Appendix B
Links to Culvert Calculations

61	606+75	115	1254+00	181	1528+00
62	612+00	116	1260+50	182	1530+00
63	621+00	117	1268+50	183	1541+00
64	1033+00	118/119	1276+00	184	1543+50
65	1037+00	120	1292+00	185	1546+50
66	1043+00	121	1301+00	186	1548+10
67	1046+50	122	1305+50	187	1554+00
68	1050+80	123	1311+50		
69	1058+00	124	1316+50		
70	1066+00	125	1319+75		
71	1069+20	126	1321+00		
13	1071+50	127	1323+25		
14	1080+80	128	1329+75		
72	1082+00	129	1330+75		
73	1085+50	130	1332+00		
74	1090+00	131	1345+00		
75	1091+50	132	1350+00		
76	1094+50	133	1351+00		
77	1099+50	134	1358+00		
78/80	1104+50	135	1364+50		
79	1106+50	137	1368+00		
81	1111+45	138	1370+00		
82	1112+50	139	1376+00		
83/84/85/86	1119+50	140	1381+00		
87	1119+00	141	1381+00		
89	1127+00	142	1395+00		
15	1132+58	143	1400+00		
90	1138+00	144/145	1404+50		
91	1144+00	146	1413+00		
92/93	1152+00	148	1418+50		
94	1155+00	149	1421+00		
95	1157+00	150/152	1422+50		
96	1162+00	151/153/154	1422+00		
97	1165+00	155	1433+00		
16	1168+26	156	1433+00		
98	1175+00	157	1434+50		
17	1176+80	158	1437+50		
99	1180+00	159	1440+00		
100	1185+00	160	1447+00		
18	1190+17	161	1451+00		
101	1196+00	162	1456+00		
102	1201+00	163	1456+00		
103	1206+00	164	1461+25		
104	1218+00	165	1466+50		
105	1223+00	166/167/168	1469+50		
19	1225+00	169/170	1476+50		
106	1227+50	171/172	1483+50		
108	1230+10	173	1490+00		
109	1233+00	174	1495+00		
110	1238+00	175	1500+00		
111	1240+00	176/177	1502+50		
112	1242+50	178	1511+00		
113	1248+00	179	1517+00		
114	1250+50	180	1521+00		

REV. NO.	DATE	PDF PAGE NUMBERS REVISED
1	8/9/2018	170-178

CULVERT 61

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 61**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.34	4.8039
Grass	0.25	4.22	1.0553
Woods	0.15	17.25	2.5878
	Σ	**26.81**	8.4470

$C_{ave} = \frac{8.4470}{26.81} = 0.32$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	6.66	5.9922
Grass	0.25	2.90	0.7252
Woods	0.15	17.25	2.5878
	Σ	**26.81**	9.3052

$C_{ave} = \frac{9.3052}{26.81} = 0.35$

T_c =	26.72	min.
I_{05} =	4.04	in / hr
I_{10} =	4.44	in / hr
I_{25} =	5.02	in / hr
I_{50} =	5.49	in / hr
I_{100} =	5.95	in / hr

Pre Construction Runoff:

Q_{05} =	0.32	x	4.04	x	26.81	x	1	=	**34.15**	cfs
Q_{10} =	0.32	x	4.44	x	26.81	x	1	=	**37.48**	cfs
Q_{25} =	0.32	x	5.02	x	26.81	x	1.1	=	**46.66**	cfs
Q_{50} =	0.32	x	5.49	x	26.81	x	1.2	=	**55.67**	cfs
Q_{100} =	0.32	x	5.95	x	26.81	x	1.25	=	**62.81**	cfs

Post Construction Runoff:

Q_{05} =	0.35	x	4.04	x	26.81	x	1	=	**37.62**	cfs
Q_{10} =	0.35	x	4.44	x	26.81	x	1	=	**41.29**	cfs
Q_{25} =	0.35	x	5.02	x	26.81	x	1.1	=	**51.40**	cfs
Q_{50} =	0.35	x	5.49	x	26.81	x	1.2	=	**61.33**	cfs
Q_{100} =	0.35	x	5.95	x	26.81	x	1.25	=	**69.19**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 61	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0600**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.380**	+		=	**0.380**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**900**				
9	Watercourse slope, s		ft/ft	**0.0556**				
10	Average velocity, V (figure 3-1)		ft/s	**3.80**	**0.00**			
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.066**	+		=	**0.066**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+ **#DIV/0!**		=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.445**
							min	**26.72**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 46.66 cfs

Design Flow: 55.67 cfs

Maximum Flow: 62.81 cfs

Table 1 - Summary of Culvert Flows at Crossing: 606+75 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
318.30	46.66	46.66	0.00	1
318.35	48.27	48.27	0.00	1
318.41	49.89	49.89	0.00	1
318.47	51.50	51.50	0.00	1
318.52	53.12	53.12	0.00	1
318.58	54.73	54.73	0.00	1
318.61	55.67	55.67	0.00	1
318.68	57.97	57.97	0.00	1
318.74	59.58	59.58	0.00	1
318.79	61.20	61.20	0.00	1
318.84	62.81	62.81	0.00	1
327.00	209.68	209.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
46.66	46.66	318.30	2.878	0.0*	1-S2n	1.116	2.045	1.116	1.537	15.695	4.290
48.27	48.27	318.35	2.935	0.0*	1-S2n	1.136	2.081	1.136	1.564	15.850	4.330
49.89	49.89	318.41	2.991	0.0*	1-S2n	1.155	2.116	1.212	1.590	14.973	4.369
51.50	51.50	318.47	3.047	0.0*	1-S2n	1.174	2.150	1.212	1.616	15.456	4.406
53.12	53.12	318.52	3.102	0.0*	1-S2n	1.193	2.187	1.193	1.642	16.288	4.443
54.73	54.73	318.58	3.156	0.0*	1-S2n	1.212	2.221	1.212	1.666	16.422	4.479
55.67	55.67	318.61	3.188	0.0*	1-S2n	1.223	2.241	1.277	1.681	15.566	4.500
57.97	57.97	318.68	3.264	0.0*	1-S2n	1.249	2.287	1.249	1.715	16.696	4.549
59.58	59.58	318.74	3.317	0.0*	1-S2n	1.267	2.320	1.267	1.739	16.835	4.583
61.20	61.20	318.79	3.370	0.0*	1-S2n	1.284	2.355	1.341	1.762	15.979	4.616
62.81	62.81	318.84	3.423	0.0*	1-S2n	1.302	2.387	1.345	1.785	16.335	4.648

* Full Flow Headwater elevation is below inlet invert.

****

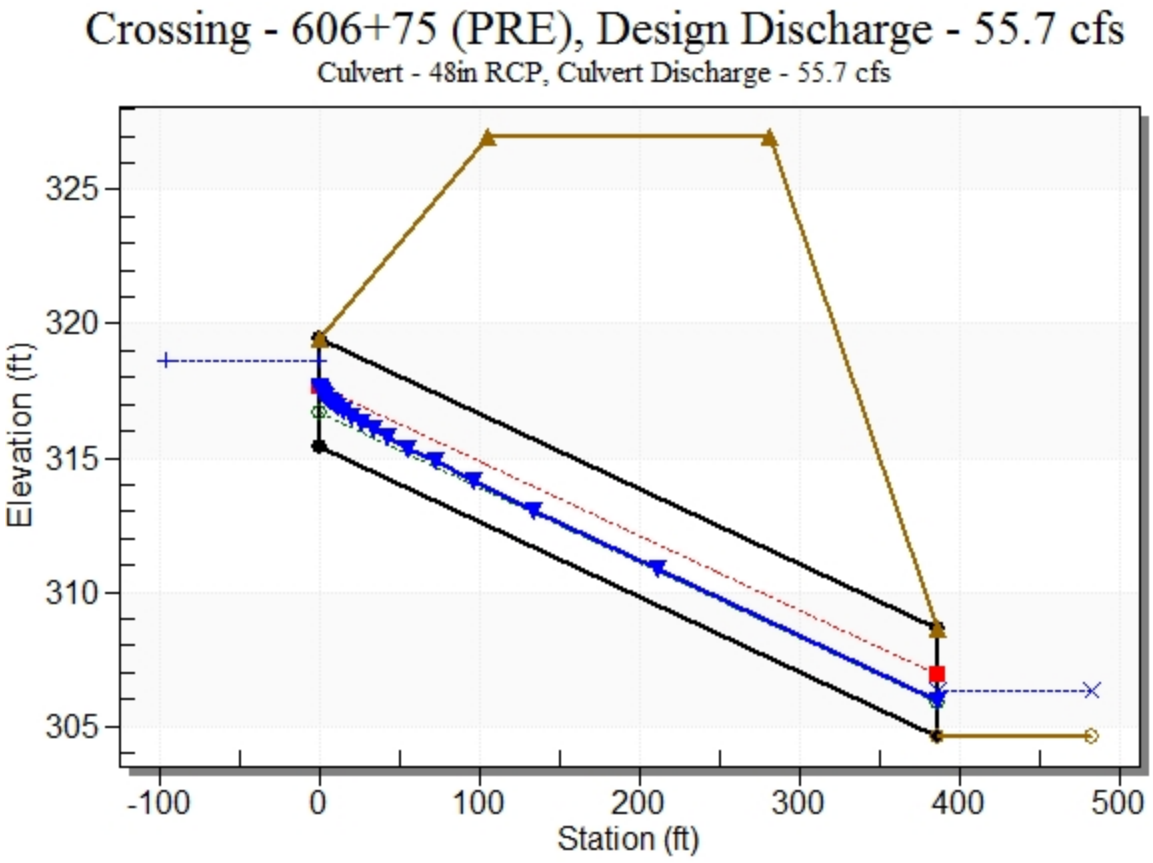
Straight Culvert

Inlet Elevation (invert): 315.42 ft, Outlet Elevation (invert): 304.64 ft

Culvert Length: 386.15 ft, Culvert Slope: 0.0279

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 315.42 ft

Outlet Station: 386.00 ft

Outlet Elevation: 304.64 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Table 3 - Downstream Channel Rating Curve (Crossing: 606+75 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
46.66	306.18	1.54	4.29	2.88	0.73
48.27	306.20	1.56	4.33	2.93	0.73
49.89	306.23	1.59	4.37	2.98	0.73
51.50	306.26	1.62	4.41	3.03	0.73
53.12	306.28	1.64	4.44	3.07	0.74
54.73	306.31	1.67	4.48	3.12	0.74
55.67	306.32	1.68	4.50	3.15	0.74
57.97	306.36	1.72	4.55	3.21	0.74
59.58	306.38	1.74	4.58	3.25	0.74
61.20	306.40	1.76	4.62	3.30	0.74
62.81	306.43	1.79	4.65	3.34	0.74

