

DRAINAGE PLAN
WILLOWBEND
NORTH ESTATES
2ND ADDITION
TO
WICHITA, SEDGWICK COUNTY,
KANSAS

DRAINAGE PLAN
WILLOWBEND NORTH
ESTATES 2ND
ADDITION
TO
WICHITA, SEDGWICK COUNTY, KANSAS

Prepared By



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NARRATIVE

This report provides information and supporting documentation to support the "Drainage Plan" for the property located in the Northeast Quarter of Section 30, T-26-S, R-2-E in Sedgwick County, Kansas.

The "Drainage Plan" being submitted herein is intended to serve as a guide for the design of streets and storm water sewer improvements to the proposed development. Modifications to structures, pipes, etc. may be made as necessary during the final design in order to obtain the most economical design and construction possible.

Storm water sewer systems within this proposed development have been designed to convey the 2-yr rainfall event. A sub-division grading plan has been prepared in conjunction with the storm water sewer design. This grading plan allows for emergency outflow points during major rainfall events.

Calculations

MASTER DESIGN STORM SUMMARY

Default Network Design Storm File, ID WICHITA.RNQ WICHITA

Return Event	Total Depth in	Rainfall Type	RNF File	RNF ID	
2-yr	3.6000	Synthetic Curve	SCSTYPES	TypeII	24hr
5-yr	4.5600	Synthetic Curve	SCSTYPES	TypeII	24hr
100-yr	7.6800	Synthetic Curve	SCSTYPES	TypeII	24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Storage Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond ac-ft
OFFSITE	AREA	2	70.127		12.6500	367.71		
OFFSITE	AREA	5	98.798		12.6500	519.68		
OFFSITE	AREA	100	196.836		12.6500	1024.18		
*OUTFALL	JCT	2	72.603		12.7000	370.92		
*OUTFALL	JCT	5	102.262		12.7000	523.34		
*OUTFALL	JCT	100	203.658		12.6500	1029.91		
SITE	AREA	2	2.479		12.0500	35.82		
SITE	AREA	5	3.466		12.0500	49.56		
SITE	AREA	100	6.824		12.0500	94.38		
WILLOWBEND	IN POND	2	72.606		12.6500	371.99		
WILLOWBEND	IN POND	5	102.265		12.6500	525.42		
WILLOWBEND	IN POND	100	203.660		12.6500	1034.62		
WILLOWBEND	OUT POND	2	72.603		12.7000	370.92	180.37	2.289
WILLOWBEND	OUT POND	5	102.262		12.7000	523.34	180.61	2.503
WILLOWBEND	OUT POND	100	203.658		12.6500	1029.91	181.26	3.118

CUMULATIVE RAINFALL DEPTHS (in)
 Output Time increment = .1000 hrs
 Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0036	.0073	.0110	.0147
.5000	.0185	.0222	.0261	.0300	.0339
1.0000	.0378	.0418	.0458	.0499	.0539
1.5000	.0581	.0622	.0664	.0706	.0749
2.0000	.0792	.0836	.0879	.0923	.0968
2.5000	.1013	.1058	.1103	.1149	.1196
3.0000	.1242	.1289	.1336	.1384	.1432
3.5000	.1481	.1529	.1579	.1628	.1678
4.0000	.1728	.1779	.1830	.1882	.1935
4.5000	.1989	.2043	.2098	.2154	.2211
5.0000	.2268	.2326	.2385	.2444	.2504
5.5000	.2565	.2627	.2689	.2752	.2816
6.0000	.2880	.2945	.3011	.3078	.3145
6.5000	.3213	.3282	.3351	.3421	.3492
7.0000	.3564	.3636	.3709	.3783	.3858
7.5000	.3933	.4009	.4086	.4163	.4241
8.0000	.4320	.4401	.4486	.4574	.4666
8.5000	.4761	.4860	.4963	.5069	.5179
9.0000	.5292	.5407	.5522	.5638	.5753
9.5000	.5868	.5986	.6110	.6240	.6375
10.0000	.6516	.6664	.6821	.6987	.7161
10.5000	.7344	.7538	.7747	.7970	.8208
11.0000	.8460	.8736	.9048	.9393	.9773
11.5000	1.0188	1.1046	1.2757	1.5508	2.0443
12.0000	2.3868	2.4551	2.5151	2.5669	2.6106
12.5000	2.6460	2.6764	2.7049	2.7315	2.7563
13.0000	2.7792	2.8007	2.8211	2.8405	2.8590
13.5000	2.8764	2.8930	2.9088	2.9239	2.9383
14.0000	2.9520	2.9652	2.9781	2.9908	3.0033
14.5000	3.0155	3.0274	3.0391	3.0505	3.0617
15.0000	3.0726	3.0833	3.0937	3.1039	3.1138
15.5000	3.1235	3.1329	3.1420	3.1509	3.1596
16.0000	3.1680	3.1762	3.1844	3.1924	3.2004
16.5000	3.2083	3.2161	3.2238	3.2314	3.2389
17.0000	3.2463	3.2536	3.2609	3.2680	3.2751
17.5000	3.2821	3.2890	3.2958	3.3025	3.3091
18.0000	3.3156	3.3220	3.3284	3.3346	3.3408
18.5000	3.3469	3.3529	3.3588	3.3646	3.3703
19.0000	3.3759	3.3814	3.3869	3.3922	3.3975
19.5000	3.4027	3.4078	3.4128	3.4177	3.4225
20.0000	3.4272	3.4319	3.4365	3.4412	3.4458
20.5000	3.4504	3.4550	3.4595	3.4641	3.4686
21.0000	3.4731	3.4776	3.4821	3.4865	3.4910
21.5000	3.4954	3.4998	3.5042	3.5085	3.5129
22.0000	3.5172	3.5215	3.5258	3.5301	3.5343
22.5000	3.5386	3.5428	3.5470	3.5512	3.5554

Type... Synthetic Cumulative Depth
Name... TypeII 24hr Tag: 2-yr
File... C:\HAESTAD\PPKW\RAINFALL\SCSTYPES.RNF
Storm... TypeII 24hr Tag: 2-yr

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Event: 2 yr

CUMULATIVE RAINFALL DEPTHS (in)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
23.0000	3.5595	3.5636	3.5677	3.5718	3.5759
23.5000	3.5800	3.5840	3.5880	3.5920	3.5960
24.0000	3.6000				

Type.... Synthetic Cumulative Depth
 Name.... TypeII 24hr Tag: 5-yr
 File.... C:\HAESTAD\PPKW\RAINFALL\SCSTYPES.RNF
 Storm... TypeII 24hr Tag: 5-yr

