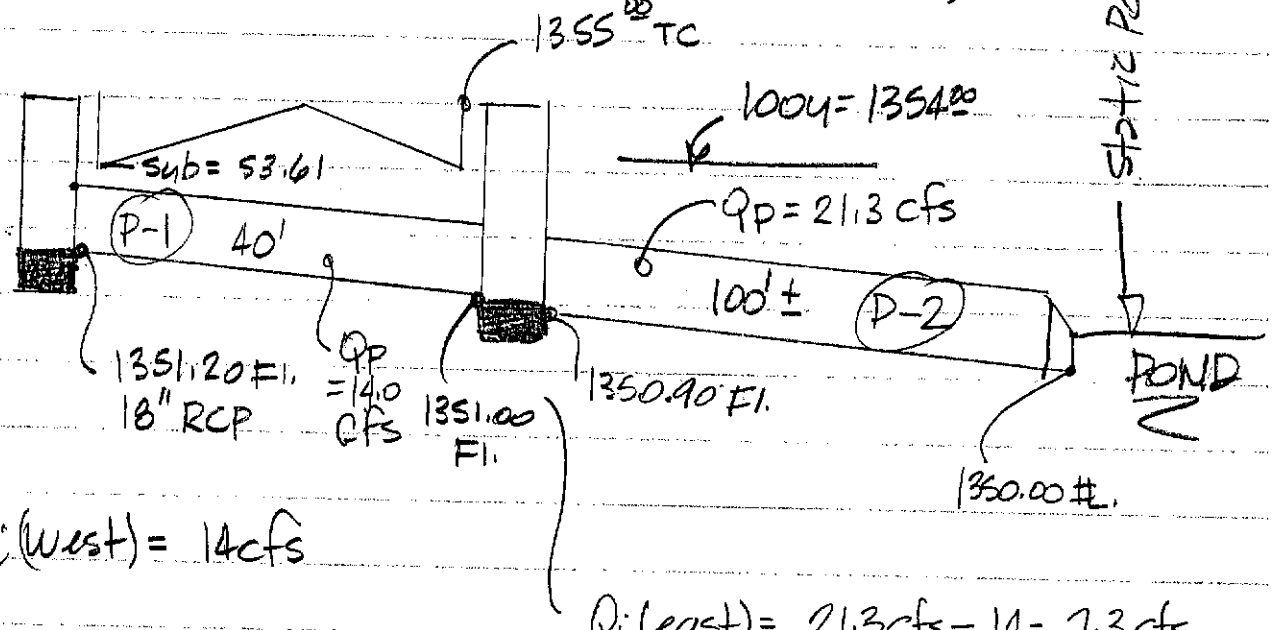
Area G
Area = 0.8 acres
$Q_2 = 0.50(3.83)(0.8) = 1.5$ cfs
$Q_{100} = 0.76(7.37)(0.8) = 4.5$ cfs

This area will drain into Central Avenue via the drive approach.

11-11-05
CMB

Central Development Addition:

Sump A (100 year overspill Is Allowed.)



Q_i (west) = 14cfs

Q_i (east) = 21.3cfs − 14 = 7.3 cfs

Stormcad Results (ProfileA.dxf) {Central Development Folder}

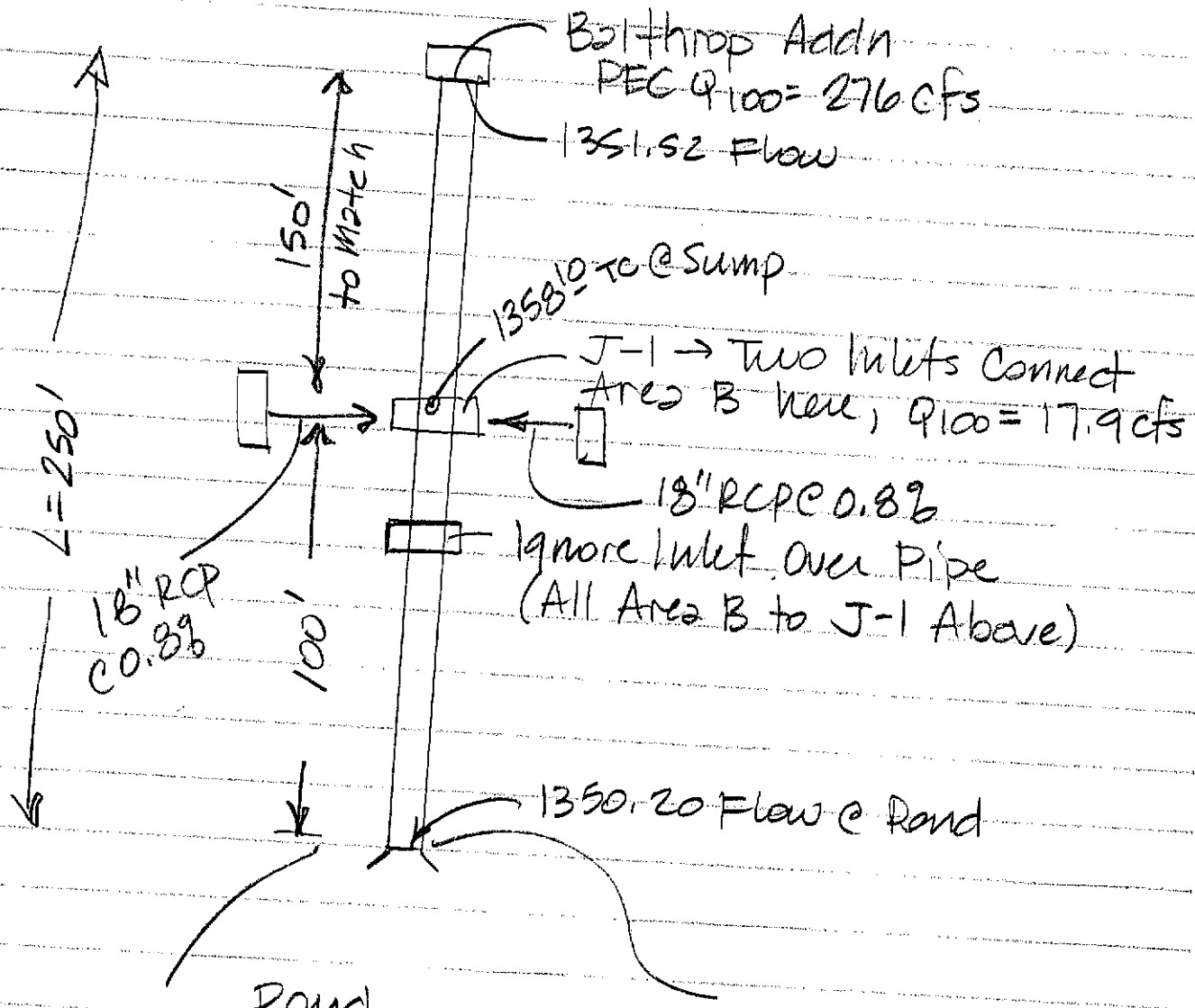
P-1 = 2-18" RCP's

P-2 = 1-36" RCP

HGL Under T.C. Elevation: OK

Central Development
Sump B (4'x7' RCBC)

11/11/05
CWB

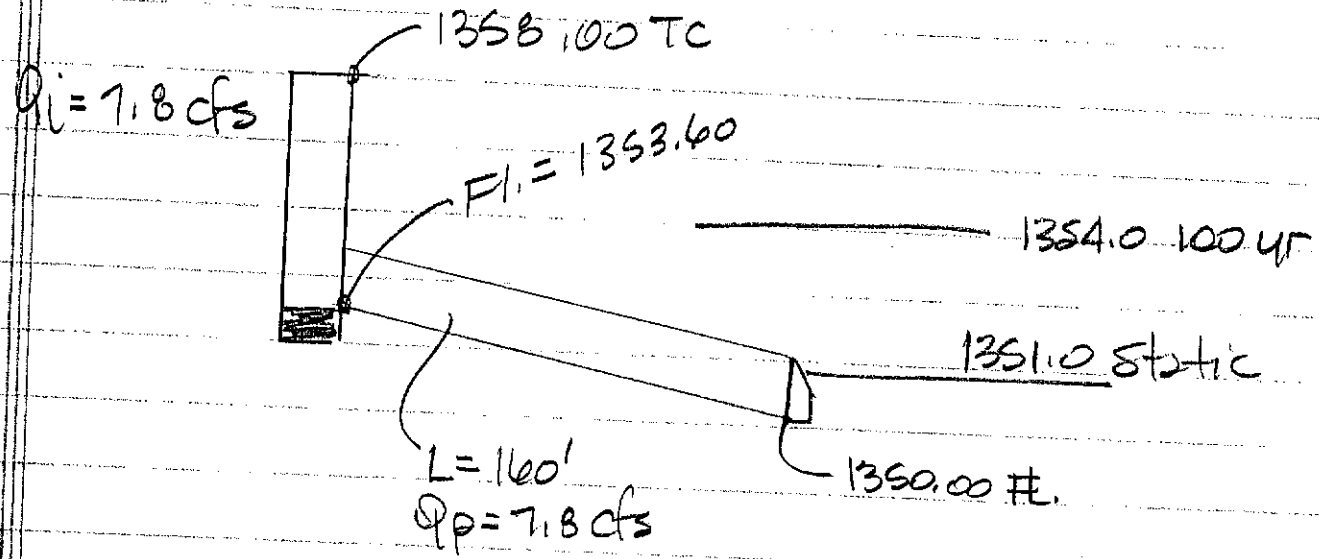


With StormCAD; Q100 (entire length) = 276 + 17.9
= 294 cfs

At full 100 yr Capacity, MAX HGL < 1355 Elev;
Lowest T.C = 1358.10 @ New Sump; O.K.
Connecting Pipes = 9 cfs each, Use 18" RCPC 0.89; OK
(Design Data 4 - Manning's Gravity Flow)

Central Development Site
Sump C

11/11/05
CMB



From Storm Cad - Use 15" RCP → O.K.

NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-3077
Double Unit Inlet Frame and Grate

Heavy Duty

For full double unit—specify **R-3077**.

For left section (frame and grate) only—specify **R-3077-L**.

For left section frame only—specify **R-3077-L** frame only.

For right section (frame and grate) only—specify **R-3077-R**.

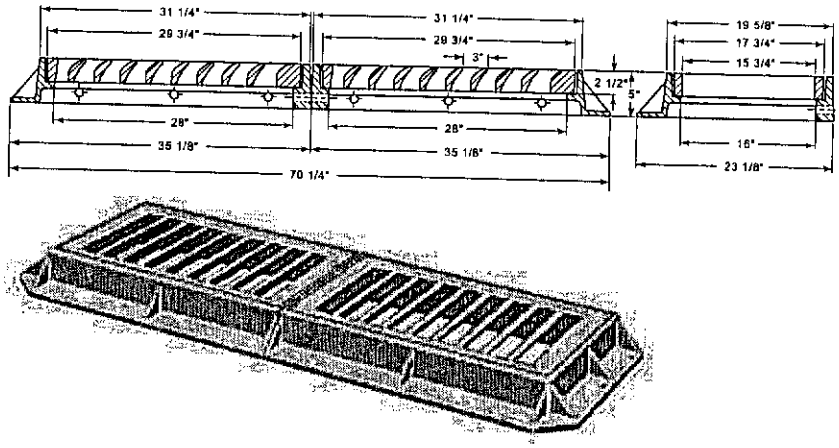
For right section frame only—specify **R-3077-R** frame only.

Grates are same as **R-3076** unit.

Also available with Type L grate see **R-3079**.

If curb hoods are required, see listing under **R-3076**.

Type V grate shown not recommended for bicycle traffic when used without barrier curb hoods.

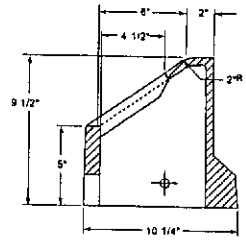


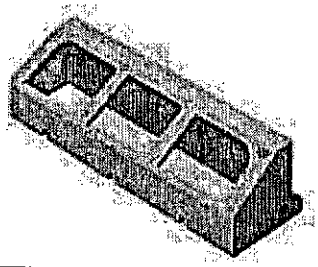
NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-3076-4M Curb Hoods

Heavy Duty

Catalog # refers to hood only.

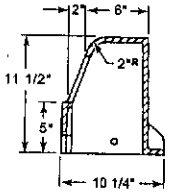




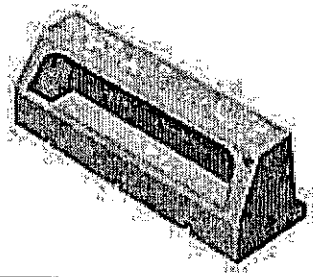
R-3076-6B Curb Hoods

Heavy Duty

Catalog # refers to hood only.



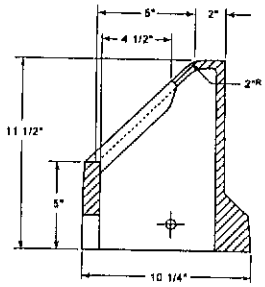
6" BARRIER CURB HOOD

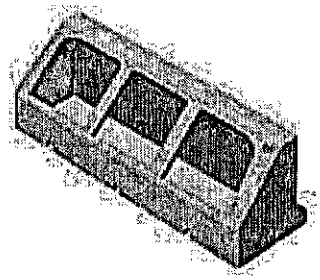


R-3076-6M Curb Hoods

Heavy Duty

Catalog # refers to hood only.

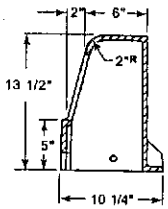




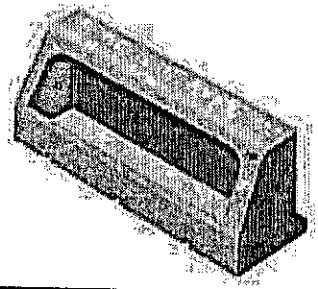
R-3076-8B Curb Hoods

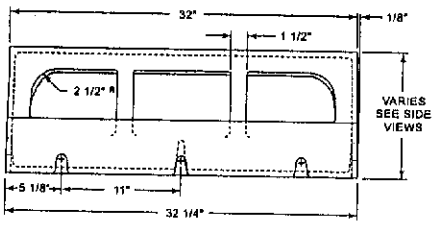
Heavy Duty

Catalog # refers to hood only.