Tailwater Channel Data - 606+75 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 304.64 ft

Roadway Data for Crossing: 606+75 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 327.00 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 51.4 cfs

Design Flow: 61.33 cfs

Maximum Flow: 69.19 cfs

Table 1 - Summary of Culvert Flows at Crossing: 606+75 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
318.46	51.40	51.40	0.00	1
318.52	53.18	53.18	0.00	1
318.58	54.96	54.96	0.00	1
318.64	56.74	56.74	0.00	1
318.70	58.52	58.52	0.00	1
318.76	60.30	60.30	0.00	1
318.79	61.33	61.33	0.00	1
318.88	63.85	63.85	0.00	1
318.93	65.63	65.63	0.00	1
318.99	67.41	67.41	0.00	1
319.05	69.19	69.19	0.00	1
327.00	209.68	209.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
51.40	51.40	318.46	3.043	0.0*	1-S2n	1.173	2.148	1.212	1.614	15.421	4.404
53.18	53.18	318.52	3.104	0.0*	1-S2n	1.194	2.189	1.194	1.642	16.293	4.444
54.96	54.96	318.58	3.164	0.0*	1-S2n	1.215	2.226	1.274	1.670	15.412	4.484
56.74	56.74	318.64	3.223	0.0*	1-S2n	1.235	2.262	1.278	1.697	15.842	4.523
58.52	58.52	318.70	3.282	0.0*	1-S2n	1.255	2.298	1.255	1.723	16.744	4.560
60.30	60.30	318.76	3.340	0.0*	1-S2n	1.274	2.334	1.274	1.749	16.895	4.597
61.33	61.33	318.79	3.374	0.0*	1-S2n	1.286	2.358	1.342	1.764	16.005	4.618
63.85	63.85	318.88	3.457	0.0*	1-S2n	1.314	2.408	1.314	1.800	17.146	4.668
65.63	65.63	318.93	3.515	0.0*	1-S2n	1.333	2.442	1.333	1.825	17.273	4.703
67.41	67.41	318.99	3.572	0.0*	1-S2n	1.352	2.476	1.412	1.849	16.414	4.736
69.19	69.19	319.05	3.630	0.0*	1-S2n	1.371	2.509	1.419	1.873	16.724	4.769

* Full Flow Headwater elevation is below inlet invert.

****

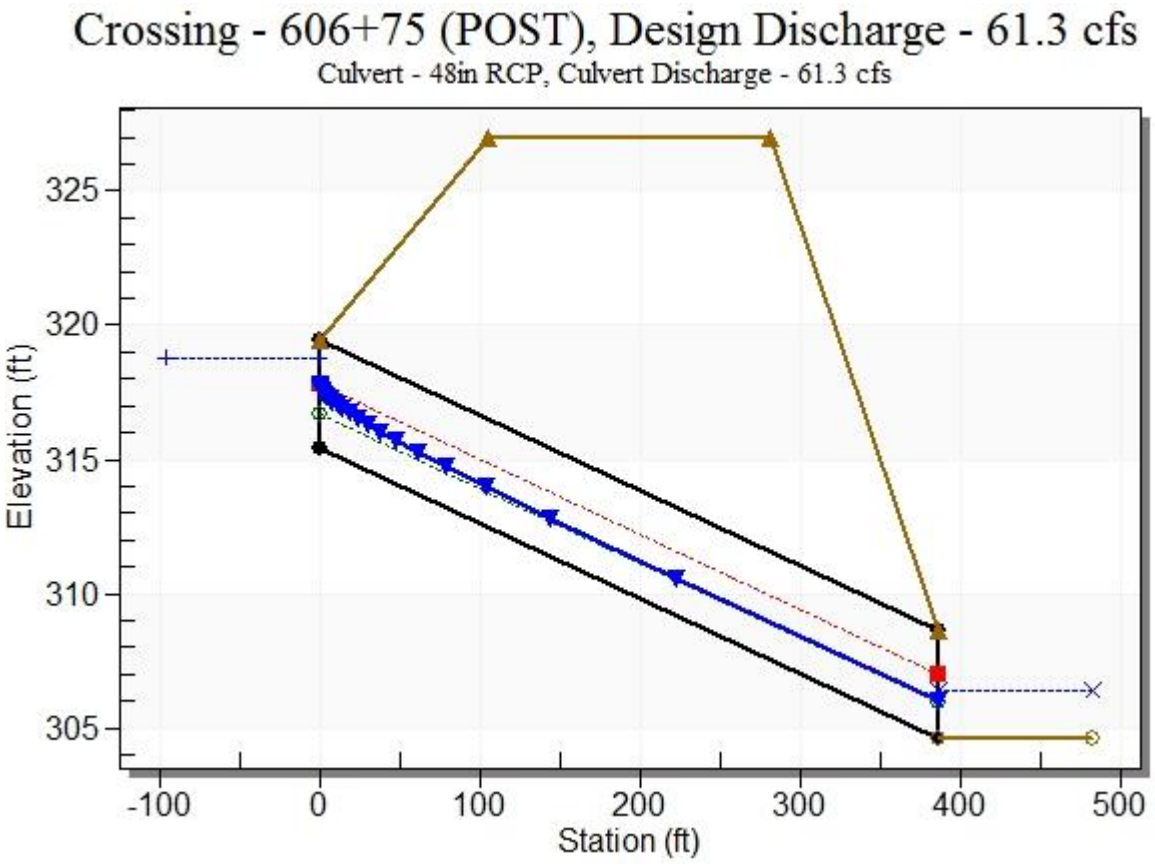
Straight Culvert

Inlet Elevation (invert): 315.42 ft, Outlet Elevation (invert): 304.64 ft

Culvert Length: 386.15 ft, Culvert Slope: 0.0279

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 315.42 ft

Outlet Station: 386.00 ft

Outlet Elevation: 304.64 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Table 3 - Downstream Channel Rating Curve (Crossing: 606+75 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
51.40	306.25	1.61	4.40	3.02	0.73
53.18	306.28	1.64	4.44	3.07	0.74
54.96	306.31	1.67	4.48	3.13	0.74
56.74	306.34	1.70	4.52	3.18	0.74
58.52	306.36	1.72	4.56	3.23	0.74
60.30	306.39	1.75	4.60	3.27	0.74
61.33	306.40	1.76	4.62	3.30	0.74
63.85	306.44	1.80	4.67	3.37	0.74
65.63	306.46	1.82	4.70	3.42	0.75
67.41	306.49	1.85	4.74	3.46	0.75
69.19	306.51	1.87	4.77	3.51	0.75

Tailwater Channel Data - 606+75 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 304.64 ft

Roadway Data for Crossing: 606+75 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 327.00 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

CULVERT 62

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 62**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4283
Grass	0.25	0.81	0.2015
Woods	0.15	0.00	0.0000
	Σ	**1.28**	0.6298

$C_{ave} = \frac{0.6298}{1.28} = 0.49$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.81	0.7254
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.81**	0.7254

$C_{ave} = \frac{0.7254}{0.81} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.42	in / hr								
I_{10} =	7.12	in / hr								
I_{25} =	8.16	in / hr								
I_{50} =	9.03	in / hr								
I_{100} =	9.88	in / hr								

Pre Construction Runoff:

Q_{05} =	0.49	**x**	6.42	**x**	1.28	**x**	1	=	**4.04**	cfs
Q_{10} =	0.49	**x**	7.12	**x**	1.28	**x**	1	=	**4.48**	cfs
Q_{25} =	0.49	**x**	8.16	**x**	1.28	**x**	1.1	=	**5.66**	cfs
Q_{50} =	0.49	**x**	9.03	**x**	1.28	**x**	1.2	=	**6.82**	cfs
Q_{100} =	0.49	**x**	9.88	**x**	1.28	**x**	1.25	=	**7.78**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.42	**x**	0.81	**x**	1	=	**4.66**	cfs
Q_{10} =	0.90	**x**	7.12	**x**	0.81	**x**	1	=	**5.16**	cfs
Q_{25} =	0.90	**x**	8.16	**x**	0.81	**x**	1.1	=	**6.51**	cfs
Q_{50} =	0.90	**x**	9.03	**x**	0.81	**x**	1.2	=	**7.86**	cfs
Q_{100} =	0.90	**x**	9.88	**x**	0.81	**x**	1.25	=	**8.96**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.66 cfs