CUMULATIVE RAINFALL DEPTHS (in)
 Output Time increment = .1000 hrs
 Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0046	.0092	.0139	.0186
.5000	.0234	.0282	.0331	.0379	.0429
1.0000	.0479	.0529	.0580	.0632	.0683
1.5000	.0736	.0788	.0841	.0895	.0949
2.0000	.1003	.1058	.1114	.1170	.1226
2.5000	.1283	.1340	.1398	.1456	.1514
3.0000	.1573	.1633	.1693	.1753	.1814
3.5000	.1876	.1937	.2000	.2062	.2125
4.0000	.2189	.2253	.2318	.2384	.2451
4.5000	.2519	.2588	.2658	.2729	.2800
5.0000	.2873	.2946	.3021	.3096	.3172
5.5000	.3249	.3327	.3406	.3486	.3566
6.0000	.3648	.3731	.3814	.3898	.3984
6.5000	.4070	.4157	.4245	.4334	.4424
7.0000	.4514	.4606	.4699	.4792	.4886
7.5000	.4982	.5078	.5175	.5273	.5372
8.0000	.5472	.5575	.5682	.5793	.5910
8.5000	.6031	.6156	.6286	.6420	.6560
9.0000	.6703	.6849	.6995	.7141	.7287
9.5000	.7433	.7582	.7739	.7903	.8075
10.0000	.8254	.8441	.8640	.8850	.9071
10.5000	.9302	.9549	.9813	1.0096	1.0397
11.0000	1.0716	1.1066	1.1460	1.1898	1.2379
11.5000	1.2905	1.3992	1.6159	1.9644	2.5894
12.0000	3.0233	3.1097	3.1858	3.2515	3.3067
12.5000	3.3516	3.3901	3.4262	3.4599	3.4913
13.0000	3.5203	3.5475	3.5734	3.5980	3.6214
13.5000	3.6434	3.6644	3.6845	3.7036	3.7219
14.0000	3.7392	3.7559	3.7723	3.7884	3.8041
14.5000	3.8196	3.8347	3.8495	3.8640	3.8781
15.0000	3.8920	3.9055	3.9187	3.9316	3.9441
15.5000	3.9564	3.9683	3.9799	3.9912	4.0022
16.0000	4.0128	4.0232	4.0335	4.0438	4.0538
16.5000	4.0638	4.0737	4.0834	4.0931	4.1026
17.0000	4.1120	4.1213	4.1304	4.1395	4.1485
17.5000	4.1573	4.1660	4.1746	4.1831	4.1915
18.0000	4.1998	4.2079	4.2159	4.2239	4.2317
18.5000	4.2394	4.2470	4.2544	4.2618	4.2690
19.0000	4.2761	4.2832	4.2900	4.2968	4.3035
19.5000	4.3101	4.3165	4.3228	4.3290	4.3351
20.0000	4.3411	4.3470	4.3529	4.3588	4.3646
20.5000	4.3705	4.3763	4.3821	4.3878	4.3936
21.0000	4.3993	4.4050	4.4106	4.4163	4.4219
21.5000	4.4275	4.4331	4.4386	4.4441	4.4496
22.0000	4.4551	4.4606	4.4660	4.4714	4.4768
22.5000	4.4822	4.4875	4.4929	4.4982	4.5035

Type... Synthetic Cumulative Depth
Name... TypeII 24hr Tag: 5-yr
File... C:\HAESTAD\PPKW\RAINFALL\SCSTYPES.RNF
Storm... TypeII 24hr Tag: 5-yr

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Event: 5 yr

CUMULATIVE RAINFALL DEPTHS (in)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
23.0000	4.5087	4.5139	4.5191	4.5243	4.5295
23.5000	4.5346	4.5398	4.5449	4.5499	4.5550
24.0000	4.5600				

Type.... Synthetic Cumulative Depth
 Name.... TypeII 24hr Tag: 100-yr
 File.... C:\HAESTAD\PPKW\RAINFALL\SCSTYPES.RNF
 Storm... TypeII 24hr Tag: 100-yr

CUMULATIVE RAINFALL DEPTHS (in)
 Output Time increment = .1000 hrs
 Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0078	.0155	.0234	.0313
.5000	.0394	.0475	.0557	.0639	.0723
1.0000	.0806	.0892	.0977	.1064	.1150
1.5000	.1239	.1327	.1417	.1507	.1598
2.0000	.1690	.1783	.1875	.1970	.2064
2.5000	.2160	.2256	.2354	.2451	.2551
3.0000	.2650	.2750	.2851	.2953	.3055
3.5000	.3159	.3262	.3368	.3473	.3580
4.0000	.3686	.3795	.3905	.4016	.4129
4.5000	.4243	.4359	.4477	.4596	.4716
5.0000	.4838	.4962	.5087	.5214	.5342
5.5000	.5472	.5603	.5736	.5871	.6007
6.0000	.6144	.6283	.6424	.6566	.6709
6.5000	.6854	.7001	.7149	.7299	.7450
7.0000	.7603	.7758	.7913	.8071	.8230
7.5000	.8390	.8552	.8716	.8881	.9048
8.0000	.9216	.9389	.9569	.9757	.9953
8.5000	1.0157	1.0368	1.0587	1.0813	1.1048
9.0000	1.1290	1.1535	1.1781	1.2027	1.2273
9.5000	1.2518	1.2770	1.3035	1.3311	1.3600
10.0000	1.3901	1.4217	1.4552	1.4905	1.5277
10.5000	1.5667	1.6082	1.6527	1.7004	1.7510
11.0000	1.8048	1.8638	1.9301	2.0039	2.0850
11.5000	2.1734	2.3565	2.7215	3.3085	4.3612
12.0000	5.0918	5.2375	5.3656	5.4761	5.5692
12.5000	5.6448	5.7096	5.7704	5.8273	5.8801
13.0000	5.9290	5.9747	6.0184	6.0598	6.0991
13.5000	6.1363	6.1716	6.2054	6.2377	6.2684
14.0000	6.2976	6.3258	6.3534	6.3805	6.4070
14.5000	6.4330	6.4584	6.4834	6.5077	6.5316
15.0000	6.5549	6.5777	6.5999	6.6216	6.6427
15.5000	6.6634	6.6834	6.7030	6.7220	6.7405
16.0000	6.7584	6.7760	6.7933	6.8105	6.8275
16.5000	6.8443	6.8609	6.8774	6.8936	6.9096
17.0000	6.9254	6.9411	6.9565	6.9718	6.9869
17.5000	7.0018	7.0164	7.0310	7.0452	7.0594
18.0000	7.0733	7.0870	7.1005	7.1139	7.1270
18.5000	7.1400	7.1528	7.1654	7.1777	7.1899
19.0000	7.2019	7.2137	7.2253	7.2368	7.2480
19.5000	7.2591	7.2699	7.2806	7.2910	7.3013
20.0000	7.3114	7.3213	7.3313	7.3412	7.3510
20.5000	7.3608	7.3706	7.3803	7.3900	7.3997
21.0000	7.4093	7.4189	7.4284	7.4379	7.4474
21.5000	7.4568	7.4662	7.4756	7.4849	7.4941
22.0000	7.5034	7.5126	7.5217	7.5309	7.5399
22.5000	7.5490	7.5580	7.5670	7.5759	7.5848