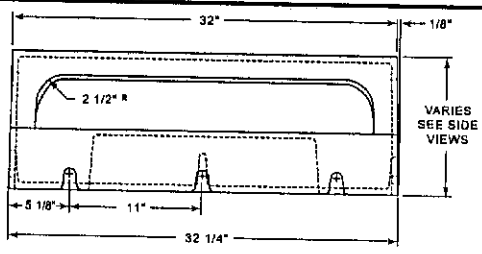


8" BARRIER CURB HOOD





FRONT VIEW FOR R-3076-4M AND R-3076-8M

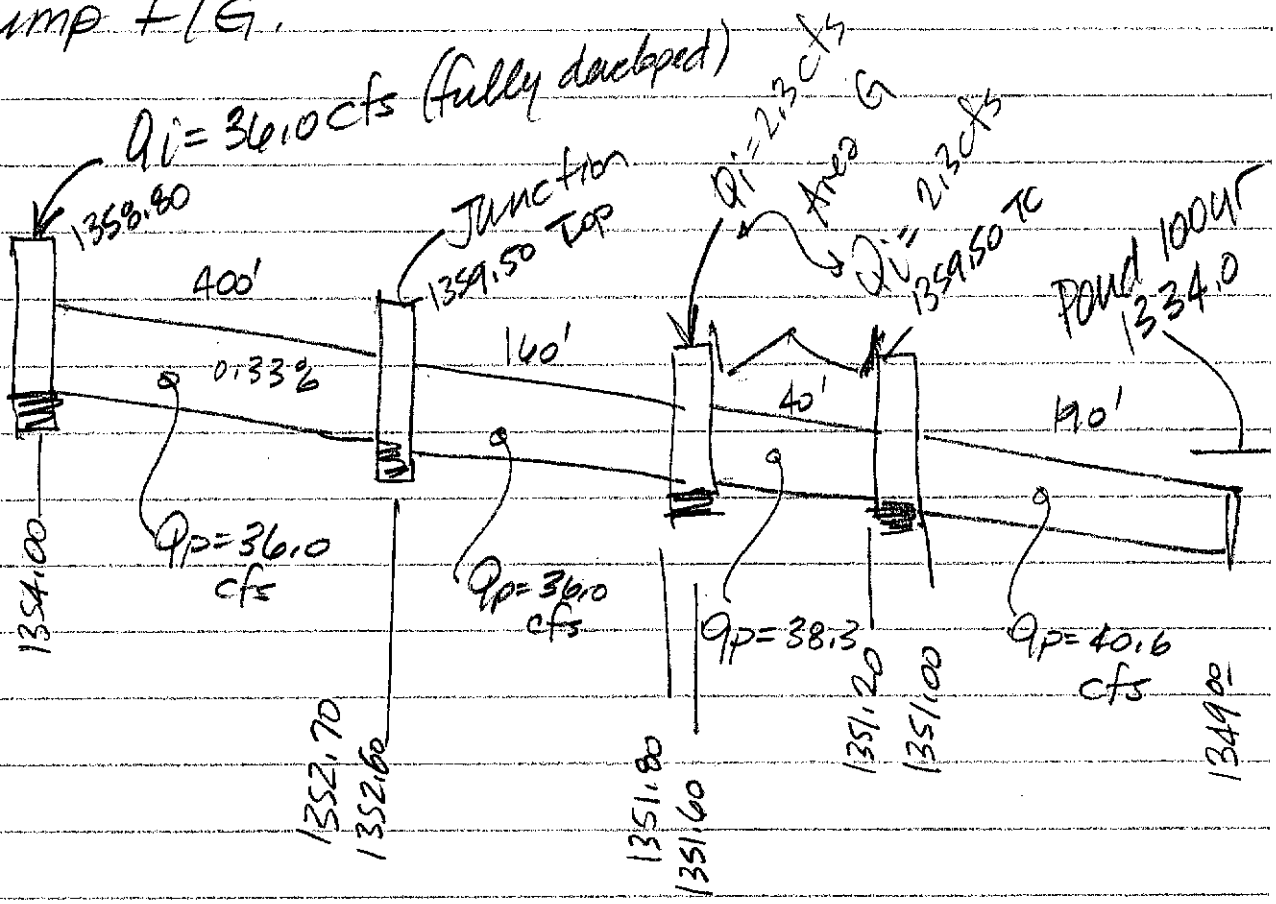


FRONT VIEW FOR R-3076-6B AND R-3076-8B

Central Development

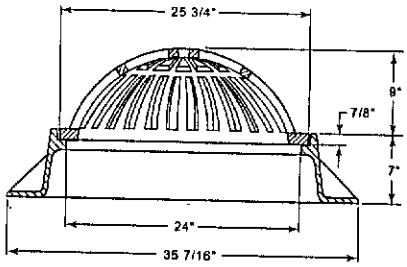
11/15/05
CMB

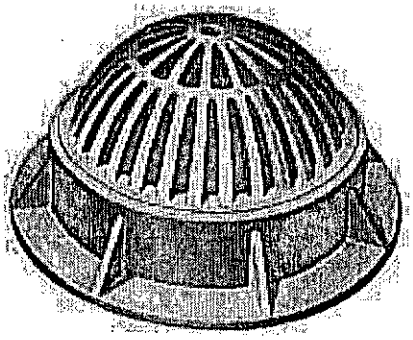
Sump F/G.



NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-2561
High Beehive Grate and Frame





Uses R-1733 frame.

R-2561-A

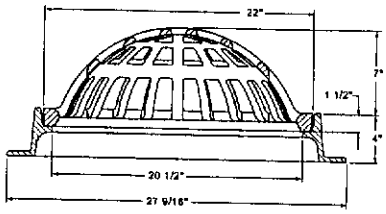
Same as **R-2561** except with 6" high beehive grate.

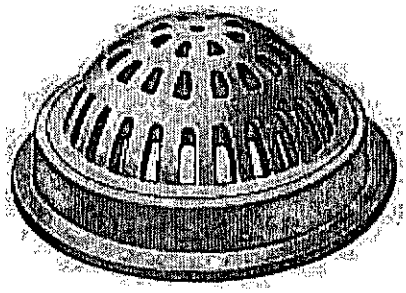
Furnished standard with as-cast bearing surfaces.

R-2563
Beehive Grate and Frame

Designed to fit in bell of 24" sewer pipe.

Furnished standard with as-cast bearing surfaces.



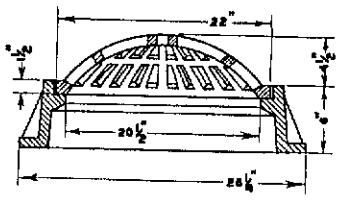


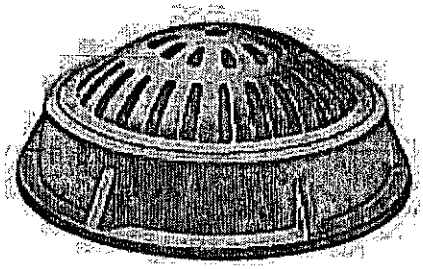
Uses R-1690 frame.

R-2564
Beehive Grate and Frame

Designed to fit in bell of 24" sewer pipe.

Furnished standard with as-cast bearing surfaces.





Uses R-1761 frame.

Weir & Orifice Flow Comparison

$Q = 0.6A\sqrt{2gh}$

(Orifice Flow Equation)

Q = Capacity in CFS
A = Free open area of grate in sq. ft.
g = 32.2 (feet per sec/sec)
h = Head in feet

Orifice Information

Instructions:

- Either Select catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
- Enter head value
- Press CALCULATE

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, a pop-up window will offer Neenah grates which fall within the parameters chosen.

$Q = 3.3P(h)^{1.5}$

(Weir Equation)

Q = Capacity in CFS
P = Feet perimeter
h = Head in feet

Weir Information

Catalog number and grate type: R-2561 Beehive

Head in feet (h): 1

Feet perimeter (P): 6.7

Calculate

Free open area in sq. ft. (A): 2

Weir capacity in cfs:

Transitional flow in cfs:

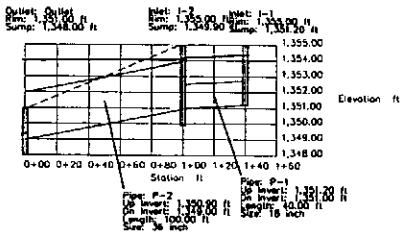
Orifice capacity in cfs: 9.6

(Results assume no debris restriction.)

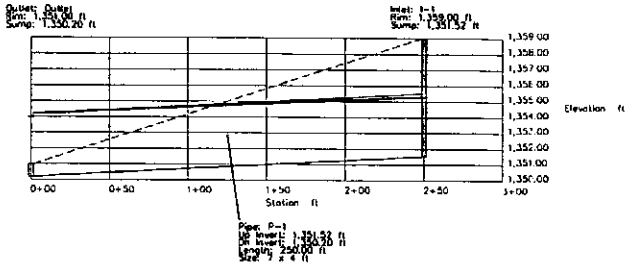
NOTE: The above results do not account for the dome height of Beehive-type grates. Please take note of this when determining the Head (h) value.

For additional information regarding Neenah Inlet Grate Capacities, please contact our Product Engineer, Steve Akkala, at 920-725-7000 or at sakkala@nfco.com.

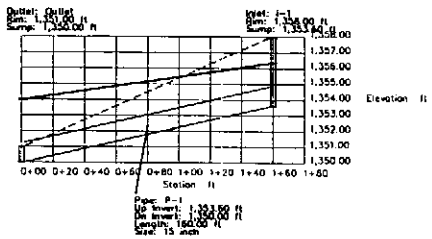
LINE A PROFILE



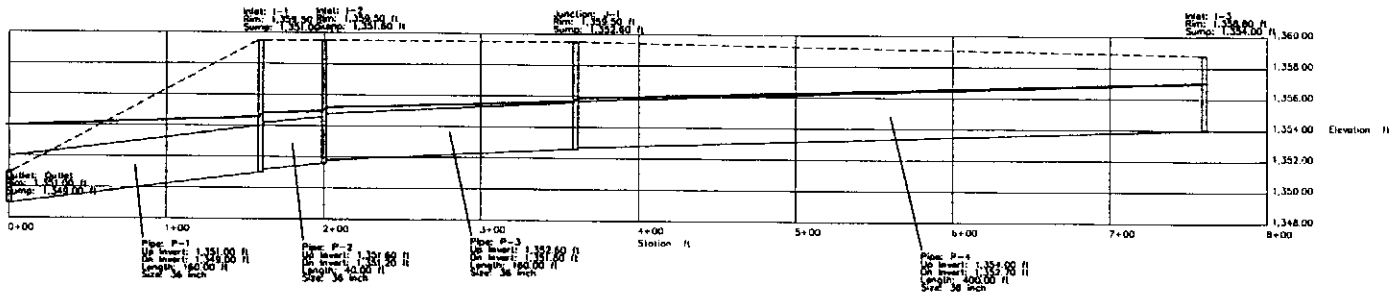
LINE B PROFILE



LINE C PROFILE



LINE F/G PROFILE



CENTRAL DEVELOPMENT
SERIES 1 SWS PROFILES

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824 North Main
Wichita, Kansas 67203
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(316) 264-4634 fax
E-mail: info@rbkansas.com

DRAINAGE REPORT
FOR
CENTRAL DEVELOPMENT ADDITION CrestLake
WICHITA, SEDGWICK COUNTY, KANSAS

NOVEMBER 2, 2005

Ruggles & Bohm P.A.
Engineering, Surveying, Land Planning

CENTRAL DEVELOPMENT ADDITION
DRAINAGE ANALYSIS
NOVEMBER 2, 2005

INTRODUCTION

This report contains supporting documentation and calculations for the proposed Central Development Addition. The existing site is an undeveloped 36 acre tract of land located west of the northwest corner of Central Ave. and K-96 highway. The area is currently pasture land with two major drainage ways through the site. The first drainage way crosses the southwest corner of the property and the other is near the easterly side of the property flowing from north to south. Existing off-site drainage enters the site from one location on the west and two locations on the north lines of this property.

The drainage from the north comes from three (3) 8.5 sq. ft. RCPH pipes under K-96 that drain the K-96 right-of-way on the east and a 7' x 4' RCB from Balthrop 4th Addition on the west. The drainage crossing the southwest corner of the property discharges from a pond just west of the subject property and drains approximately 424 acres to the west and north. Both drainage ways are controlled by existing reinforced concrete box culverts (RCB's) under Central Avenue.

The site will be developed into residential lots with on-site detention to be accomplished using the two (2) existing ponds in the center of the property, which will be combined into a single common pond. Detention for this site will also include the required detention for the Balthrop 4th Addition. The pond will also provide detention storage for approximately 7 acres of ground adjacent to and east of the east line of the addition in its fully developed condition as commercial property.