Design Flow: 6.82 cfs

Maximum Flow: 7.78 cfs

Table 1 - Summary of Culvert Flows at Crossing: 612+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
336.87	5.66	5.66	0.00	1
336.94	5.87	5.87	0.00	1
337.00	6.08	6.08	0.00	1
337.07	6.30	6.30	0.00	1
337.14	6.51	6.51	0.00	1
337.21	6.72	6.72	0.00	1
337.25	6.82	6.82	0.00	1
337.36	7.14	7.14	0.00	1
337.40	7.36	7.25	0.05	15
337.41	7.57	7.28	0.26	5
337.42	7.78	7.29	0.45	4
337.40	7.24	7.24	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.66	5.66	336.87	1.665	0.0*	5-S2n	0.584	0.960	0.608	0.561	9.235	3.230
5.87	5.87	336.94	1.727	0.0*	5-S2n	0.597	0.977	0.622	0.572	9.322	3.264
6.08	6.08	337.00	1.792	0.0*	5-S2n	0.609	0.993	0.635	0.583	9.404	3.297
6.30	6.30	337.07	1.859	0.0*	5-S2n	0.622	1.009	0.648	0.593	9.485	3.329
6.51	6.51	337.14	1.929	0.0*	5-S2n	0.634	1.024	0.661	0.604	9.564	3.359
6.72	6.72	337.21	2.002	0.0*	5-S2n	0.646	1.039	0.674	0.614	9.641	3.390
6.82	6.82	337.25	2.037	0.0*	5-S2n	0.652	1.046	0.680	0.619	9.677	3.404
7.14	7.14	337.36	2.155	0.0*	5-S2n	0.671	1.066	0.700	0.634	9.792	3.448
7.36	7.25	337.40	2.195	0.0*	5-S2n	0.677	1.073	0.706	0.644	9.829	3.476
7.57	7.28	337.41	2.204	0.0*	5-S2n	0.679	1.075	0.702	0.653	9.932	3.504
7.78	7.29	337.42	2.211	0.0*	5-S2n	0.680	1.076	0.703	0.663	9.937	3.531

* Full Flow Headwater elevation is below inlet invert.

****

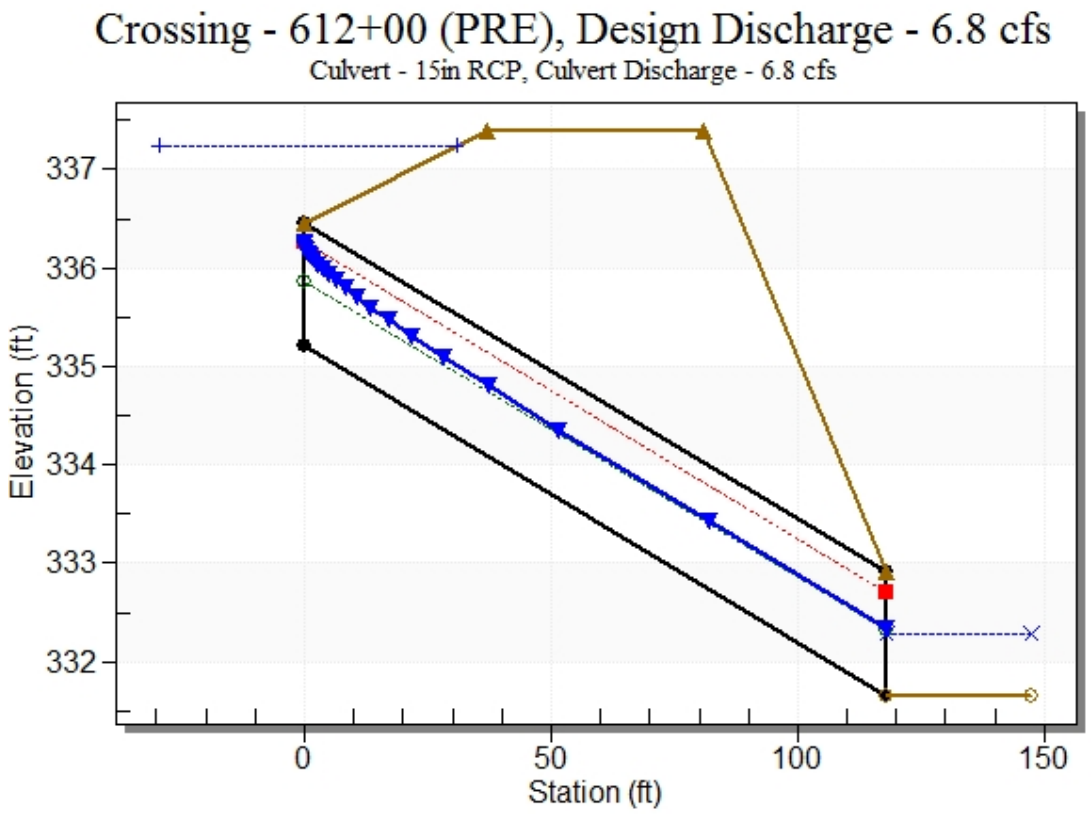
Straight Culvert

Inlet Elevation (invert): 335.21 ft, Outlet Elevation (invert): 331.66 ft

Culvert Length: 118.05 ft, Culvert Slope: 0.0301

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 335.21 ft

Outlet Station: 118.00 ft

Outlet Elevation: 331.66 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 612+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.66	332.22	0.56	3.23	2.10	0.89
5.87	332.23	0.57	3.26	2.14	0.89
6.08	332.24	0.58	3.30	2.18	0.89
6.30	332.25	0.59	3.33	2.22	0.89
6.51	332.26	0.60	3.36	2.26	0.89
6.72	332.27	0.61	3.39	2.30	0.90
6.82	332.28	0.62	3.40	2.32	0.90
7.14	332.29	0.63	3.45	2.37	0.90
7.36	332.30	0.64	3.48	2.41	0.90
7.57	332.31	0.65	3.50	2.45	0.90
7.78	332.32	0.66	3.53	2.48	0.90

Tailwater Channel Data - 612+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 331.66 ft

Roadway Data for Crossing: 612+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 337.40 ft

Roadway Surface: Paved

Roadway Top Width: 44.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.51 cfs

Design Flow: 7.86 cfs

Maximum Flow: 8.96 cfs

Table 1 - Summary of Culvert Flows at Crossing: 612+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
337.14	6.51	6.51	0.00	1
337.22	6.75	6.75	0.00	1
337.31	7.00	7.00	0.00	1
337.38	7.25	7.19	0.00	27
337.41	7.49	7.27	0.18	9
337.42	7.74	7.29	0.40	4
337.42	7.86	7.30	0.51	3
337.43	8.23	7.32	0.87	4
337.44	8.47	7.34	1.09	3
337.44	8.71	7.35	1.32	3
337.45	8.96	7.36	1.56	3
337.40	7.24	7.24	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.51	6.51	337.14	1.930	0.0*	5-S2n	0.634	1.024	0.661	0.604	9.565	3.360
6.75	6.75	337.22	2.014	0.0*	5-S2n	0.648	1.041	0.676	0.616	9.654	3.395
7.00	7.00	337.31	2.102	0.0*	5-S2n	0.663	1.057	0.691	0.627	9.740	3.429
7.25	7.19	337.38	2.172	0.0*	5-S2n	0.674	1.069	0.702	0.639	9.808	3.462
7.49	7.27	337.41	2.201	0.0*	5-S2n	0.678	1.074	0.701	0.650	9.930	3.494
7.74	7.29	337.42	2.209	0.0*	5-S2n	0.679	1.075	0.703	0.661	9.935	3.525
7.86	7.30	337.42	2.213	0.0*	5-S2n	0.680	1.076	0.703	0.666	9.938	3.541
8.23	7.32	337.43	2.223	0.0*	5-S2n	0.681	1.077	0.705	0.682	9.945	3.585
8.47	7.34	337.44	2.228	0.0*	5-S2n	0.682	1.078	0.706	0.692	9.948	3.615
8.71	7.35	337.44	2.233	0.0*	5-S2n	0.683	1.079	0.707	0.703	9.952	3.643
8.96	7.36	337.45	2.238	0.0*	5-S2n	0.684	1.080	0.707	0.713	9.956	3.670

* Full Flow Headwater elevation is below inlet invert.