Type.... Synthetic Cumulative Depth
Name.... TypeII 24hr Tag: 100-yr
File.... C:\HAESTAD\PPKW\RAINFALL\SCSTYPES.RNF
Storm... TypeII 24hr Tag: 100-yr

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Event: 100 yr

CUMULATIVE RAINFALL DEPTHS (in)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
23.0000	7.5936	7.6024	7.6112	7.6199	7.6286
23.5000	7.6373	7.6459	7.6545	7.6630	7.6716
24.0000	7.6800				

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
 Duration = 24.0000 hrs Rain Depth = 3.6000 in
 Rain Dir = C:\HAESTAD\PPKW\RAINFALL\
 Rain File -ID = SCSTYPES.RNF - TypeII 24hr
 Unit Hyd Type = Default Curvilinear
 HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 HYG File - ID = - OFFSITE 2-yr
 Tc = 1.3000 hrs
 Drainage Area = 400.000 acres Runoff CN= 85

=====
 Computational Time Increment = .17333 hrs
 Computed Peak Time = 12.6533 hrs
 Computed Peak Flow = 368.27 cfs

 Time Increment for HYG File = .0500 hrs
 Peak Time, Interpolated Output = 12.6500 hrs
 Peak Flow, Interpolated Output = 367.71 cfs
 =====

DRAINAGE AREA

 ID:None Selected
 CN = 85
 Area = 400.000 acres
 S = 1.7647 in
 0.2S = .3529 in

Cumulative Runoff

 2.1037 in
 70.124 ac-ft

HYG Volume... 70.127 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.30000 hrs (ID: None Selected)
 Computational Incr, Tm = .17333 hrs = 0.20000 Tp

 Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
 K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
 Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

 Unit peak, qp = 348.63 cfs
 Unit peak time, Tp = .86667 hrs
 Unit receding limb, Tr = 3.46667 hrs
 Total unit time, Tb = 4.33333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 5 year storm
 Duration = 24.0000 hrs Rain Depth = 4.5600 in
 Rain Dir = C:\HAESTAD\PPKW\RAINFALL\
 Rain File -ID = SCSTYPES.RNF - TypeII 24hr
 Unit Hyd Type = Default Curvilinear
 HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 HYG File - ID = - OFFSITE 5-yr
 Tc = 1.3000 hrs
 Drainage Area = 400.000 acres Runoff CN= 85

=====
 Computational Time Increment = .17333 hrs
 Computed Peak Time = 12.6533 hrs
 Computed Peak Flow = 520.42 cfs
 Time Increment for HYG File = .0500 hrs
 Peak Time, Interpolated Output = 12.6500 hrs
 Peak Flow, Interpolated Output = 519.68 cfs
 =====

DRAINAGE AREA

 ID:None Selected
 CN = 85
 Area = 400.000 acres
 S = 1.7647 in
 0.2S = .3529 in

Cumulative Runoff

 2.9638 in
 98.795 ac-ft

HYG Volume... 98.798 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.30000 hrs (ID: None Selected)
 Computational Incr, Tm = .17333 hrs = 0.20000 Tp
 Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
 K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
 Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)
 Unit peak, qp = 348.63 cfs
 Unit peak time Tp = .86667 hrs
 Unit receding limb, Tr = 3.46667 hrs
 Total unit time, Tb = 4.33333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm

Duration = 24.0000 hrs Rain Depth = 7.6800 in

Rain Dir = C:\HAESTAD\PPKW\RAINFALL\

Rain File -ID = SCSTYPES.RNF - TypeII 24hr

Unit Hyd Type = Default Curvilinear

HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\

HYG File - ID = - OFFSITE 100-yr

Tc = 1.3000 hrs

Drainage Area = 400.000 acres Runoff CN= 85

=====
Computational Time Increment = .17333 hrs

Computed Peak Time = 12.6533 hrs

Computed Peak Flow = 1025.42 cfs

Time Increment for HYG File = .0500 hrs

Peak Time, Interpolated Output = 12.6500 hrs

Peak Flow, Interpolated Output = 1024.18 cfs
=====

DRAINAGE AREA

ID:None Selected

CN = 85

Area = 400.000 acres

S = 1.7647 in

0.2S = .3529 in

Cumulative Runoff

5.9049 in

196.829 ac-ft

HYG Volume... 196.836 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.30000 hrs (ID: None Selected)

Computational Incr, Tm = .17333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)

K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))

Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 348.63 cfs

Unit peak time, Tp = .86667 hrs

Unit receding limb, Tr = 3.46667 hrs

Total unit time, Tb = 4.33333 hrs

Name... SITE Tag: 2-yr

Event: 2 yr

File... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

Storm... TypeII 24hr Tag: 2-yr

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm

Duration = 24.0000 hrs Rain Depth = 3.6000 in

Rain Dir = C:\HAESTAD\PPKW\RAINFALL\

Rain File -ID = SCSTYPES.RNF - TypeII 24hr

Unit Hyd Type = Default Curvilinear

HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\

HYG File - ID = - SITE 2-yr

Tc = .2500 hrs

Drainage Area = 13.600 acres Runoff CN= 86

=====
Computational Time Increment = .03333 hrs

Computed Peak Time = 12.0333 hrs

Computed Peak Flow = 36.12 cfs

Time Increment for HYG File = .0500 hrs

Peak Time, Interpolated Output = 12.0500 hrs

Peak Flow, Interpolated Output = 35.82 cfs
=====

DRAINAGE AREA

ID:None Selected

CN = 86

Area = 13.600 acres

S = 1.6279 in

0.2S = .3256 in

Cumulative Runoff

2.1871 in

2.479 ac-ft

HYG Volume... 2.479 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .25000 hrs (ID: None Selected)

Computational Incr, Tm = .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)