HYDROLOGY

Peak flow rates for the offsite flows were determined from a combination of drainage data from Professional Engineering Consultants, P.A. for the Balthrop 4th Addition and the U.S. Army Corps of Engineers HEC-HMS model. The HY-8 data from the box culverts under Central Ave. was used in the model as downstream controls for this site.
Additional information was obtained from the drainage map and plan and profile sheets of the construction plans for Central Avenue, County Project No. 618-34 dated July 1997.

The rational method was used to determine peak flow rates for the basins located within the plat. See the "Hydrology Data" section of this report for calculations and results for this project.

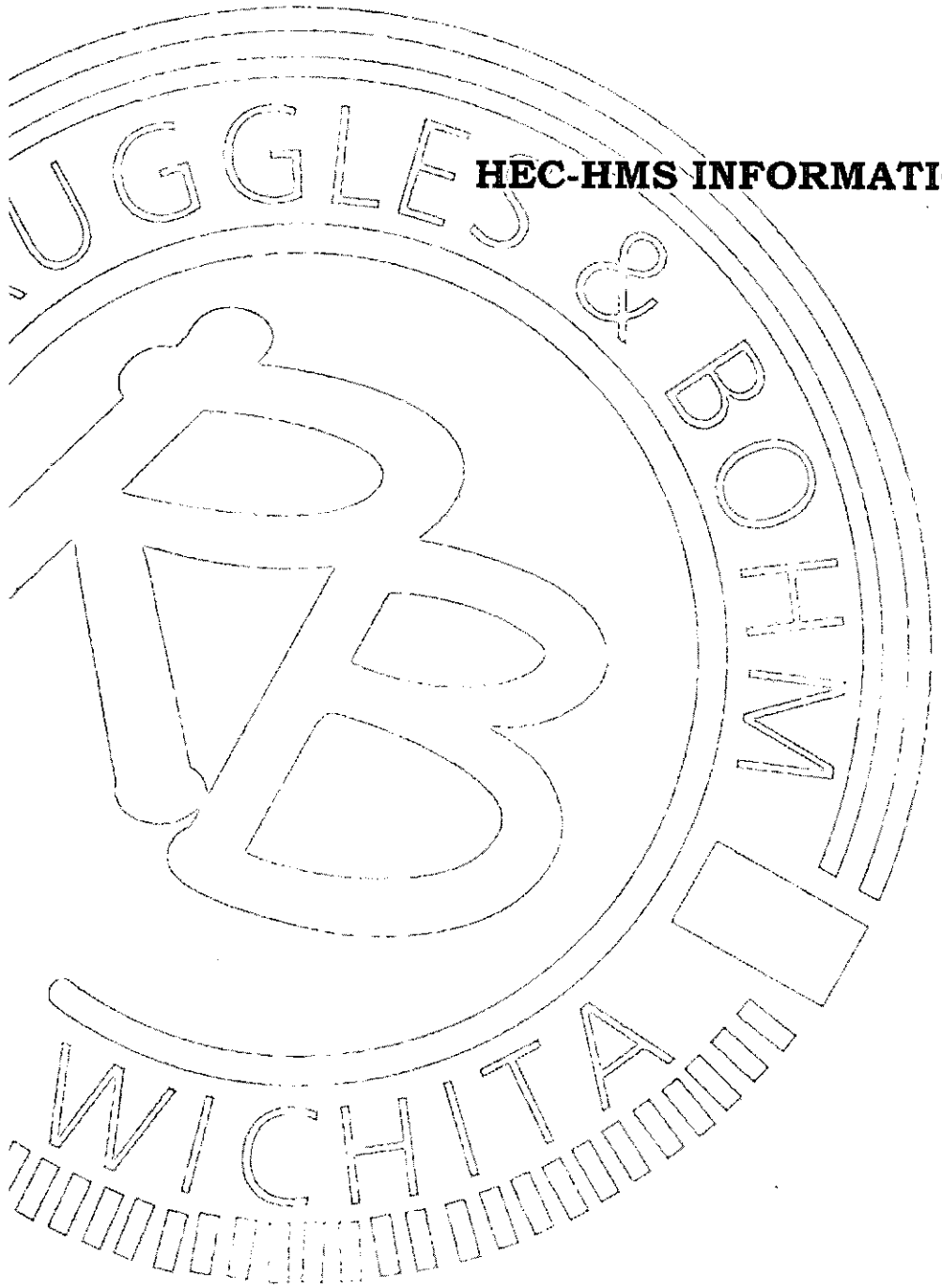
HYDRAULICS

Hydraulic characteristics and design for the channels and outfall structures for the ponds were determined using the Haestad Methods Open Channel Flow Module.

CONCLUSION

The single detention pond will provide sufficient storage to detain the necessary flow from both this site, Balthrop 4th Addition, and the adjacent 7 acres to the east. A Weir structure must be constructed on the existing pond to provide detention storage. The discharge point from the pond to Central Avenue shall have a twenty-three foot (23') broad-crested weir.

HEC-HMS INFORMATION



Ruggles & Bohm P.A.

Engineering, Surveying, Land Planning

Pond Routing Information:

The onsite ponds will be combined into a single detention pond by removing the existing dam between them.

Rainfall Data: The SCS Type II Rainfall Distribution as modeled by the HEC-~~RAS~~ program is used for analysis, with a total 100year – 24 hour rainfall event of 7.8 inches (TR-55). This rainfall model is used for all basins.

The schematic hydraulic model indicates the modeling parameters for each of the basins draining to the detention pond area.

Pond Data: The proposed detention pond will be controlled by a broad crested weir 23 feet in width. The weir coefficient used for analysis is 3.58, and the outlet characteristics of the weir are modeled by the spillway option in the HEC-RAS model.

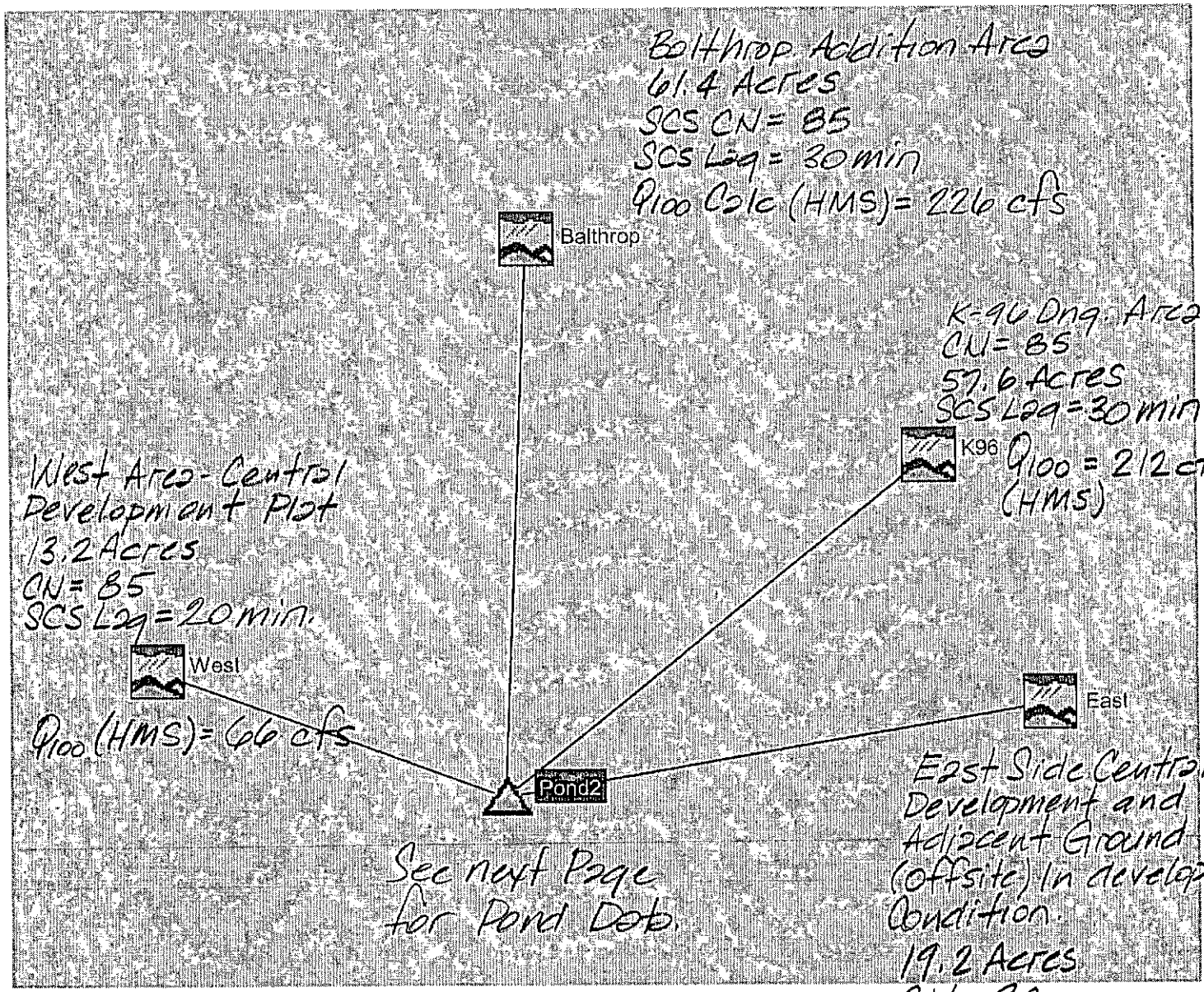
Stage Storage Information: The weir discharge elevation is 1351.0. The pond is modeled with all of the storage contained in the platted Reserve containing the pond, with no storage calculated on individual lots. From these parameters, the following stage-storage information is obtained:

Elevation (MSL)	Area (Acres)
1351	4.71
1352	5.01
1353	5.32
1354	5.62
1355	5.92

Results: Peak inflow into the detention pond totals 578 cfs. Discharge from the pond totals 435 cfs at an elevation of 1354.0 (3.0 feet of storage). These results correspond with the original KTP Addition drainage plan, allowing a discharge rate of 432 cfs into the 7'x7' RCBC under Central Avenue.