****

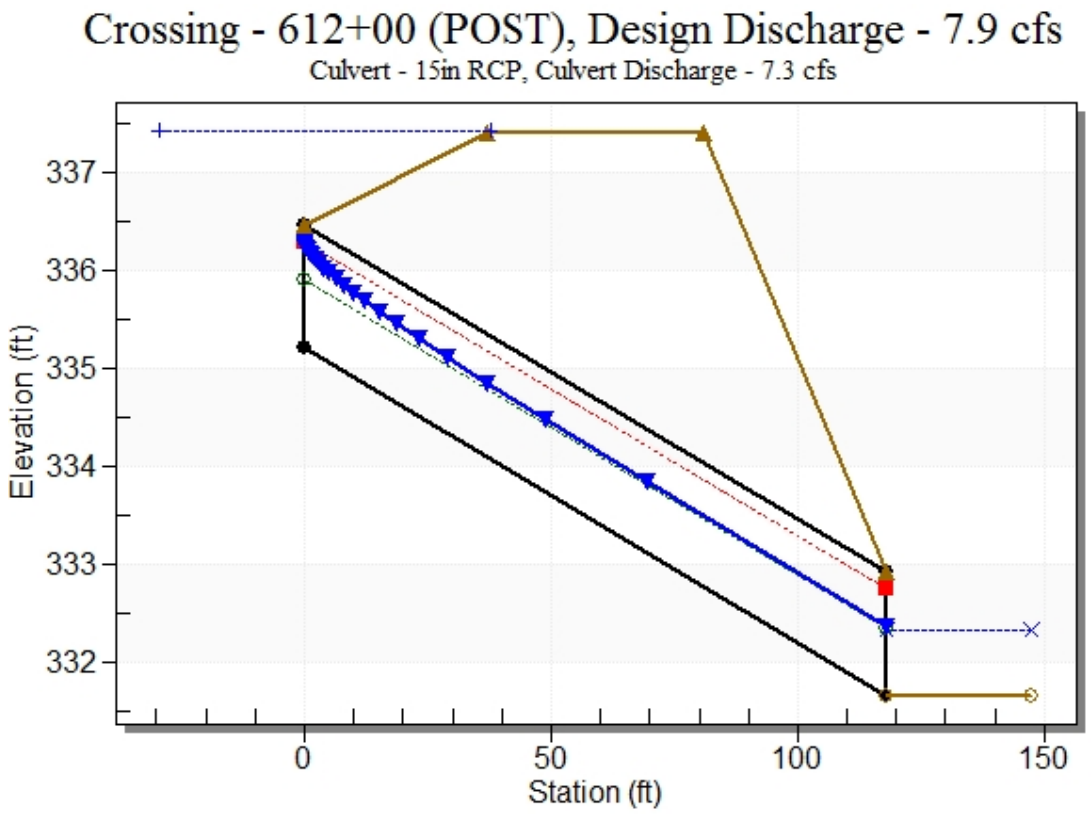
Straight Culvert

Inlet Elevation (invert): 335.21 ft, Outlet Elevation (invert): 331.66 ft

Culvert Length: 118.05 ft, Culvert Slope: 0.0301

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 335.21 ft

Outlet Station: 118.00 ft

Outlet Elevation: 331.66 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 612+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.51	332.26	0.60	3.36	2.26	0.89
6.75	332.28	0.62	3.39	2.31	0.90
7.00	332.29	0.63	3.43	2.35	0.90
7.25	332.30	0.64	3.46	2.39	0.90
7.49	332.31	0.65	3.49	2.43	0.90
7.74	332.32	0.66	3.53	2.47	0.90
7.86	332.33	0.67	3.54	2.49	0.90
8.23	332.34	0.68	3.59	2.55	0.91
8.47	332.35	0.69	3.61	2.59	0.91
8.71	332.36	0.70	3.64	2.63	0.91
8.96	332.37	0.71	3.67	2.67	0.91

Tailwater Channel Data - 612+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 331.66 ft

Roadway Data for Crossing: 612+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 337.40 ft

Roadway Surface: Paved

Roadway Top Width: 44.00 ft

CULVERT 63

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 63**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.33	0.2945
Grass	0.25	0.33	0.0816
Woods	0.15	0.23	0.0343
	Σ	**0.88**	0.4104

$C_{ave} = \frac{0.4104}{0.88} = 0.47$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.50	0.4514
Grass	0.25	0.15	0.0381
Woods	0.15	0.23	0.0343
	Σ	**0.88**	0.5237

$C_{ave} = \frac{0.5237}{0.88} = 0.59$

T_c =	5.00	min.								
I_{05} =	6.42	in / hr								
I_{10} =	7.12	in / hr								
I_{25} =	8.16	in / hr								
I_{50} =	9.03	in / hr								
I_{100} =	9.88	in / hr								

Pre Construction Runoff:

Q_{05} =	0.47	**x**	6.42	**x**	0.88	**x**	1	=	**2.63**	cfs
Q_{10} =	0.47	**x**	7.12	**x**	0.88	**x**	1	=	**2.92**	cfs
Q_{25} =	0.47	**x**	8.16	**x**	0.88	**x**	1.1	=	**3.69**	cfs
Q_{50} =	0.47	**x**	9.03	**x**	0.88	**x**	1.2	=	**4.45**	cfs
Q_{100} =	0.47	**x**	9.88	**x**	0.88	**x**	1.25	=	**5.07**	cfs

Post Construction Runoff:

Q_{05} =	0.59	**x**	6.42	**x**	0.88	**x**	1	=	**3.36**	cfs
Q_{10} =	0.59	**x**	7.12	**x**	0.88	**x**	1	=	**3.73**	cfs
Q_{25} =	0.59	**x**	8.16	**x**	0.88	**x**	1.1	=	**4.70**	cfs
Q_{50} =	0.59	**x**	9.03	**x**	0.88	**x**	1.2	=	**5.67**	cfs
Q_{100} =	0.59	**x**	9.88	**x**	0.88	**x**	1.25	=	**6.47**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.69 cfs

Design Flow: 4.45 cfs

Maximum Flow: 5.07 cfs

Table 1 - Summary of Culvert Flows at Crossing: 621+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
349.29	3.69	3.69	0.00	1
349.31	3.83	3.83	0.00	1
349.33	3.97	3.97	0.00	1
349.34	4.10	4.10	0.00	1
349.36	4.24	4.24	0.00	1
349.38	4.38	4.38	0.00	1
349.39	4.45	4.45	0.00	1
349.42	4.66	4.66	0.00	1
349.44	4.79	4.79	0.00	1
349.46	4.93	4.93	0.00	1
349.48	5.07	5.07	0.00	1
357.14	42.50	42.50	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.69	3.69	349.29	0.910	0.0*	1-S2n	0.407	0.668	0.414	0.469	7.566	2.678
3.83	3.83	349.31	0.928	0.0*	1-S2n	0.414	0.681	0.422	0.478	7.659	2.706
3.97	3.97	349.33	0.946	0.0*	1-S2n	0.421	0.694	0.431	0.488	7.693	2.735
4.10	4.10	349.34	0.964	0.0*	1-S2n	0.428	0.707	0.440	0.497	7.752	2.762
4.24	4.24	349.36	0.981	0.0*	1-S2n	0.435	0.720	0.447	0.505	7.831	2.788
4.38	4.38	349.38	0.998	0.0*	1-S2n	0.442	0.732	0.454	0.514	7.927	2.814
4.45	4.45	349.39	1.008	0.0*	1-S2n	0.446	0.738	0.446	0.518	8.248	2.826
4.66	4.66	349.42	1.039	0.0*	1-S2n	0.456	0.757	0.465	0.531	8.100	2.863
4.79	4.79	349.44	1.059	0.0*	1-S2n	0.463	0.765	0.472	0.539	8.170	2.887
4.93	4.93	349.46	1.078	0.0*	1-S2n	0.470	0.777	0.480	0.548	8.206	2.910
5.07	5.07	349.48	1.098	0.0*	1-S2n	0.476	0.789	0.488	0.556	8.255	2.933

* Full Flow Headwater elevation is below inlet invert.

****

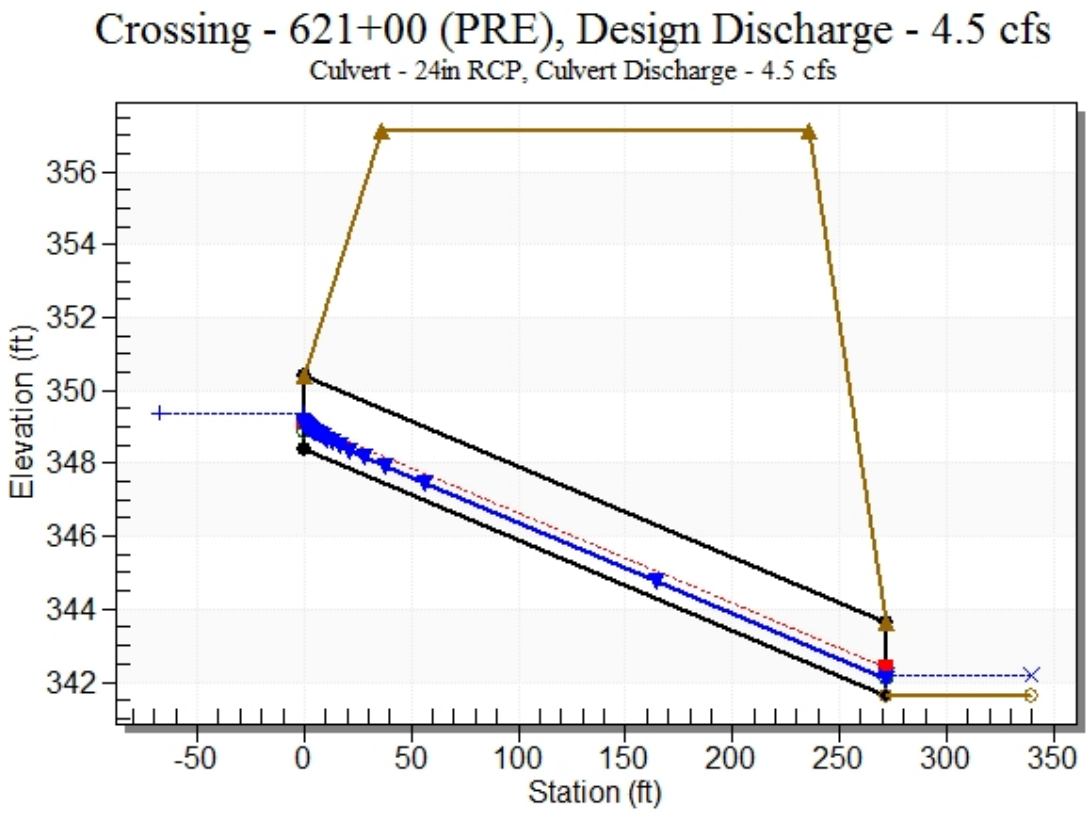
Straight Culvert

Inlet Elevation (invert): 348.38 ft, Outlet Elevation (invert): 341.64 ft

Culvert Length: 272.08 ft, Culvert Slope: 0.0248

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 348.38 ft

Outlet Station: 272.00 ft

Outlet Elevation: 341.64 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 621+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.69	342.11	0.47	2.68	1.46	0.79
3.83	342.12	0.48	2.71	1.49	0.79
3.97	342.13	0.49	2.73	1.52	0.80
4.10	342.14	0.50	2.76	1.55	0.80
4.24	342.15	0.51	2.79	1.58	0.80
4.38	342.15	0.51	2.81	1.60	0.80
4.45	342.16	0.52	2.83	1.62	0.80
4.66	342.17	0.53	2.86	1.66	0.80
4.79	342.18	0.54	2.89	1.68	0.81
4.93	342.19	0.55	2.91	1.71	0.81
5.07	342.20	0.56	2.93	1.73	0.81