K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp)))

Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 61.64 cfs

Unit peak time, Tp = .16667 hrs

Unit receding limb, Tr = .66667 hrs

Total unit time, Tb = .83333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 5 year storm
 Duration = 24.0000 hrs Rain Depth = 4.5600 in
 Rain Dir = C:\HAESTAD\PPKW\RAINFALL\
 Rain File -ID = SCSTYPES.RNF - TypeII 24hr
 Unit Hyd Type = Default Curvilinear
 HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 HYG File - ID = - SITE 5-yr
 Tc = .2500 hrs
 Drainage Area = 13.600 acres Runoff CN= 86

=====
 Computational Time Increment = .03333 hrs
 Computed Peak Time = 12.0333 hrs
 Computed Peak Flow = 50.09 cfs

 Time Increment for HYG File = .0500 hrs
 Peak Time, Interpolated Output = 12.0500 hrs
 Peak Flow, Interpolated Output = 49.56 cfs
 =====

DRAINAGE AREA

 ID:None Selected
 CN = 86
 Area = 13.600 acres
 S = 1.6279 in
 0.2S = .3256 in

Cumulative Runoff

 3.0586 in
 3.466 ac-ft

HYG Volume... 3.466 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .25000 hrs (ID: None Selected)
 Computational Incr, Tm = .03333 hrs = 0.20000 Tp

 Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
 K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
 Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

 Unit peak, qp = 61.64 cfs
 Unit peak time Tp = .16667 hrs
 Unit receding limb, Tr = .66667 hrs
 Total unit time, Tb = .83333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
 Duration = 24.0000 hrs Rain Depth = 7.6800 in
 Rain Dir = C:\HAESTAD\PPKW\RAINFALL\
 Rain File -ID = SCSTYPES.RNF - TypeII 24hr
 Unit Hyd Type = Default Curvilinear
 HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 HYG File - ID = - SITE 100-yr
 Tc = .2500 hrs
 Drainage Area = 13.600 acres Runoff CN= 86

```

=====
Computational Time Increment = .03333 hrs
Computed Peak Time          = 12.0333 hrs
Computed Peak Flow          = 95.72 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.0500 hrs
Peak Flow, Interpolated Output = 94.38 cfs
=====
  
```

DRAINAGE AREA

```

-----
ID:None Selected
CN = 86
Area = 13.600 acres
S = 1.6279 in
0.2S = .3256 in
  
```

Cumulative Runoff

```

-----
6.0215 in
6.824 ac-ft
  
```

HYG Volume... 6.824 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .25000 hrs (ID: None Selected)
 Computational Incr, Tm = .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
 K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
 Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 61.64 cfs
 Unit peak time Tp = .16667 hrs
 Unit receding limb, Tr = .66667 hrs
 Total unit time, Tb = .83333 hrs

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sq(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
177.50	-----	.7000	.0000	.000	.000
179.00	-----	.8000	2.2483	1.124	1.124
183.00	-----	1.1000	2.8381	3.784	4.908

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Area1, Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

File... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 177.50 ft
Increment = .20 ft
Max. Elev.= 183.00 ft

OUTLET CONNECTIVITY

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Culvert-Circular	CV	--->	TW	177.500	183.000
Weir-Rectangular	WR	--->	TW	179.500	183.000
TW SETUP, DS Channel					

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

OUTLET STRUCTURE INPUT DATA

Structure ID = CV
Structure Type = Culvert-Circular

No. Barrels = 1
Barrel Diameter = 2.0000 ft
Upstream Invert = 177.50 ft
Dnstream Invert = 177.00 ft
Horiz. Length = 50.00 ft
Barrel Length = 50.00 ft
Barrel Slope = .01000 ft/ft

OUTLET CONTROL DATA...

Mannings n = .0130
Ke = .5000 (forward entrance loss)
Kb = .012411 (per ft of full flow)
Kr = .5000 (reverse entrance loss)
HW Convergence = .001 +/- ft

INLET CONTROL DATA...

Equation form = 1
Inlet Control K = .0098
Inlet Control M = 2.0000
Inlet Control c = .03980
Inlet Control Y = .6700
T1 ratio (HW/D) = 1.155
T2 ratio (HW/D) = 1.302
Slope Factor = -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

At T1 Elev = 179.81 ft ---> Flow = 15.55 cfs
At T2 Elev = 180.10 ft ---> Flow = 17.77 cfs

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

OUTLET STRUCTURE INPUT DATA

Structure ID = WR
Structure Type = Weir-Rectangular

of Openings = 1
Crest Elev. = 179.50 ft
Weir Length = 150.00 ft
Weir Coeff. = 2.860000

Weir TW effects (Use adjustment equation)

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations= 30
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .10 cfs
Max. Q tolerance = .10 cfs

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

***** COMPOSITE OUTFLOW SUMMARY *****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
177.50	.00	Free Outfall		None contributing
177.70	.15	Free Outfall		CV
177.90	.59	Free Outfall		CV
178.10	1.30	Free Outfall		CV
178.30	2.26	Free Outfall		CV
178.50	3.42	Free Outfall		CV
178.70	4.79	Free Outfall		CV
178.90	6.32	Free Outfall		CV
179.10	8.00	Free Outfall		CV
179.30	9.77	Free Outfall		CV
179.50	11.62	Free Outfall		CV +WR
179.70	51.91	Free Outfall		CV +WR
179.90	123.98	Free Outfall		CV +WR
180.10	216.75	Free Outfall		CV +WR
180.30	326.07	Free Outfall		CV +WR
180.50	449.35	Free Outfall		CV +WR
180.70	585.46	Free Outfall		CV +WR
180.90	733.30	Free Outfall		CV +WR
181.10	891.96	Free Outfall		CV +WR
181.30	1060.77	Free Outfall		CV +WR
181.50	1239.13	Free Outfall		CV +WR
181.70	1426.56	Free Outfall		CV +WR
181.90	1622.63	Free Outfall		CV +WR
182.10	1827.01	Free Outfall		CV +WR
182.30	2039.33	Free Outfall		CV +WR
182.50	2259.32	Free Outfall		CV +WR
182.70	2486.72	Free Outfall		CV +WR
182.90	2721.29	Free Outfall		CV +WR
183.00	2841.21	Free Outfall		CV +WR

Name.... WILLOWBEND

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

LEVEL POOL ROUTING DATA

HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 Inflow HYG file = NONE STORED - WILLOWBEND IN 2-yr
 Outflow HYG file = NONE STORED - WILLOWBEND OUT 2-yr