HEC-HMS Project: KTP Basin Model: KTP-East

11/9/05



HMS * Summary of Results for Pond2

Project : KTP Run Name : Run 1

Start of Run	: 28Aug01 1200	Basin Model	: KTP-East
End of Run	: 29Aug01 1200	Met. Model	: 100
Execution Time	: 09Nov05 0835	Control Specs	: 100

Computed Results

Peak Inflow	: 578.33 (cfs)	Date/Time of Peak Inflow	: 29 Aug 01 0020
Peak Outflow	: 434.58 (cfs)	Date/Time of Peak Outflow	: 29 Aug 01 0035
Total Inflow	: 6.04 (in)	Peak Storage	: 15.674(ac-ft)
Total Outflow	: 5.93 (in)	Peak Elevation	: 1354.0(ft)

STORMCAD OUTPUT

Onsite Hydrology

Proposed Runoff Data (All Basins)

Hydrologic Soil Group D
Assume single family residential development for all basins (1/4 Acre Lots).
$C_2 = 0.50$
$C_{100} = 0.76$
Assume all drainage areas have a T_C of 15 minutes, which is the minimum per the City of Wichita Design Criteria.
$I_5 = 3.83$ in/hr
$I_{100} = 7.37$ in/hr

Storm water sewer design and flow capacities are calculated with Haestad Methods STORM Cad program. Output from this program is included with this report. All starting hydraulic grade line elevations are calculated using the 100 year water surface of the detention pond = 1354.0 MSL (conservative).

Area A

Area = 3.8 acres
$Q_2 = 0.50(3.83)(3.8) = 7.3$ cfs
$Q_{100} = 0.76(7.37)(3.8) = 21.3$ cfs

Area A drains to a sump with two, 10' long type 1A Inlets, Inlet capacity at top of full curb for a 5' wide inlet = 7.0 cfs, for a 10' inlet = 14.0 cfs, therefore two 10' long inlet provide 28 cfs of capacity at top of curb elevation, which is greater than 21.3 cfs, OK.

Pipe system: Assume the west inlet will carry full inlet capacity (larger basin to this point), so Q = 14 cfs, cross street pipe should carry 14 cfs. See STORM Cad output for pipe sizes and HGL Information. STMC/Central Development/profileA.*

Area B

Area = 3.2 acres
$Q_2 = 0.50(3.83)(3.2) = 6.1$ cfs
$Q_{100} = 0.76(7.37)(3.2) = 17.9$ cfs

Area B will connect to the extension of the 4' x 7' RCBC from Balthrop North Addition. Proposed are three inlets, two of which will be 5' type 1A inlets, and the third, an inlet casting directly over the box. The combined inlet capacity at the sump will exceed 21.0 cfs, which is greater than the 17.9 cfs approach flow.

Upstream (match) flowline = 1351.52, length of extension to pond = 250 feet. Use a slope of 0.5% on the extension, resulting in a downstream flow line elevation of 1350.20.

From the PEC Drainage plan from Balthrop Addition, the flow in the 4' x 7' RCBC is 274 cfs. The HEC-RAS model included with this report indicates a flow of 226 cfs from the

same area. Check capacity of the 4' x 7' RCBC extension with STORM Cad with a total 100 year flow of 294 cfs. Result – HGL is < 1355.0 MSL, low sump = 1358.30, OK. Use connecting pipes of 18" RCP at 0.8%.

Area C

Area = 1.4 acres

$Q_2 = 0.50(3.83)(1.4) = 2.7$ cfs

$Q_{100} = 0.76(7.37)(1.4) = 7.8$ cfs

Assume no 100 year overspill available at this location. Inlet capacity, 10' inlet at sump at top of curb elevation will provide 14 cfs of capacity, OK.

From STORM-Cad, use 15" RCP to drain to pond.

Area D

Area = 3.9 acres

$Q_2 = 0.50(3.83)(3.9) = 7.5$ cfs

$Q_{100} = 0.76(7.37)(3.9) = 21.8$ cfs

This sump is served by two dual inlet grates over the top of a proposed 3'x10' RCBC under the roadway. As before, check capacity of a 3'x10' RCBC with the full 100 year flow. From the HEC-RAS model in this report, Q100 = 212 cfs from the K-96 area, combined with the local flow of 21.8 cfs, totaling 234 cfs. From the original KTP Drainage plan, the 100 year flow at this location is 240 cfs, therefore, use 240 cfs for analysis (conservative). Using the Land Development Desktop Culvert Calculator, the following input and output are calculated:

Culvert Calculator – East 10'x3' RCBC Under Plymouth

Entered Data:

Shape	Rectangular
Number of Barrels	1
Solving for	Headwater
Chart Number	10
Scale Number	1
Chart Description	BOX CULVERT; 90-DEGREE HEADWALL; CHAMFERED OR BEVELED INLET EDGES
Scale Decsription	INLET EDGES CHAMFERED 3/4-INCH
Overtopping	Off
Flowrate	240.0000 cfs
Manning's n	0.0130
Roadway Elevation	1358.0000 ft
Inlet Elevation	1352.0000 ft
Outlet Elevation	1351.0000 ft
Height	36.0000 in
Width	120.0000 in
Length	60.0000 ft
Entrance Loss	0.5000
Tailwater	1354.0000 ft

Computed Results:

Headwater	1355.5365 ft
Slope	0.0167 ft/ft
Velocity	8.8889 fps

This RCBC has an upstream tailwater elevation of 1355.6, which confines the flow within the drainage easement situated on the Balthrop North addition to the north. OK.

3286

Inlet Grates: Neenah R-3077 Double Inlet Frame and Grate, at 0.6 feet of head, Q = 11.2 cfs per inlet, with two inlet, Q = 22.4 cfs in sump condition, without curb hood units. This exceeds the 100 year sump flow of 21.8 cfs without the companion curb opening hoods.

Inlet Hoods, R-3076-6B will add capacity, but not calculated given the grate capacity exceeds the inflow.

Area E

Area = 0.8 acres

$Q_2 = 0.50(3.83)(0.8) = 1.5$ cfs

$Q_{100} = 0.76(7.37)(0.8) = 4.5$ cfs

Use a 5' Type 1A inlet on each side of the street to intercept the flow.

Area F (Future Commercial Assumed)

Area = 6.1 acres

$Q_5 = 0.69(4.56)(6.1) = 19.2$ cfs

$Q_{100} = 0.80(7.37)(6.1) = 36.0$ cfs

For the undeveloped condition, the flow rate from Area F = 22.5 cfs (0.5 runoff coefficient). Need inlet and/or inlet/open pipe capacity to provide this flow. As the property develops, connections will be made to facilitate the site.

The Neenah R-2561 Beehive Frame and Gate in a sump condition can discharge 9.6 cfs, so for the undeveloped condition, use 3 Beehive Inlets, or a combination of Inlets and open pipe to collect the stormwater.