Tailwater Channel Data - 621+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 341.64 ft

Roadway Data for Crossing: 621+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 357.14 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.7 cfs

Design Flow: 5.67 cfs

Maximum Flow: 6.47 cfs

Table 1 - Summary of Culvert Flows at Crossing: 621+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
349.43	4.70	4.70	0.00	1
349.45	4.88	4.88	0.00	1
349.48	5.05	5.05	0.00	1
349.50	5.23	5.23	0.00	1
349.52	5.41	5.41	0.00	1
349.55	5.59	5.59	0.00	1
349.56	5.67	5.67	0.00	1
349.59	5.94	5.94	0.00	1
349.62	6.12	6.12	0.00	1
349.64	6.29	6.29	0.00	1
349.66	6.47	6.47	0.00	1
357.14	42.50	42.50	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.70	4.70	349.43	1.045	0.0*	1-S2n	0.459	0.760	0.466	0.534	8.140	2.871
4.88	4.88	349.45	1.070	0.0*	1-S2n	0.467	0.772	0.477	0.544	8.190	2.901
5.05	5.05	349.48	1.095	0.0*	1-S2n	0.475	0.788	0.487	0.555	8.248	2.930
5.23	5.23	349.50	1.120	0.0*	1-S2n	0.484	0.803	0.496	0.565	8.327	2.959
5.41	5.41	349.52	1.144	0.0*	1-S2n	0.492	0.818	0.504	0.575	8.421	2.987
5.59	5.59	349.55	1.168	0.0*	1-S2n	0.500	0.832	0.512	0.585	8.485	3.014
5.67	5.67	349.56	1.179	0.0*	1-S2n	0.504	0.839	0.515	0.589	8.538	3.027
5.94	5.94	349.59	1.214	0.0*	1-S2n	0.516	0.860	0.516	0.604	8.916	3.066
6.12	6.12	349.62	1.237	0.0*	1-S2n	0.524	0.874	0.536	0.613	8.730	3.092
6.29	6.29	349.64	1.260	0.0*	1-S2n	0.531	0.887	0.544	0.622	8.790	3.116
6.47	6.47	349.66	1.282	0.0*	1-S2n	0.539	0.901	0.552	0.631	8.860	3.141

* Full Flow Headwater elevation is below inlet invert.

****

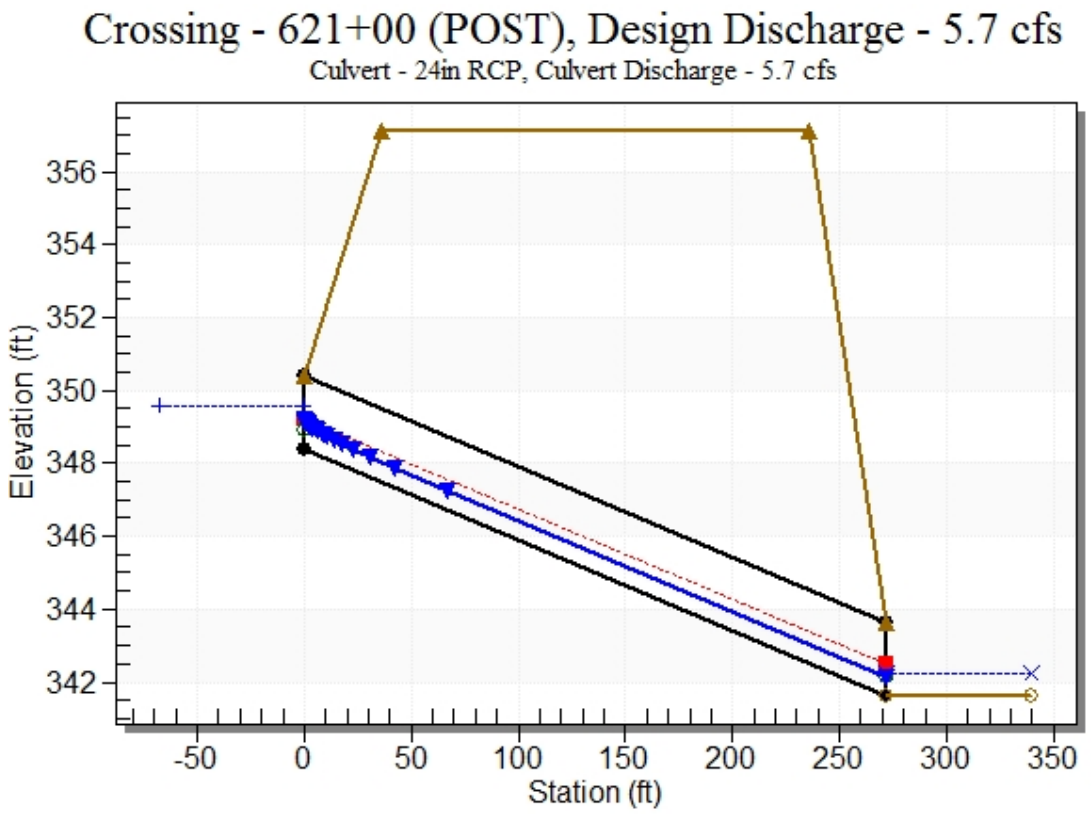
Straight Culvert

Inlet Elevation (invert): 348.38 ft, Outlet Elevation (invert): 341.64 ft

Culvert Length: 272.08 ft, Culvert Slope: 0.0248

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 348.38 ft

Outlet Station: 272.00 ft

Outlet Elevation: 341.64 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 621+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.70	342.17	0.53	2.87	1.67	0.80
4.88	342.18	0.54	2.90	1.70	0.81
5.05	342.19	0.55	2.93	1.73	0.81
5.23	342.20	0.56	2.96	1.76	0.81
5.41	342.21	0.57	2.99	1.79	0.81
5.59	342.22	0.58	3.01	1.82	0.81
5.67	342.23	0.59	3.03	1.84	0.81
5.94	342.24	0.60	3.07	1.88	0.82
6.12	342.25	0.61	3.09	1.91	0.82
6.29	342.26	0.62	3.12	1.94	0.82
6.47	342.27	0.63	3.14	1.97	0.82

Tailwater Channel Data - 621+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 341.64 ft

Roadway Data for Crossing: 621+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 357.14 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

CULVERT 64

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 64**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5909
Grass	0.25	0.74	0.1841
Woods	0.15		0.0000
	Σ	**1.39**	0.7750

$C_{ave} = \frac{0.7750}{1.39} =$ **0.56**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.74	0.6626
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.74**	0.6626

$C_{ave} = \frac{0.6626}{0.74} =$ **0.90**

T_c =	5.00	min.
I_{05} =	6.42	in / hr
I_{10} =	7.12	in / hr
I_{25} =	8.16	in / hr
I_{50} =	9.03	in / hr
I_{100} =	9.88	in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.42	x	1.39	x	1	=	**4.98**	cfs
Q_{10} =	0.56	x	7.12	x	1.39	x	1	=	**5.51**	cfs
Q_{25} =	0.56	x	8.16	x	1.39	x	1.1	=	**6.96**	cfs
Q_{50} =	0.56	x	9.03	x	1.39	x	1.2	=	**8.40**	cfs
Q_{100} =	0.56	x	9.88	x	1.39	x	1.25	=	**9.57**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.42	x	0.74	x	1	=	**4.25**	cfs
Q_{10} =	0.90	x	7.12	x	0.74	x	1	=	**4.71**	cfs
Q_{25} =	0.90	x	8.16	x	0.74	x	1.1	=	**5.95**	cfs
Q_{50} =	0.90	x	9.03	x	0.74	x	1.2	=	**7.18**	cfs
Q_{100} =	0.90	x	9.88	x	0.74	x	1.25	=	**8.19**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.96 cfs

Design Flow: 8.4 cfs

Maximum Flow: 9.57 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1033+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
290.42	6.96	6.96	0.00	1
290.51	7.22	7.22	0.00	1
290.61	7.48	7.48	0.00	1
290.72	7.74	7.74	0.00	1
290.83	8.00	8.00	0.00	1
290.94	8.27	8.27	0.00	1
291.00	8.40	8.40	0.00	1
291.18	8.79	8.79	0.00	1
291.30	9.05	9.05	0.00	1
291.43	9.31	9.31	0.00	1
291.56	9.57	9.57	0.00	1
292.18	10.71	10.71	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.96	6.96	290.42	2.096	0.0*	5-S2n	0.831	1.055	0.860	0.505	7.505	4.579
7.22	7.22	290.51	2.193	1.622	5-S2n	0.854	1.071	0.884	0.515	7.566	4.628
7.48	7.48	290.61	2.294	1.749	5-S2n	0.878	1.087	0.909	0.525	7.600	4.675
7.74	7.74	290.72	2.398	1.880	5-S2n	0.903	1.101	0.935	0.535	7.645	4.720
8.00	8.00	290.83	2.507	2.015	5-S2n	0.929	1.115	0.961	0.544	7.698	4.765
8.27	8.27	290.94	2.620	2.153	5-S2n	0.958	1.127	0.989	0.553	7.736	4.809
8.40	8.40	291.00	2.680	2.226	5-S2n	0.973	1.133	1.005	0.558	7.737	4.831
8.79	8.79	291.18	2.857	2.444	7-M2c	1.250	1.148	1.148	0.571	7.448	4.893
9.05	9.05	291.30	2.981	2.540	7-M2c	1.250	1.156	1.156	0.580	7.633	4.933
9.31	9.31	291.43	3.109	2.671	7-M2c	1.250	1.163	1.163	0.589	7.823	4.972
9.57	9.57	291.56	3.240	2.887	7-M2c	1.250	1.175	1.175	0.598	7.995	5.011

* Full Flow Headwater elevation is below inlet invert.