Pond Node Data = WILLOWBEND
 Pond Volume Data = WILLOWBEND
 Pond Outlet Data = OUTFALL

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 177.50 ft
 Starting Volume = .000 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout = .00 cfs
 Time Increment = .0500 hrs

Elevation ft	Outflow cfs	Storage ac-ft	Area acres	Infiltr. cfs	Q Total cfs	2S/t + 0 cfs
177.50	.00	.000	.7000	.00	.00	.00
177.70	.15	.141	.7129	.00	.15	68.53
177.90	.59	.285	.7260	.00	.59	138.62
178.10	1.30	.432	.7392	.00	1.30	210.25
178.30	2.26	.581	.7525	.00	2.26	283.40
178.50	3.42	.733	.7659	.00	3.42	358.05
178.70	4.79	.887	.7795	.00	4.79	434.22
178.90	6.32	1.045	.7931	.00	6.32	511.86
179.10	8.00	1.205	.8069	.00	8.00	590.98
179.30	9.77	1.367	.8208	.00	9.77	671.53
179.50	11.62	1.533	.8349	.00	11.62	753.53
179.70	51.91	1.701	.8491	.00	51.91	875.31
179.90	123.98	1.872	.8633	.00	123.98	1030.26
180.10	216.75	2.047	.8777	.00	216.75	1207.30
180.30	326.07	2.224	.8923	.00	326.07	1402.29
180.50	449.35	2.404	.9069	.00	449.35	1612.65
180.70	585.46	2.586	.9217	.00	585.46	1837.26
180.90	733.30	2.772	.9366	.00	733.30	2075.03
181.10	891.96	2.961	.9516	.00	891.96	2325.09
181.30	1060.77	3.153	.9667	.00	1060.77	2586.73
181.50	1239.13	3.348	.9819	.00	1239.13	2859.40
181.70	1426.56	3.546	.9973	.00	1426.56	3142.63
181.90	1622.63	3.747	1.0127	.00	1622.63	3435.98

Name.... WILLOWBEND

File.... F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\WILLOWBEND.PPW

LEVEL POOL ROUTING DATA

HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 Inflow HYG file = NONE STORED - WILLOWBEND IN 2-yr
 Outflow HYG file = NONE STORED - WILLOWBEND OUT 2-yr

Pond Node Data = WILLOWBEND
 Pond Volume Data = WILLOWBEND
 Pond Outlet Data = OUTFALL

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 177.50 ft
 Starting Volume = .000 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout = .00 cfs
 Time Increment = .0500 hrs

Elevation ft	Outflow cfs	Storage ac-ft	Area acres	Infiltr. cfs	Q Total cfs	2S/t + 0 cfs
182.10	1827.01	3.951	1.0283	.00	1827.01	3739.16
182.30	2039.33	4.158	1.0441	.00	2039.33	4051.78
182.50	2259.32	4.368	1.0599	.00	2259.32	4373.59
182.70	2486.72	4.582	1.0758	.00	2486.72	4704.36
182.90	2721.29	4.799	1.0919	.00	2721.29	5043.85
183.00	2841.21	4.908	1.1000	.00	2841.21	5216.81

LEVEL POOL ROUTING DATA

HYG Dir = F:\HYDRO\PROJECTS\WILLOWBENDNORTHESTATES\
 Inflow HYG file = NONE STORED - WILLOWBEND IN 2-yr
 Outflow HYG file = NONE STORED - WILLOWBEND OUT 2-yr

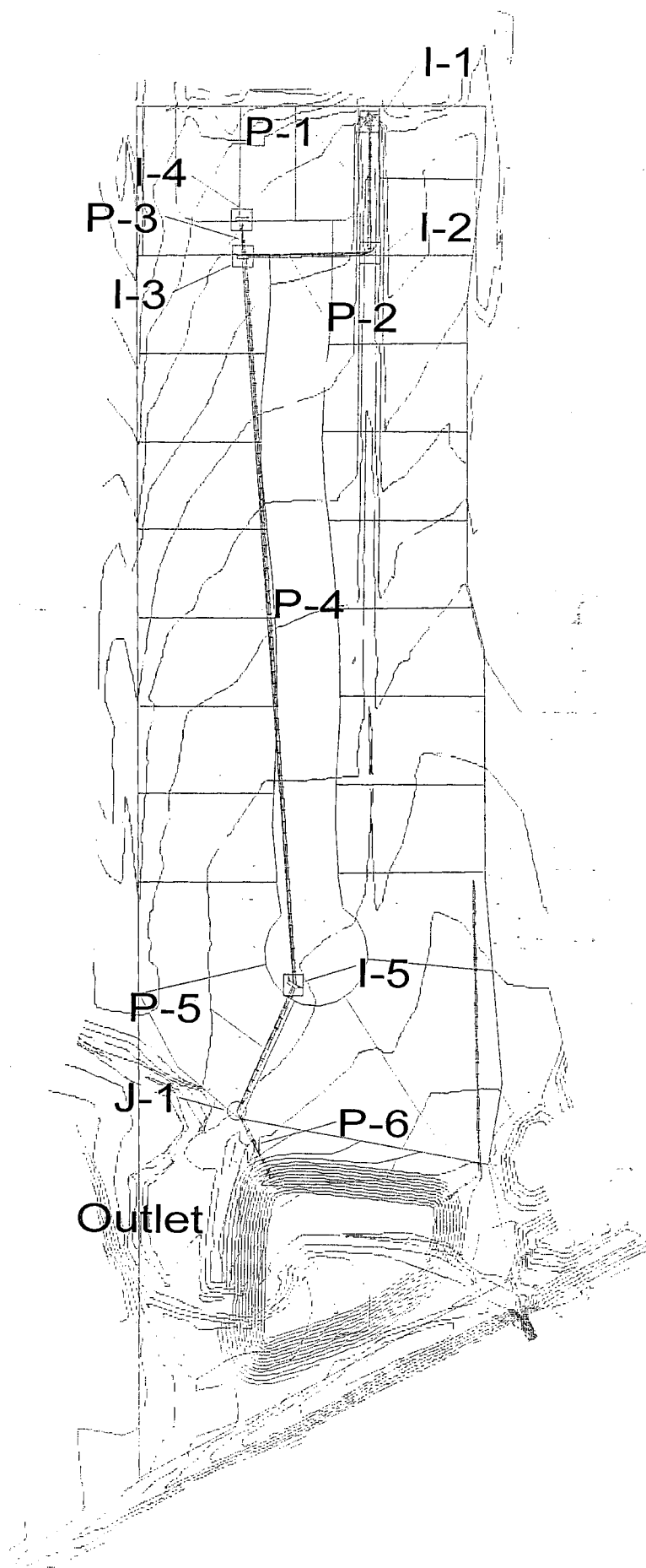
Pond Node Data = WILLOWBEND
 Pond Volume Data = WILLOWBEND
 Pond Outlet Data = OUTFALL