Area G

Area = 0.8 acres

$Q_2 = 0.50(3.83)(0.8) = 1.5$ cfs

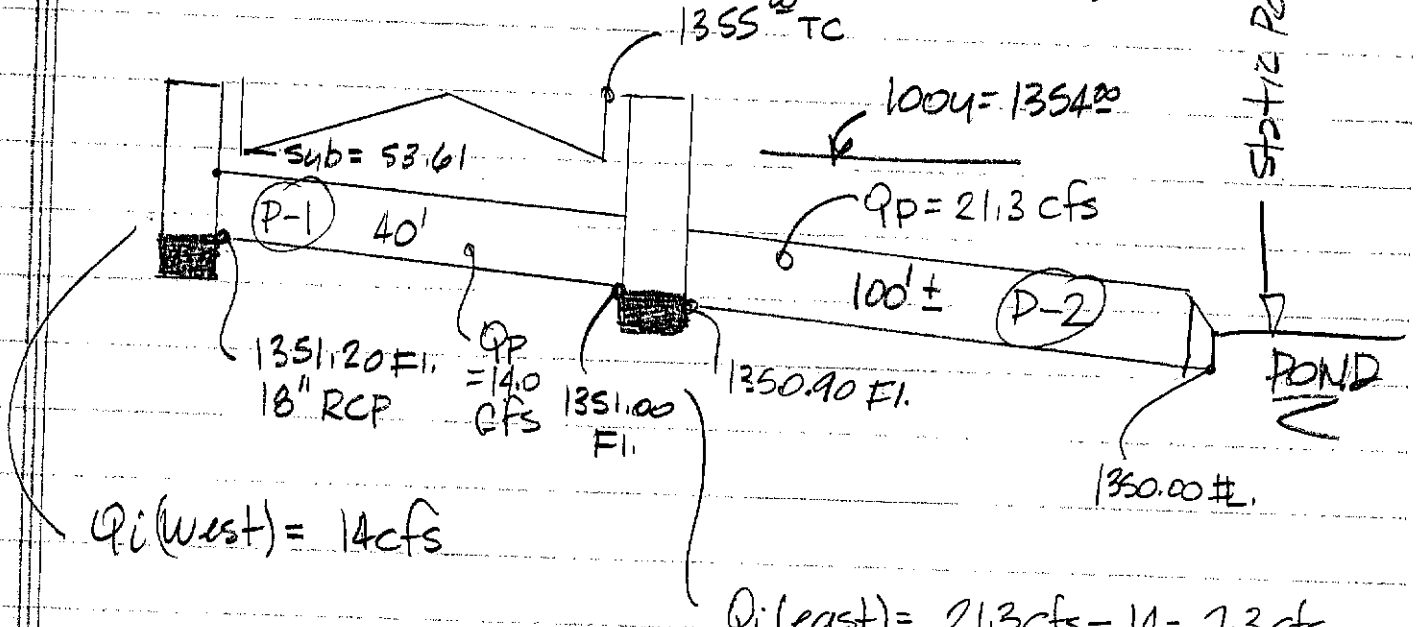
$Q_{100} = 0.76(7.37)(0.8) = 4.5$ cfs

This area will drain into Central Avenue via the drive approach.

11-11-05
CWB

Central Development Addition:

Sump A (100 year overspill Is Allowed.)

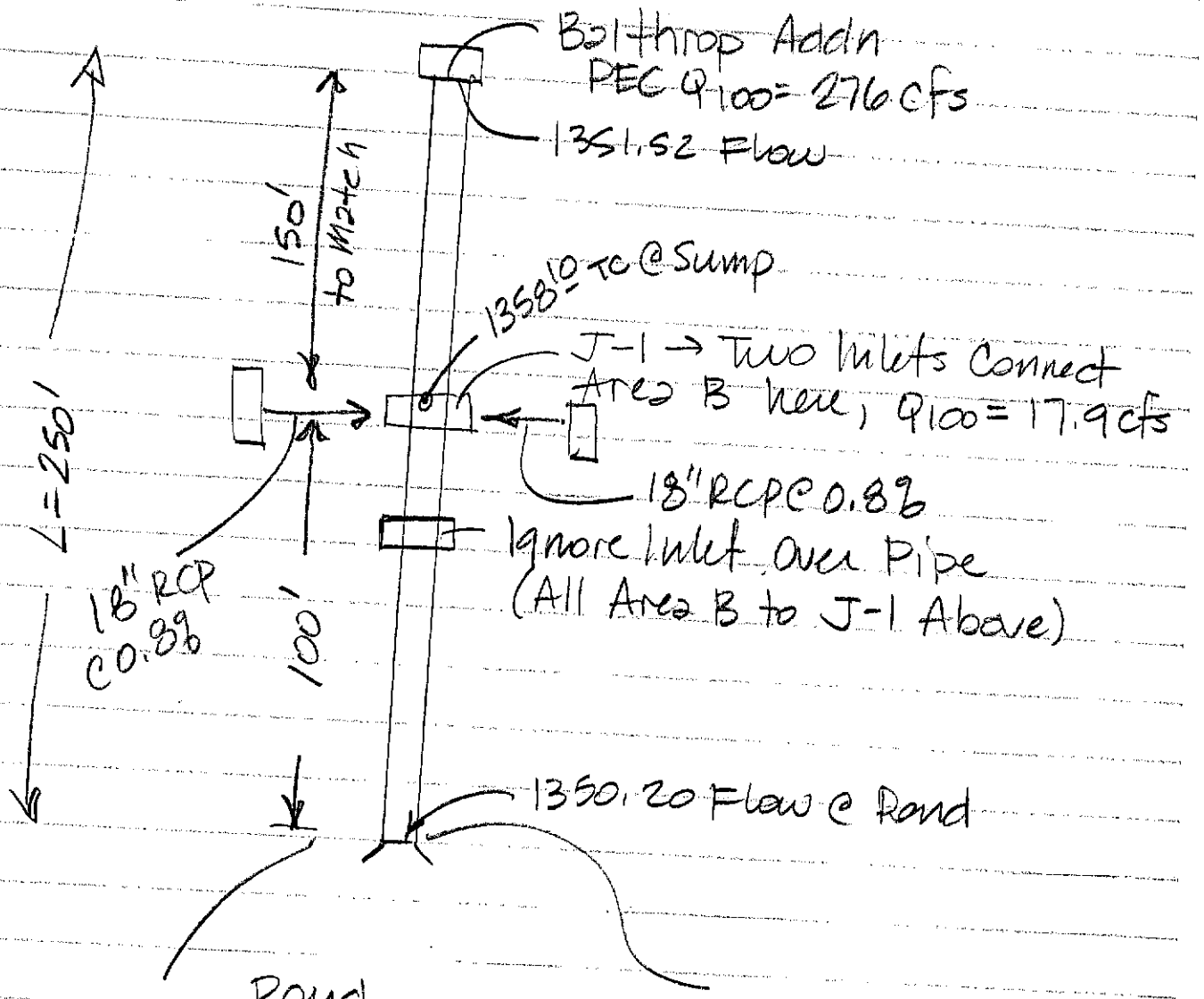


Stormcad Results (ProfileA.dxf) {Central Development Folder}

P-1 = 2-18" RCP's
P-2 = 1-36" RCP
HGL Under T.C. Elevation: OK

Central Development
Sump B (4'x7' RCBC)

11/11/05
CWB

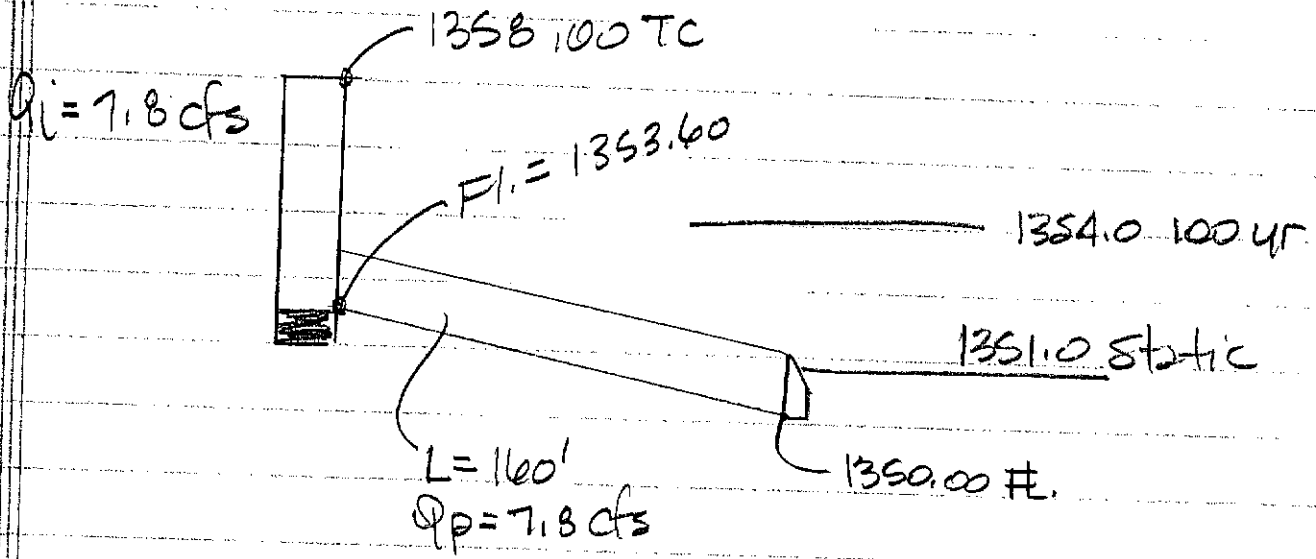


With StormCAD; Q100 (entire length) = 276 + 17.9
= 294 cfs

At full 100 yr Capacity, MAX HGL < 1355 Elev;
Lowest T.C = 1358.10 @ New sump; O.K.
Connecting Pipes = 9 cfs each, Use 18" RCPC 0.8%; OK
(Design Data 4- Manning's Gravity Flow)