****

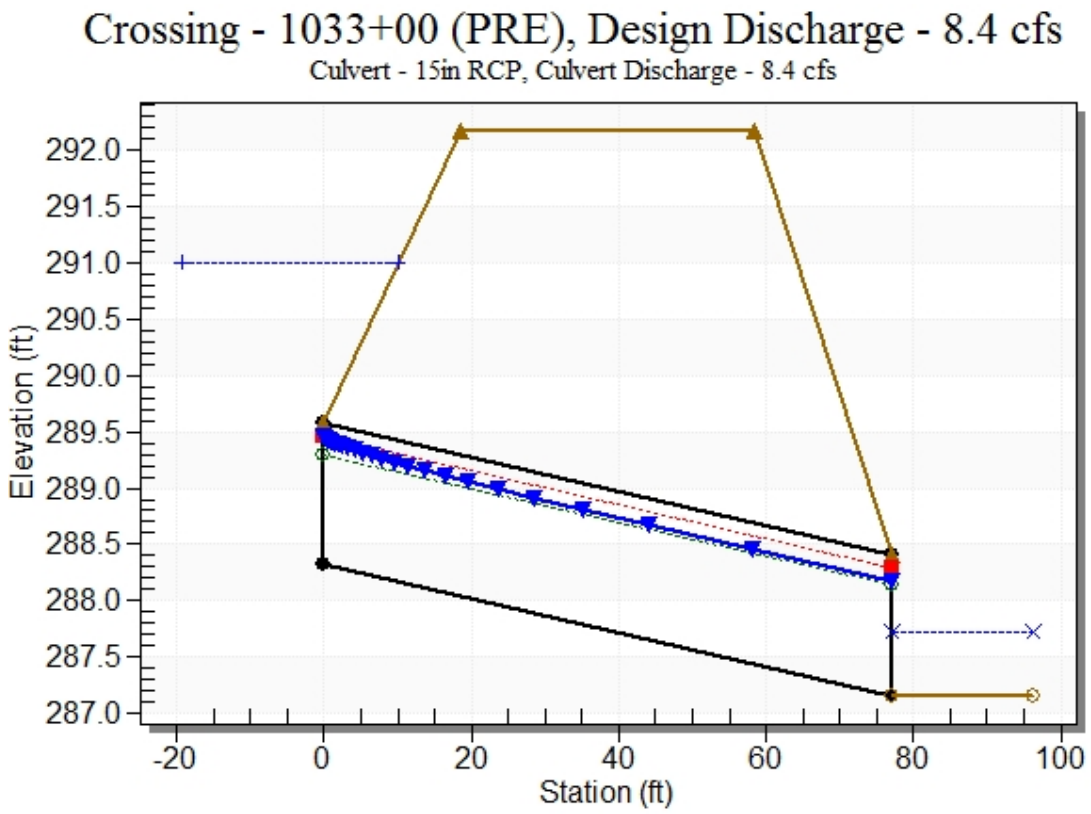
Straight Culvert

Inlet Elevation (invert): 288.32 ft, Outlet Elevation (invert): 287.16 ft

Culvert Length: 77.01 ft, Culvert Slope: 0.0151

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 288.32 ft

Outlet Station: 77.00 ft

Outlet Elevation: 287.16 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1033+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.96	287.66	0.50	4.58	1.89	1.31
7.22	287.67	0.51	4.63	1.93	1.32
7.48	287.68	0.52	4.68	1.96	1.32
7.74	287.69	0.53	4.72	2.00	1.32
8.00	287.70	0.54	4.77	2.04	1.32
8.27	287.71	0.55	4.81	2.07	1.33
8.40	287.72	0.56	4.83	2.09	1.33
8.79	287.73	0.57	4.89	2.14	1.33
9.05	287.74	0.58	4.93	2.17	1.33
9.31	287.75	0.59	4.97	2.21	1.34
9.57	287.76	0.60	5.01	2.24	1.34

Tailwater Channel Data - 1033+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0400

Channel Invert Elevation: 287.16 ft

Roadway Data for Crossing: 1033+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 292.18 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.95 cfs

Design Flow: 7.18 cfs

Maximum Flow: 8.19 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1033+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
290.08	5.95	5.95	0.00	1
290.15	6.17	6.17	0.00	1
290.22	6.40	6.40	0.00	1
290.30	6.62	6.62	0.00	1
290.38	6.85	6.85	0.00	1
290.46	7.07	7.07	0.00	1
290.50	7.18	7.18	0.00	1
290.63	7.52	7.52	0.00	1
290.72	7.74	7.74	0.00	1
290.81	7.97	7.97	0.00	1
290.91	8.19	8.19	0.00	1
292.18	10.71	10.71	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.95	5.95	290.08	1.760	0.0*	5-S2n	0.745	0.983	0.773	0.464	7.241	4.377
6.17	6.17	290.15	1.830	1.151	5-S2n	0.763	1.000	0.792	0.474	7.309	4.424
6.40	6.40	290.22	1.902	1.246	5-S2n	0.782	1.016	0.811	0.483	7.368	4.470
6.62	6.62	290.30	1.977	1.345	5-S2n	0.801	1.032	0.829	0.492	7.435	4.514
6.85	6.85	290.38	2.055	1.446	5-S2n	0.821	1.047	0.850	0.501	7.477	4.557
7.07	7.07	290.46	2.137	1.551	5-S2n	0.840	1.062	0.871	0.509	7.519	4.599
7.18	7.18	290.50	2.178	0.0*	5-S2n	0.850	1.069	0.881	0.513	7.544	4.620
7.52	7.52	290.63	2.308	1.767	5-S2n	0.882	1.089	0.913	0.526	7.607	4.681
7.74	7.74	290.72	2.398	1.880	5-S2n	0.903	1.101	0.935	0.534	7.645	4.721
7.97	7.97	290.81	2.491	1.995	5-S2n	0.926	1.113	0.957	0.543	7.691	4.759
8.19	8.19	290.91	2.587	2.113	5-S2n	0.949	1.124	0.981	0.551	7.723	4.797

* Full Flow Headwater elevation is below inlet invert.

****

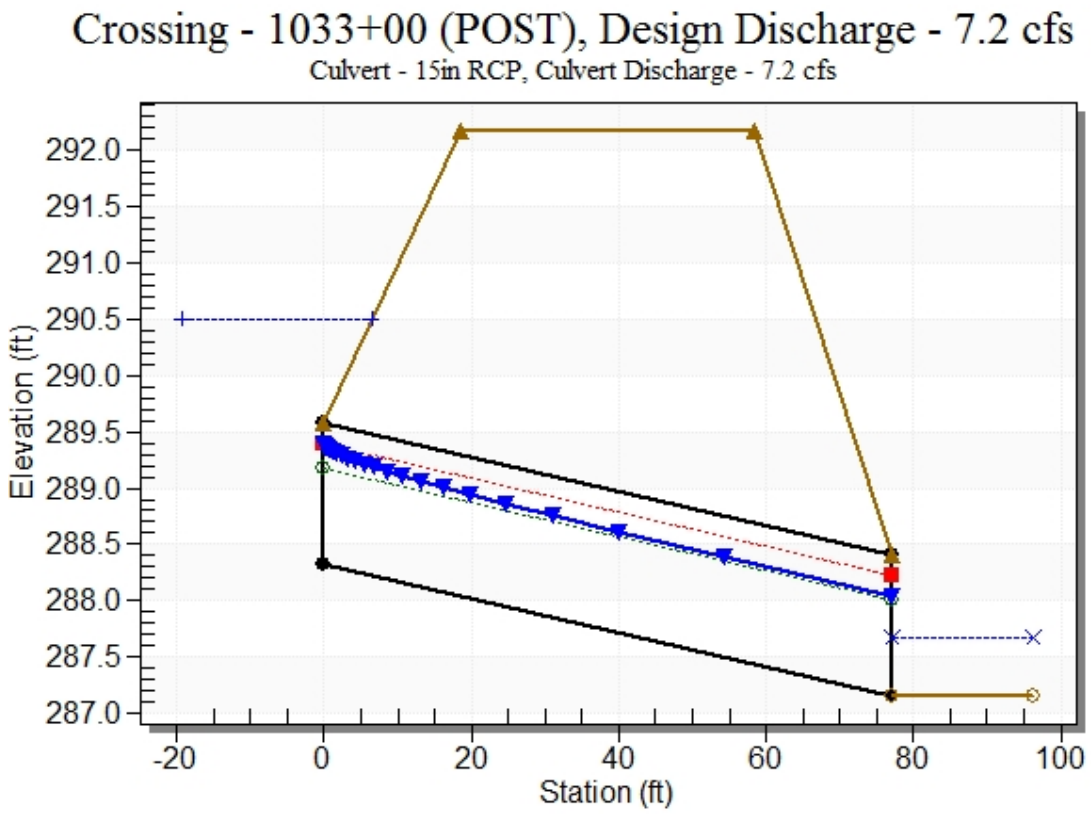
Straight Culvert

Inlet Elevation (invert): 288.32 ft, Outlet Elevation (invert): 287.16 ft

Culvert Length: 77.01 ft, Culvert Slope: 0.0151

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 288.32 ft

Outlet Station: 77.00 ft

Outlet Elevation: 287.16 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1033+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.95	287.62	0.46	4.38	1.74	1.30
6.17	287.63	0.47	4.42	1.77	1.30
6.40	287.64	0.48	4.47	1.81	1.31
6.62	287.65	0.49	4.51	1.84	1.31
6.85	287.66	0.50	4.56	1.87	1.31
7.07	287.67	0.51	4.60	1.91	1.31
7.18	287.67	0.51	4.62	1.92	1.31
7.52	287.69	0.53	4.68	1.97	1.32
7.74	287.69	0.53	4.72	2.00	1.32
7.97	287.70	0.54	4.76	2.03	1.32
8.19	287.71	0.55	4.80	2.06	1.33