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 177.50 ft
 Starting Volume = .000 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout = .00 cfs
 Time Increment = .0500 hrs

Elevation ft	Outflow cfs	Storage ac-ft	Area acres	Infiltr. cfs	Q Total cfs	2S/t + 0 cfs
177.50	.00	.000	.7000	.00	.00	.00
177.70	.15	.141	.7129	.00	.15	68.53
177.90	.59	.285	.7260	.00	.59	138.62
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181.30	1060.77	3.153	.9667	.00	1060.77	2586.73
181.50	1239.13	3.348	.9819	.00	1239.13	2859.40
181.70	1426.56	3.546	.9973	.00	1426.56	3142.63
181.90	1622.63	3.747	1.0127	.00	1622.63	3435.98



System Report

Pipe	Additional Flow (cfs)	Total Upstream Discharge (cfs)	Structure Discharge (cfs)	-Node- Upstream Downstream	-Section- Shape Size	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	-Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	-Section- Discharge Capacity (cfs)	Length (ft)	Average Velocity (ft/s)	Description
P-3	8.00	0.00	8.00	I-4	Circular	182.60	182.40	187.50	187.70	0.005801	8.00	35.00	4.53	
P-1	3.00	0.00	3.00	I-1	Circular	183.16	182.80	187.50	187.50	0.005714	7.94			
P-2	0.00	3.00	3.00	I-2	Circular	182.50	182.00	188.80	187.55	0.000176	3.00	26.00	0.95	
P-4	8.00	11.00	19.00	I-3	Circular	181.80	180.80	188.10	187.53	0.002857	12.09			
P-5	5.00	19.00	24.00	I-5	Circular	180.60	177.60	187.50	187.52	0.000176	3.00	24.00	0.95	
P-6	N/A	24.00	24.00	J-1	Circular	177.50	174.00	187.50	187.50	0.004032	14.36			
				Outlet	30 inch			186.30	182.27	0.007028	19.00	95.00	6.17	
					30 inch			186.30	182.27	0.001439	8.58			
					30 inch			183.00	181.04	0.012031	24.00	33.00	5.89	
					Circular			183.00	180.85	0.022556	61.60			
					30 inch			181.00	180.60	0.003424	24.00	73.00	4.89	
										0.047945	89.81			

Junction: J-1
 Rim: 183.00 ft
 Sump: 177.50 ft

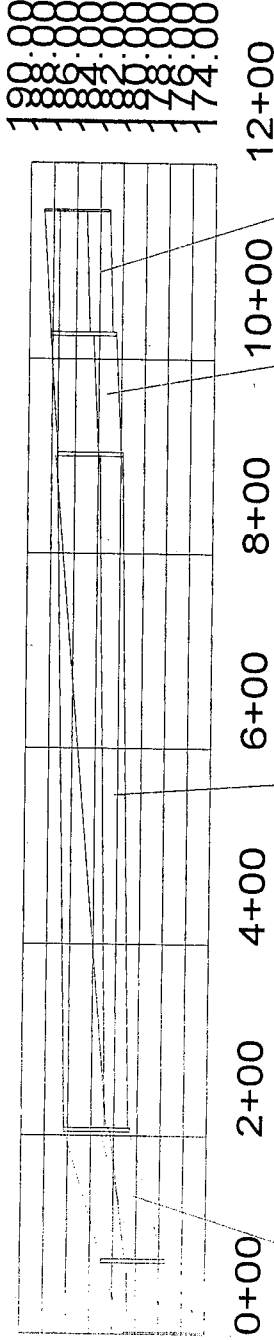
Inlet: I-5
 Rim: 186.30 ft
 Sump: 180.60 ft

Outlet: Outlet
 Rim: 181.00 ft
 Sump: 174.00 ft

Inlet: I-2
 Rim: 188.10 ft
 Sump: 182.50 ft

Inlet: I-3
 Rim: 187.50 ft
 Sump: 181.80 ft

Inlet: I-1
 Rim: 188.80 ft
 Sump: 183.16 ft



Elevation ft

Station ft

Pipe: P-5
 Up Invert: 180.60 ft
 Dn Invert: 177.60 ft
 Length: 133.00 ft
 Size: 30 inch

Pipe: P-4
 Up Invert: 181.80 ft
 Dn Invert: 180.80 ft
 Length: 695.00 ft
 Size: 24 inch

Pipe: P-1
 Up Invert: 183.16 ft
 Dn Invert: 182.80 ft
 Length: 126.00 ft
 Size: 24 inch

Pipe: P-6
 Up Invert: 177.50 ft
 Dn Invert: 174.00 ft
 Length: 73.00 ft
 Size: 30 inch

Pipe: P-2
 Up Invert: 182.50 ft
 Dn Invert: 182.00 ft
 Length: 124.00 ft
 Size: 24 inch

System Report

Pipe	Additional Flow (cfs)	Total Upstream Discharge Added (cfs)	Structure		-Node- Upstream Downstream	Section- Shape Size	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Ground- Upstream Downstream (ft)	-HGL- Upstream Downstream (ft)	-Slope- Energy Constructed (ft/ft)	Section- Discharge Capacity (cfs)	Length (ft)	Average Velocity (ft/s)	Description
			Discharge (cfs)	Discharge (cfs)											
P-3	17.00	0.00	17.00	I-4		Circular	182.60	182.40	187.50	188.42	0.026194	17.00	35.00	9.62	
P-1	8.00	0.00	8.00	I-1		Circular	183.16	182.80	187.50	187.50	0.005714	7.94			
P-2	0.00	8.00	8.00	I-2		Circular	182.50	182.00	188.10	187.86	0.001251	8.00	26.00	2.55	
P-4	17.00	25.00	42.00	I-3		Circular	181.80	180.80	187.50	187.71	0.002857	12.09			
P-5	11.00	42.00	53.00	I-5		Circular	180.60	177.60	186.30	187.66	0.001251	8.00	24.00	2.55	
P-6	N/A	53.00	53.00	J-1		Circular	177.50	174.00	183.00	187.50	0.004032	14.36			
				Outlet		Circular			183.00	210.08	0.034472	42.00	95.00	13.37	
						Circular			183.00	186.13	0.001439	8.58			
						Circular			183.00	185.22	0.016698	53.00	133.00	10.80	
						Circular			183.00	183.00	0.022556	61.60	73.00	10.80	
						Circular			181.00	182.52	0.016698	53.00	73.00	10.80	
						Circular			181.00	181.30	0.047945	89.81			