Central Development Site
Sump C

11/11/05
CMB

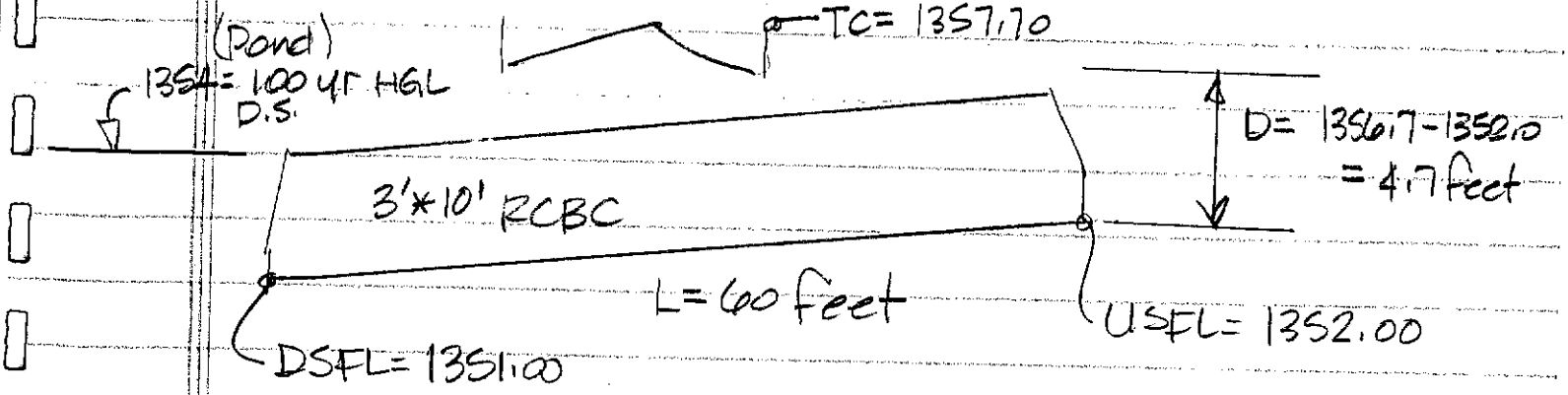


From Storm Cad - Use 15" RCP → O.K.

Central Development
Sump D, 3'X10' RCBC Under Roadway

11/11/05
CMB

Top of Curb Elevation @ Sump = 1357.70
Max HGL = TC - 1.0 ft = 1356.70
100 yr. WS D.S = 1354.00



See output from LDD Culvert Calculator

NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-3077
Double Unit Inlet Frame and Grate

Heavy Duty

For full double unit—specify **R-3077**.

For left section (frame and grate) only—specify **R-3077-L**.

For left section frame only—specify **R-3077-L** frame only.

For right section (frame and grate) only—specify **R-3077-R**.

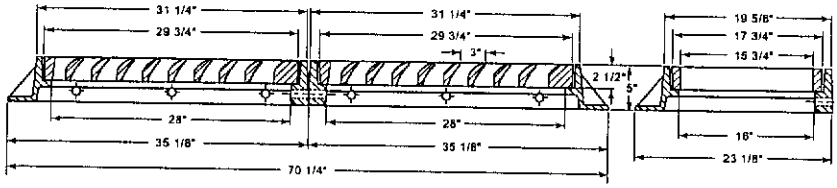
For right section frame only—specify **R-3077-R** frame only.

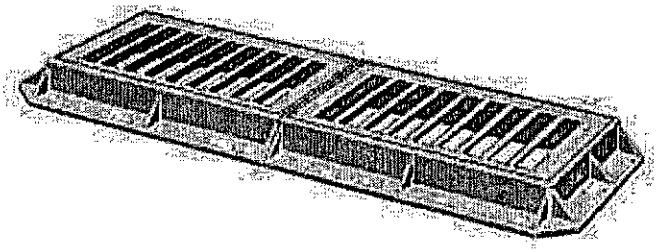
Grates are same as **R-3076** unit.

Also available with Type L grate see **R-3079**.

If curb hoods are required, see listing under **R-3076**.

Type V grate shown not recommended for bicycle traffic when used without barrier curb hoods.



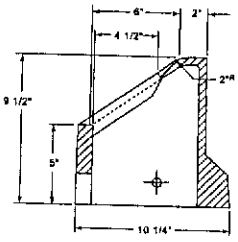


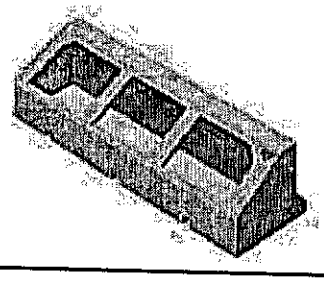
NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-3076-4M Curb Hoods

Heavy Duty

Catalog # refers to hood only.

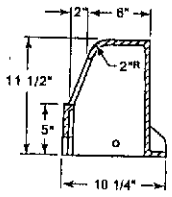




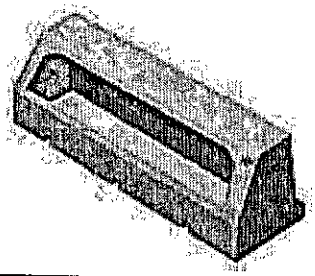
R-3076-6B Curb Hoods

Heavy Duty

Catalog # refers to hood only.



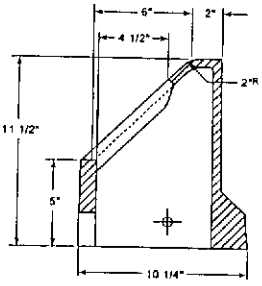
6" BARRIER CURB HOOD

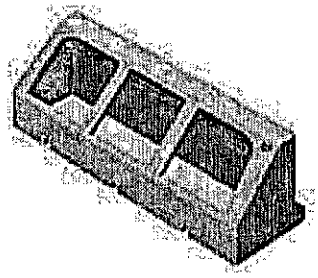


R-3076-6M Curb Hoods

Heavy Duty

Catalog # refers to hood only.

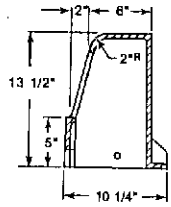




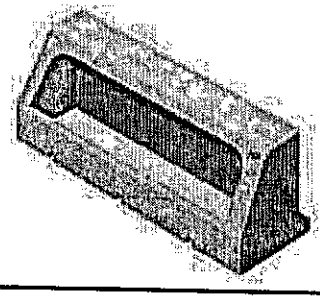
R-3076-8B Curb Hoods

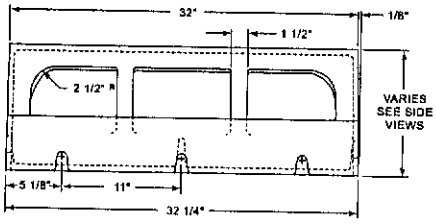
Heavy Duty

Catalog # refers to hood only.