Tailwater Channel Data - 1033+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0400

Channel Invert Elevation: 287.16 ft

Roadway Data for Crossing: 1033+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 292.18 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

CULVERT 65

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 65**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.52	0.4709
Grass	0.25	0.64	0.1596
Woods	0.15	0.00	0.0000
	Σ	**1.16**	0.6305

$C_{ave} = \frac{0.6305}{1.16} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.64	0.5746
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.64**	0.5746

$C_{ave} = \frac{0.5746}{0.64} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.42	in / hr								
I_{10} =	7.12	in / hr								
I_{25} =	8.16	in / hr								
I_{50} =	9.03	in / hr								
I_{100} =	9.88	in / hr								

Pre Construction Runoff:

Q_{05} =	0.54	**x**	6.42	**x**	1.16	**x**	1	=	**4.05**	cfs
Q_{10} =	0.54	**x**	7.12	**x**	1.16	**x**	1	=	**4.49**	cfs
Q_{25} =	0.54	**x**	8.16	**x**	1.16	**x**	1.1	=	**5.66**	cfs
Q_{50} =	0.54	**x**	9.03	**x**	1.16	**x**	1.2	=	**6.83**	cfs
Q_{100} =	0.54	**x**	9.88	**x**	1.16	**x**	1.25	=	**7.79**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.42	**x**	0.64	**x**	1	=	**3.69**	cfs
Q_{10} =	0.90	**x**	7.12	**x**	0.64	**x**	1	=	**4.09**	cfs
Q_{25} =	0.90	**x**	8.16	**x**	0.64	**x**	1.1	=	**5.16**	cfs
Q_{50} =	0.90	**x**	9.03	**x**	0.64	**x**	1.2	=	**6.22**	cfs
Q_{100} =	0.90	**x**	9.88	**x**	0.64	**x**	1.25	=	**7.10**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.66 cfs

Design Flow: 6.83 cfs

Maximum Flow: 7.79 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1037+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
289.23	5.66	5.66	0.00	1
289.30	5.87	5.87	0.00	1
289.36	6.09	6.09	0.00	1
289.43	6.30	6.30	0.00	1
289.50	6.51	6.51	0.00	1
289.57	6.72	6.72	0.00	1
289.61	6.83	6.83	0.00	1
289.73	7.15	7.15	0.00	1
289.81	7.36	7.36	0.00	1
289.89	7.58	7.58	0.00	1
289.98	7.79	7.79	0.00	1
291.24	10.40	10.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.66	5.66	289.23	1.643	0.0*	5-S2n	0.472	0.960	0.472	0.919	12.897	3.353
5.87	5.87	289.30	1.706	0.0*	5-S2n	0.482	0.977	0.519	0.932	11.802	3.384
6.09	6.09	289.36	1.771	0.0*	5-S2n	0.491	0.993	0.520	0.944	12.193	3.414
6.30	6.30	289.43	1.839	0.0*	5-S2n	0.500	1.009	0.521	0.956	12.600	3.444
6.51	6.51	289.50	1.909	0.0*	5-S2n	0.510	1.024	0.510	0.968	13.390	3.472
6.72	6.72	289.57	1.982	0.0*	5-S2n	0.519	1.039	0.519	0.980	13.511	3.501
6.83	6.83	289.61	2.019	0.0*	5-S2n	0.523	1.046	0.523	0.986	13.570	3.514
7.15	7.15	289.73	2.136	0.0*	5-S2n	0.537	1.067	0.537	1.003	13.721	3.555
7.36	7.36	289.81	2.217	0.0*	5-S2n	0.546	1.080	0.546	1.014	13.828	3.581
7.58	7.58	289.89	2.300	0.0*	5-S2n	0.555	1.092	0.555	1.025	13.937	3.606
7.79	7.79	289.98	2.387	0.0*	5-S2n	0.564	1.104	0.564	1.036	14.027	3.632

* Full Flow Headwater elevation is below inlet invert.

****

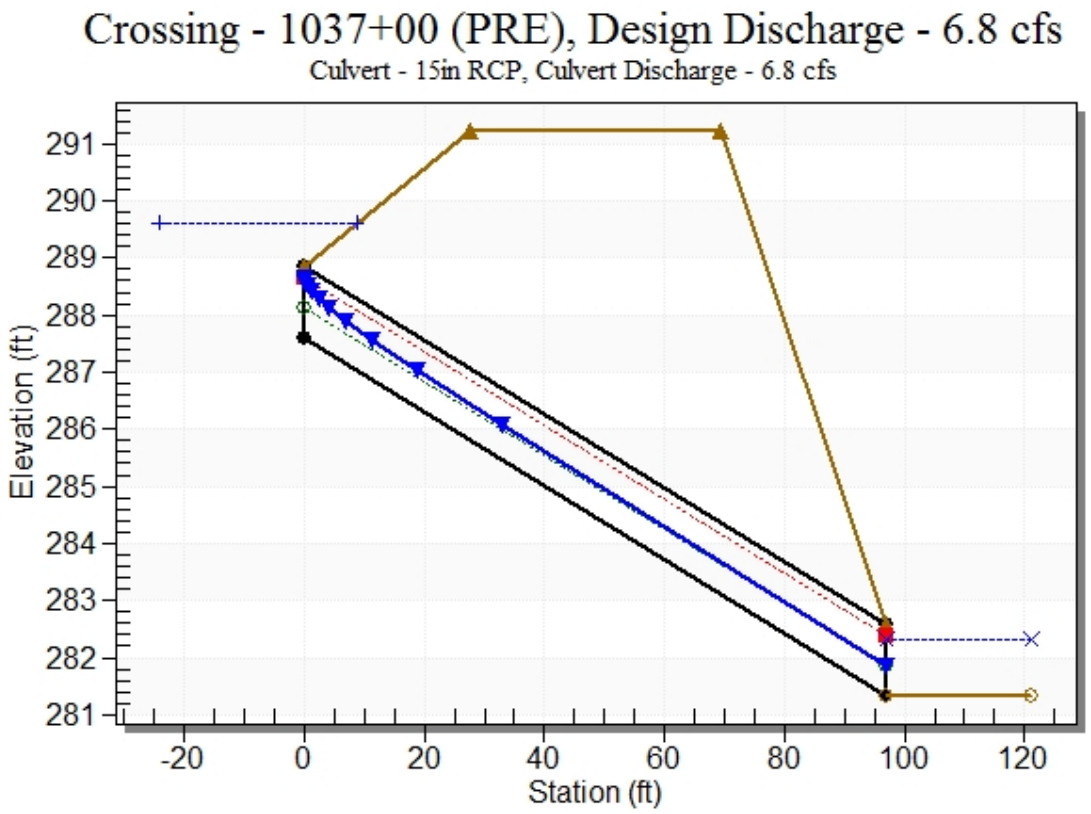
Straight Culvert

Inlet Elevation (invert): 287.59 ft, Outlet Elevation (invert): 281.34 ft

Culvert Length: 97.20 ft, Culvert Slope: 0.0644

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 287.59 ft

Outlet Station: 97.00 ft

Outlet Elevation: 281.34 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1037+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.66	282.26	0.92	3.35	3.44	0.87
5.87	282.27	0.93	3.38	3.49	0.87
6.09	282.28	0.94	3.41	3.53	0.88
6.30	282.30	0.96	3.44	3.58	0.88
6.51	282.31	0.97	3.47	3.63	0.88
6.72	282.32	0.98	3.50	3.67	0.88
6.83	282.33	0.99	3.51	3.69	0.88
7.15	282.34	1.00	3.55	3.75	0.88
7.36	282.35	1.01	3.58	3.80	0.89
7.58	282.36	1.02	3.61	3.84	0.89
7.79	282.38	1.04	3.63	3.88	0.89

Tailwater Channel Data - 1037+00 (PRE)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 281.34 ft

Roadway Data for Crossing: 1037+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 291.24 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.16 cfs

Design Flow: 6.22 cfs

Maximum Flow: 7.1 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1037+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
289.10	5.16	5.16	0.00	1
289.15	5.35	5.35	0.00	1
289.20	5.55	5.55	0.00	1
289.26	5.74	5.74	0.00	1
289.31	5.94	5.94	0.00	1
289.37	6.13	6.13	0.00	1
289.40	6.22	6.22	0.00	1
289.50	6.52	6.52	0.00	1
289.57	6.71	6.71	0.00	1
289.64	6.91	6.91	0.00	1
289.71	7.10	7.10	0.00	1
291.24	10.40	10.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.16	5.16	289.10	1.505	0.0*	5-S2n	0.449	0.918	0.449	0.887	12.583	3.276
5.35	5.35	289.15	1.557	0.0*	5-S2n	0.458	0.934	0.458	0.900	12.725	3.307
5.55	5.55	289.20	1.611	0.0*	5-S2n	0.467	0.951	0.467	0.912	12.826	3.336
5.74	5.74	289.26	1.667	0.0*	5-S2n	0.476	0.966	0.476	0.924	12.949	3.365
5.94	5.94	289.31	1.725	0.0*	5-S2n	0.484	0.982	0.519	0.935	11.915	3.393
6.13	6.13	289.37	1.785	0.0*	5-S2n	0.493	0.997	0.520	0.947	12.276	3.420
6.22	6.22	289.40	1.813	0.0*	5-S2n	0.497	1.003	0.520	0.952	12.448	3.433
6.52	6.52	289.50	1.911	0.0*	5-S2n	0.510	1.025	0.510	0.969	13.393	3.473
6.71	6.71	289.57	1.977	0.0*	5-S2n	0.518	1.038	0.518	0.979	13.503	3.499
6.91	6.91	289.64	2.046	0.0*	5-S2n	0.527	1.051	0.527	0.990	13.612	3.524
7.10	7.10	289.71	2.117	0.0*	5-S2n	0.535	1.064	0.535	1.000	13.695	3.548

* Full Flow Headwater elevation is below inlet invert.