Inlet: I-2
 Rim: 188.10 ft
 Sump: 182.50 ft

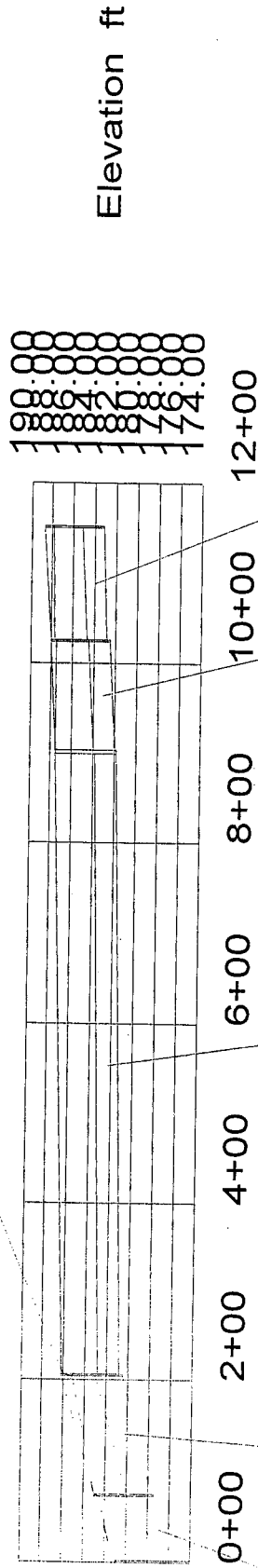
Junction: J-1
 Rim: 183.00 ft
 Sump: 177.50 ft

Inlet: I-1
 Rim: 188.80 ft
 Sump: 183.16 ft

Inlet: I-5
 Rim: 186.30 ft
 Sump: 180.60 ft

Outlet: Outlet
 Rim: 181.00 ft
 Sump: 174.00 ft

Inlet: I-3
 Rim: 187.50 ft
 Sump: 181.80 ft



Pipe: P-5
 Up Invert: 180.60 ft
 Dn Invert: 177.60 ft
 Length: 133.00 ft
 Size: 30 inch

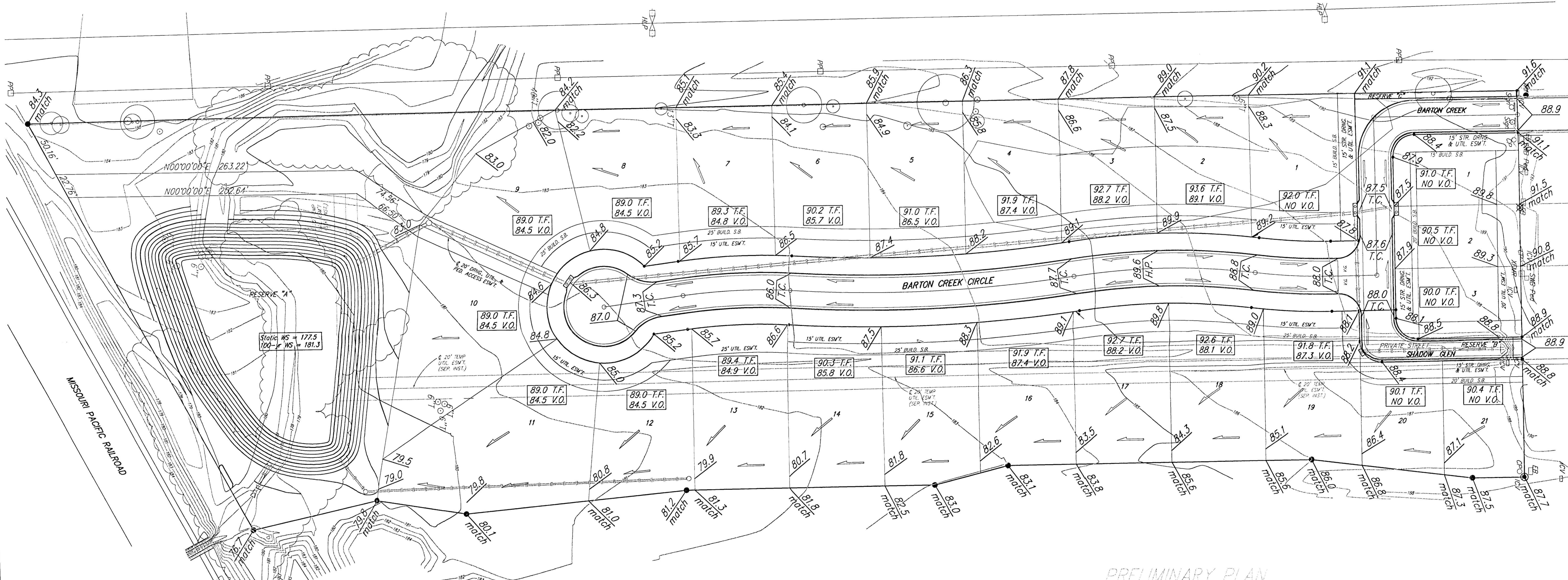
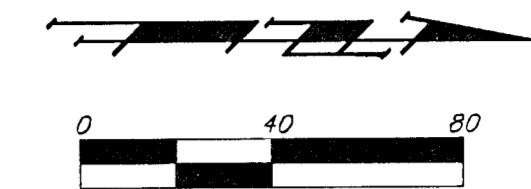
Pipe: P-6
 Up Invert: 177.50 ft
 Dn Invert: 174.00 ft
 Length: 73.00 ft
 Size: 30 inch

Pipe: P-4
 Up Invert: 181.80 ft
 Dn Invert: 180.80 ft
 Length: 695.00 ft
 Size: 24 inch