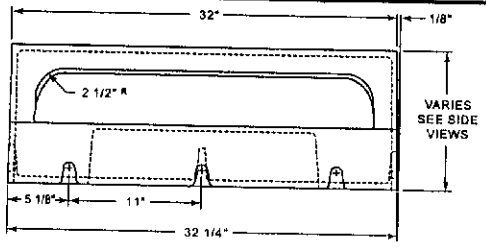


8" BARRIER CURB HOOD





FRONT VIEW FOR R-3076-4M AND R-3076-6M

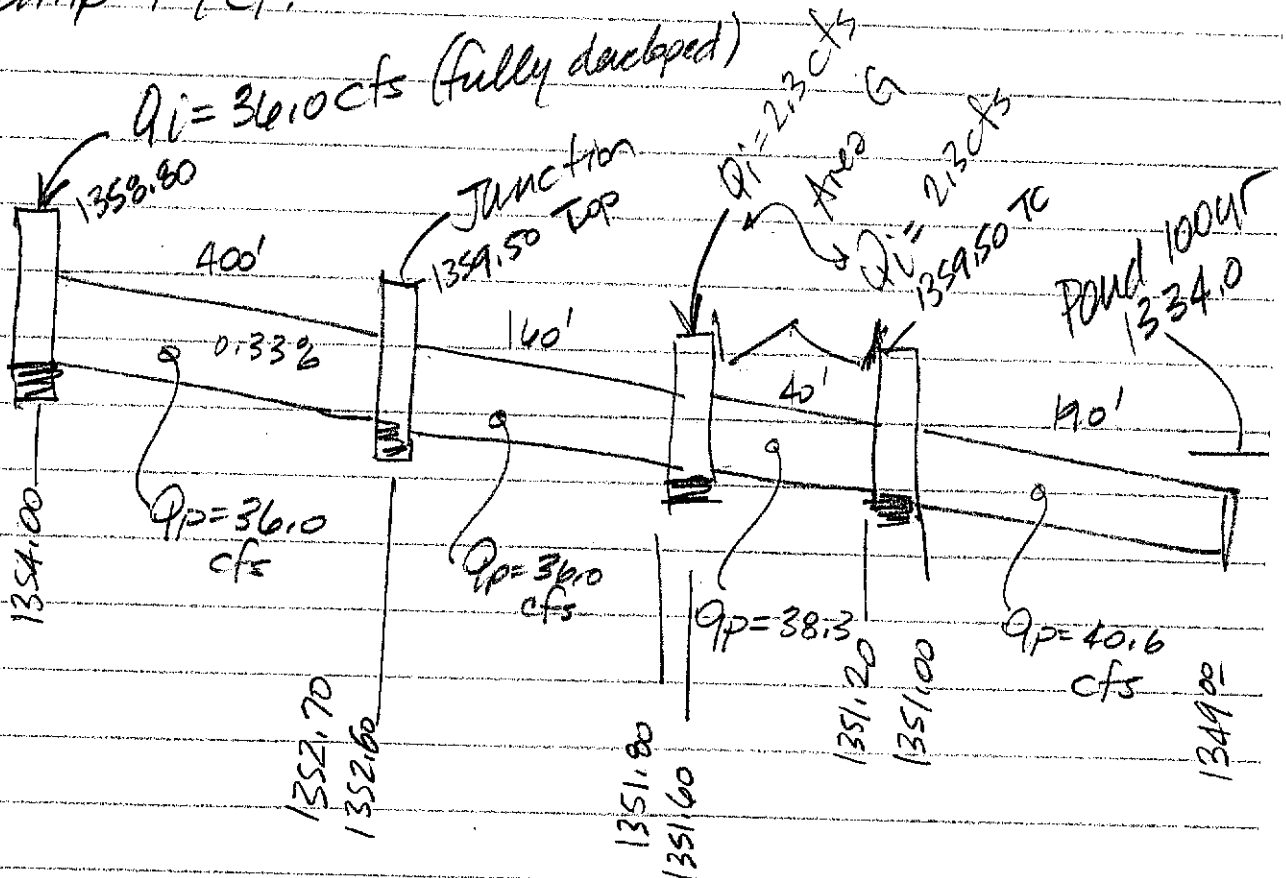


FRONT VIEW FOR R-3076-6B AND R-3076-8B

Central Development

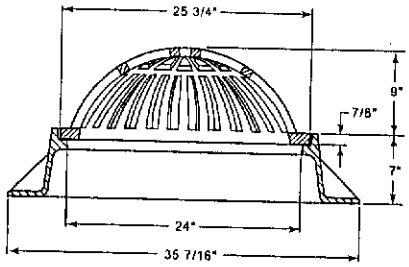
11/15/05
CMB

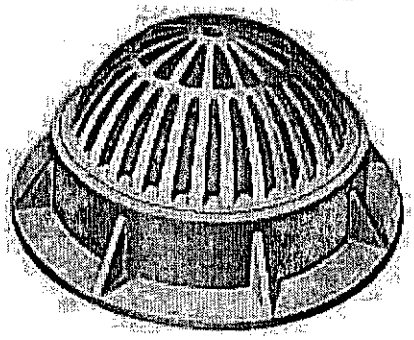
Sump H/G.



NOTE: When specifying/ordering grates, refer to "CHOOSING THE PROPER INLET GRATE" on pages 108-109. For FREE OPEN AREAS of Neenah Grates, refer to pages 326-330.

R-2561
High Beehive Grate and Frame





Uses R-1733 frame.

R-2561-A

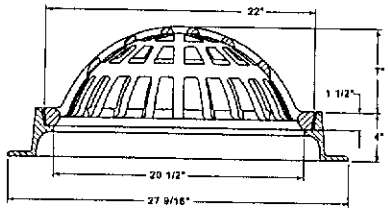
Same as **R-2561** except with 6" high beehive grate.

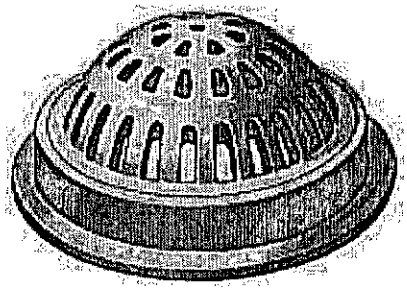
Furnished standard with as-cast bearing surfaces.

R-2563
Beehive Grate and Frame

Designed to fit in bell of 24" sewer pipe.

Furnished standard with as-cast bearing surfaces.



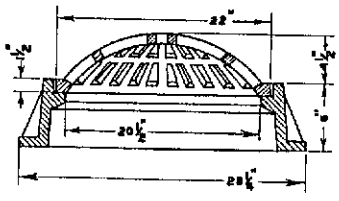


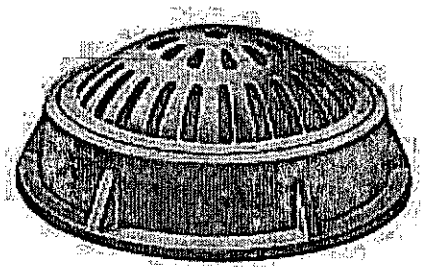
Uses R-1690 frame.

R-2564
Beehive Grate and Frame

Designed to fit in bell of 24" sewer pipe.

Furnished standard with as-cast bearing surfaces.





Uses R-1761 frame.

Weir & Orifice Flow Comparison

$Q = 0.6A\sqrt{2gh}$

(Orifice Flow Equation)

Q = Capacity in CFS
A = Free open area of grate in sq. ft.
g = 32.2 (feet per sec/sec)
h = Head in feet

Orifice Information

Instructions:

- Either Select catalog number (will automatically fill in Open Area and Perimeter) or enter your own values
- Enter head value
- Press CALCULATE

The results will determine automatically if your situation falls into a Weir, Transitional or Orifice flow. Additionally, a pop-up window will offer Neenah grates which fall within the parameters chosen.

$Q = 3.3P(h)^{1.5}$

(Weir Equation)

Q = Capacity in CFS
P = Feet perimeter
h = Head in feet

Weir Information

Catalog number and grate type: R-2561 Beehive

Head in feet (h): 1

Feet perimeter (P): 6.7

Calculate

Free open area in sq. ft. (A): 2

Weir capacity in cfs:

Transitional flow in cfs:

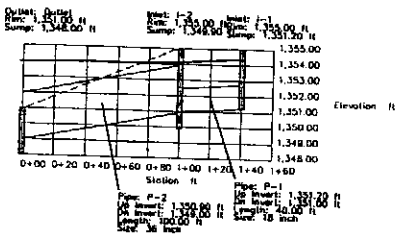
Orifice capacity in cfs: 9.6

(Results assume no debris restriction.)

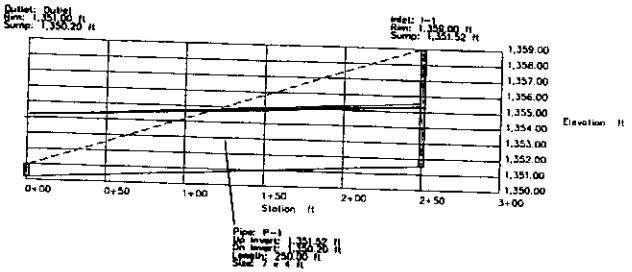
NOTE: The above results do not account for the dome height of Beehive-type grates. Please take note of this when determining the Head (h) value.

For additional information regarding Neenah Inlet Grate Capacities, please contact our Product Engineer, Steve Akkala, at 920-725-7000 or at sakkala@nfco.com.

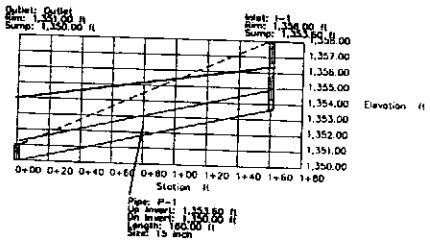
LINE A PROFILE



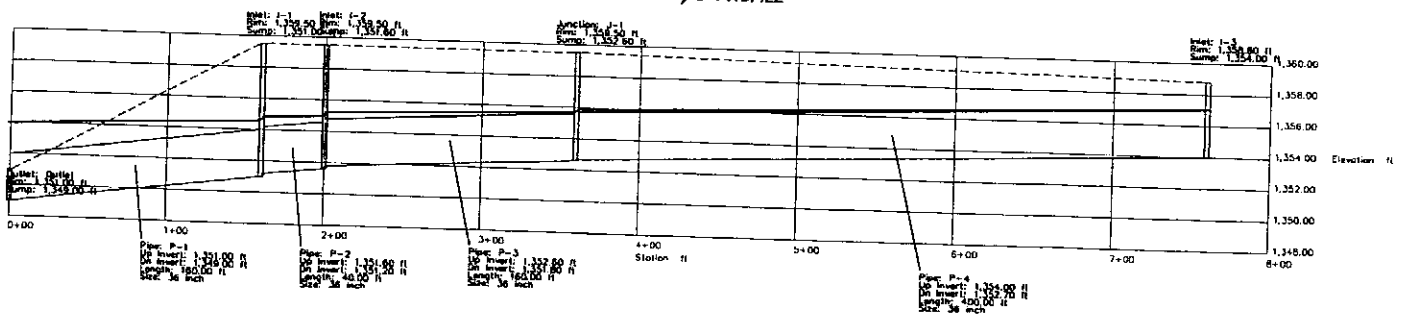
LINE B PROFILE



LINE C PROFILE



LINE F/G PROFILE



CENTRAL DEVELOPMENT
SERIES 1 SWS PROFILES

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