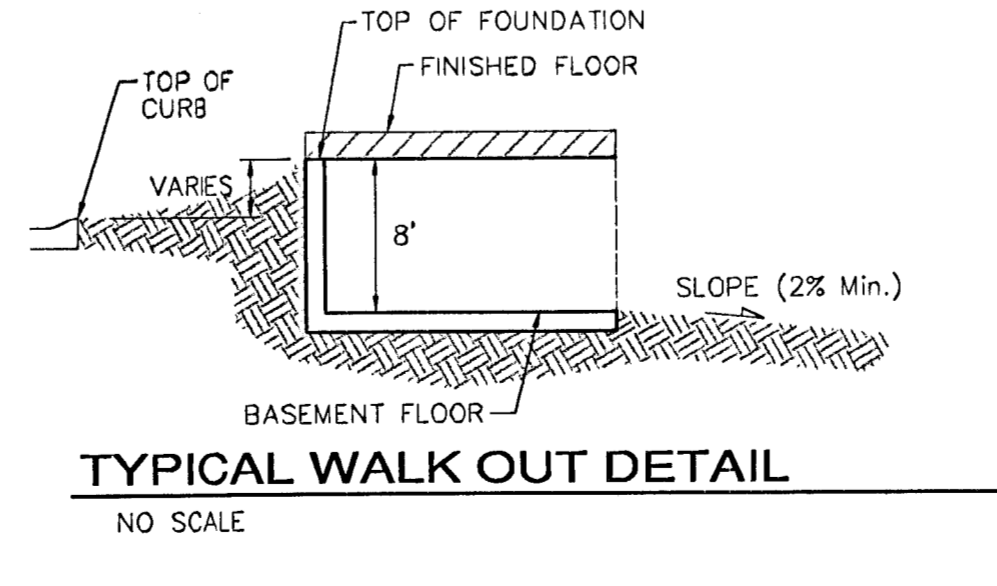
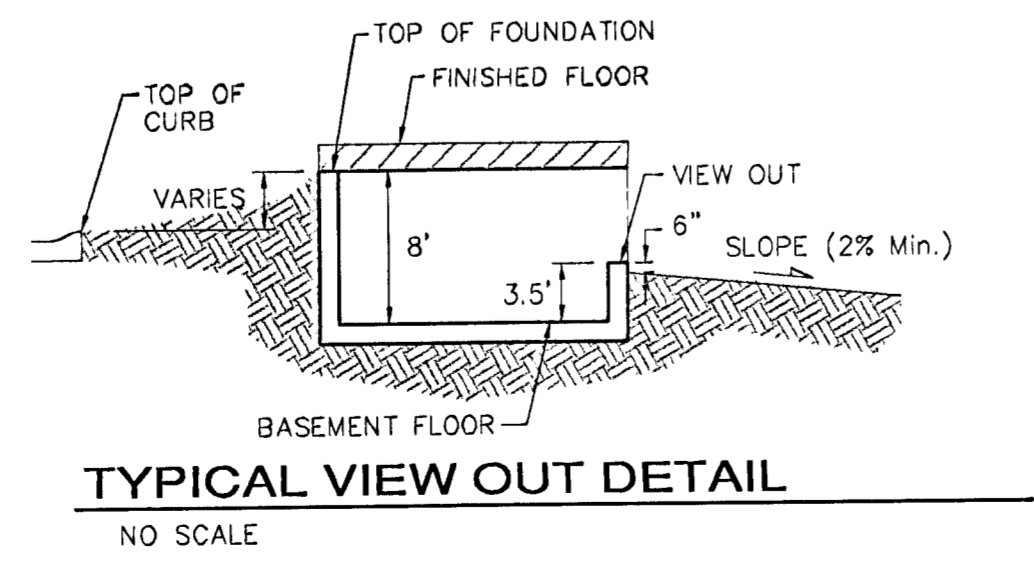
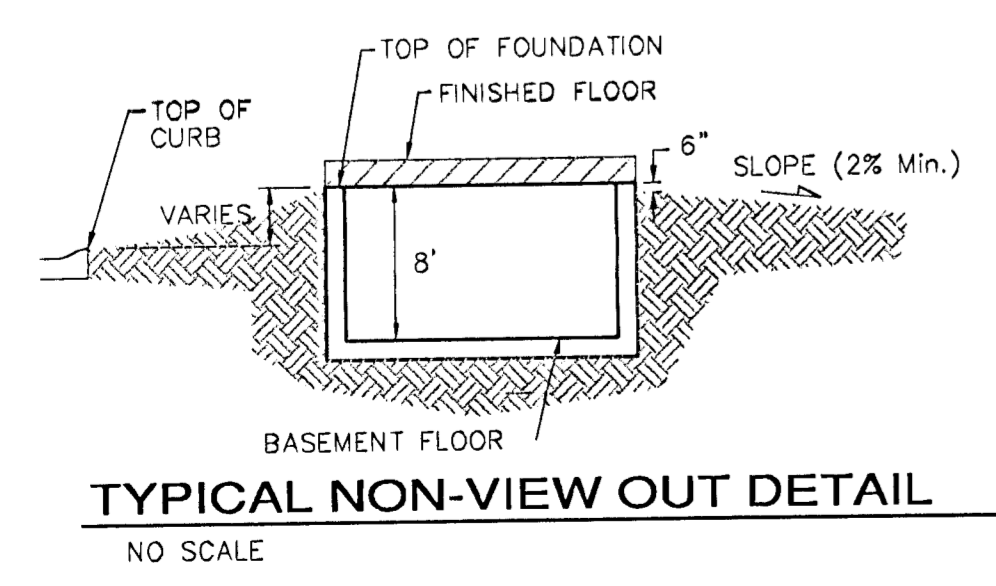
Pipe: P-1
 Up Invert: 183.16 ft
 Dn Invert: 182.80 ft
 Length: 126.00 ft
 Size: 24 inch

Pipe: P-2
 Up Invert: 182.50 ft
 Dn Invert: 182.00 ft
 Length: 124.00 ft
 Size: 24 inch

BENCHMARK:
 "□" Top of Curb, ENE Curb return,
 Barton Creek & Castle Pines St.,
 Elev. = 196.79 City Datum
 (1384.19 NGVD29)



PRELIMINARY PLAN
 NOT FOR CONSTRUCTION



NOTES:
 Proposed Top of Foundation Elevations Are Shown On Plans. Contractor to Set Finished Floor Elevations.
 All Street Elevations Shown on Plans Are for Top of Curb (Full-Height).
 This Grading Plan is Designed with View-Outs. Elevations Shown at Rear of House (XXX V.O.)
 Lot dimensions have been omitted on this plan, refer to the recorded plot for this information.

WILLOWBEND NORTH ESTATES 2ND ADD.
GRADING PLAN
 WICHITA, KANSAS

BAUGHMAN COMPANY P.A.
 ENGINEERING, SURVEYING, & PLANNING
 318-262-7271 • 315 ELLIS • WICHITA, KANSAS 67211

DESIGN	DRAWN	APPROVED	DATE	SCALE
BLG	BLG		04-21-03	NOTED

PROJECT NUMBER: _____ SHEET: **1** OF **1**