****

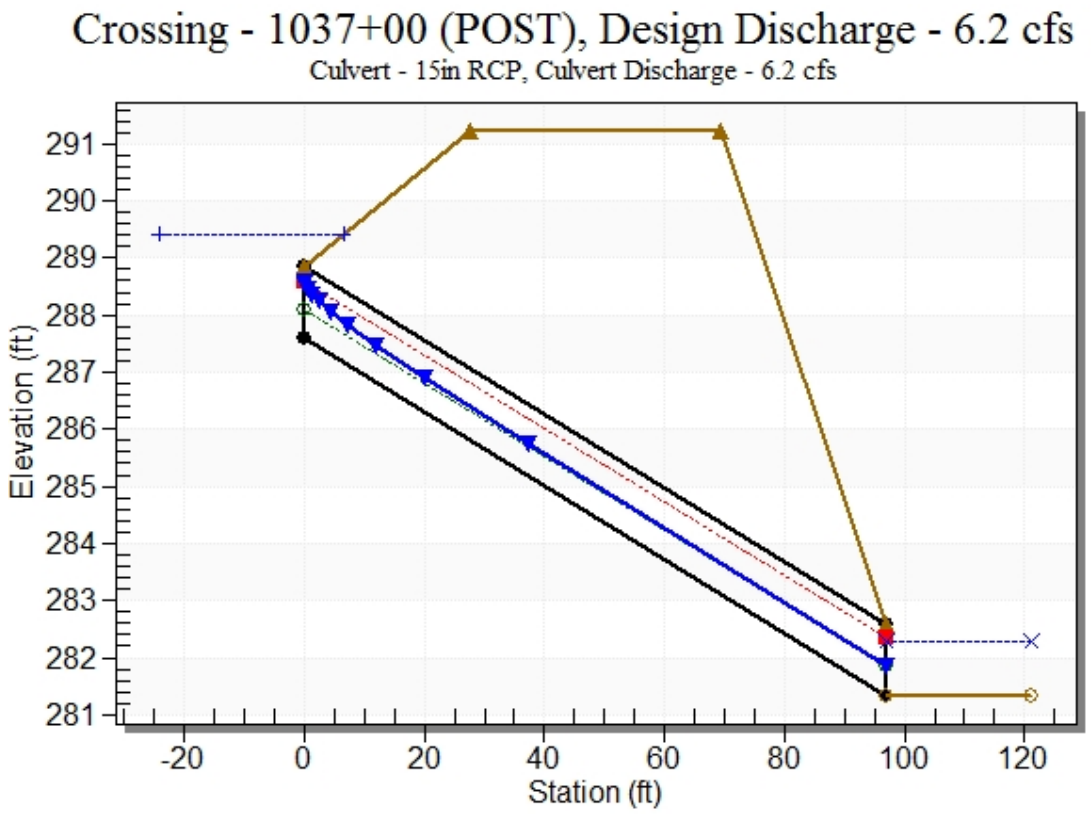
Straight Culvert

Inlet Elevation (invert): 287.59 ft, Outlet Elevation (invert): 281.34 ft

Culvert Length: 97.20 ft, Culvert Slope: 0.0644

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 287.59 ft

Outlet Station: 97.00 ft

Outlet Elevation: 281.34 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1037+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.16	282.23	0.89	3.28	3.32	0.87
5.35	282.24	0.90	3.31	3.37	0.87
5.55	282.25	0.91	3.34	3.41	0.87
5.74	282.26	0.92	3.36	3.46	0.87
5.94	282.28	0.94	3.39	3.50	0.87
6.13	282.29	0.95	3.42	3.54	0.88
6.22	282.29	0.95	3.43	3.56	0.88
6.52	282.31	0.97	3.47	3.63	0.88
6.71	282.32	0.98	3.50	3.67	0.88
6.91	282.33	0.99	3.52	3.71	0.88
7.10	282.34	1.00	3.55	3.74	0.88

Tailwater Channel Data - 1037+00 (POST)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 281.34 ft

Roadway Data for Crossing: 1037+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 291.24 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

CULVERT 66

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 66**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3972
Grass	0.25	0.35	0.0883
Woods	0.15	0.35	0.0525
	Σ	**1.14**	0.5380

$C_{ave} = \frac{0.5380}{1.14} = 0.47$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.61	0.5447
Grass	0.25	0.09	0.0237
Woods	0.15	0.35	0.0525
	Σ	**1.05**	0.6209

$C_{ave} = \frac{0.6209}{1.05} = 0.59$

T_c =	26.19	min.								
I_{05} =	4.02	in / hr								
I_{10} =	4.44	in / hr								
I_{25} =	5.04	in / hr								
I_{50} =	5.50	in / hr								
I_{100} =	5.96	in / hr								

Pre Construction Runoff:

Q_{05} =	0.47	**x**	4.02	**x**	1.14	**x**	1	=	**2.17**	cfs
Q_{10} =	0.47	**x**	4.44	**x**	1.14	**x**	1	=	**2.39**	cfs
Q_{25} =	0.47	**x**	5.04	**x**	1.14	**x**	1.1	=	**2.98**	cfs
Q_{50} =	0.47	**x**	5.50	**x**	1.14	**x**	1.2	=	**3.55**	cfs
Q_{100} =	0.47	**x**	5.96	**x**	1.14	**x**	1.25	=	**4.01**	cfs

Post Construction Runoff:

Q_{05} =	0.59	**x**	4.02	**x**	1.05	**x**	1	=	**2.50**	cfs
Q_{10} =	0.59	**x**	4.44	**x**	1.05	**x**	1	=	**2.75**	cfs
Q_{25} =	0.59	**x**	5.04	**x**	1.05	**x**	1.1	=	**3.44**	cfs
Q_{50} =	0.59	**x**	5.50	**x**	1.05	**x**	1.2	=	**4.10**	cfs
Q_{100} =	0.59	**x**	5.96	**x**	1.05	**x**	1.25	=	**4.63**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	JEN	Date	11/20/17
Location	Site 66	Checked		Date	

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID						
1	Surface Desciption (table 3-1)	----------		Woods	Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**	**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**35**	**35**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0091**	**0.2857**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.349**	**0.088**	+	=	**0.436**	
Shallow Concentrated Flow			Segment ID						
7	Surface Desciption (paved or unpaved)	----------							
8	Flow length, L	----------	ft						
9	Watercourse slope, s	----------	ft/ft						
10	Average velocity, V (figure 3-1)	----------	ft/s	**0.00**	**0.00**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr			+	=		
Channel Flow			Segment ID						
	Front Slope, (_ : 1)	----------							
	Back Slope, (_ : 1)	----------							
	Bottom Width	----------	ft						
	Flow Depth	----------	ft						
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**				
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**				
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**				
15	Channel Slope, s	----------	ft/ft						
16	Manning's roughness coeff., n	----------							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**				
18	Flow length, L	----------	ft						
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr			+	=	**0.000**	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.436**	
							min	**26.19**	

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.98 cfs

Design Flow: 3.55 cfs

Maximum Flow: 4.01 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1043+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
304.60	2.98	2.98	0.00	1
304.62	3.08	3.08	0.00	1
304.64	3.19	3.19	0.00	1
304.66	3.29	3.29	0.00	1
304.68	3.39	3.39	0.00	1
304.70	3.50	3.50	0.00	1
304.71	3.55	3.55	0.00	1
304.74	3.70	3.70	0.00	1
304.75	3.80	3.80	0.00	1
304.77	3.91	3.91	0.00	1
304.79	4.01	4.01	0.00	1
305.78	9.39	9.39	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.98	2.98	304.60	0.922	0.0*	1-S2n	0.373	0.656	0.383	0.435	8.116	7.885
3.08	3.08	304.62	0.942	0.0*	1-S2n	0.380	0.668	0.389	0.440	8.213	7.952
3.19	3.19	304.64	0.961	0.0*	1-S2n	0.386	0.679	0.399	0.446	8.149	8.018
3.29	3.29	304.66	0.981	0.0*	1-S2n	0.392	0.691	0.392	0.451	8.671	8.082
3.39	3.39	304.68	1.000	0.0*	1-S2n	0.398	0.702	0.410	0.456	8.373	8.144
3.50	3.50	304.70	1.019	0.0*	1-S2n	0.405	0.713	0.417	0.461	8.443	8.205
3.55	3.55	304.71	1.029	0.0*	1-S2n	0.408	0.719	0.420	0.464	8.482	8.238
3.70	3.70	304.74	1.056	0.0*	1-S2n	0.417	0.735	0.429	0.472	8.593	8.324
3.80	3.80	304.75	1.074	0.0*	1-S2n	0.423	0.746	0.435	0.476	8.630	8.381
3.91	3.91	304.77	1.092	0.0*	1-S2n	0.429	0.756	0.442	0.481	8.682	8.437
4.01	4.01	304.79	1.110	0.0*	1-S2n	0.434	0.766	0.448	0.486	8.738	8.492

* Full Flow Headwater elevation is below inlet invert.

****

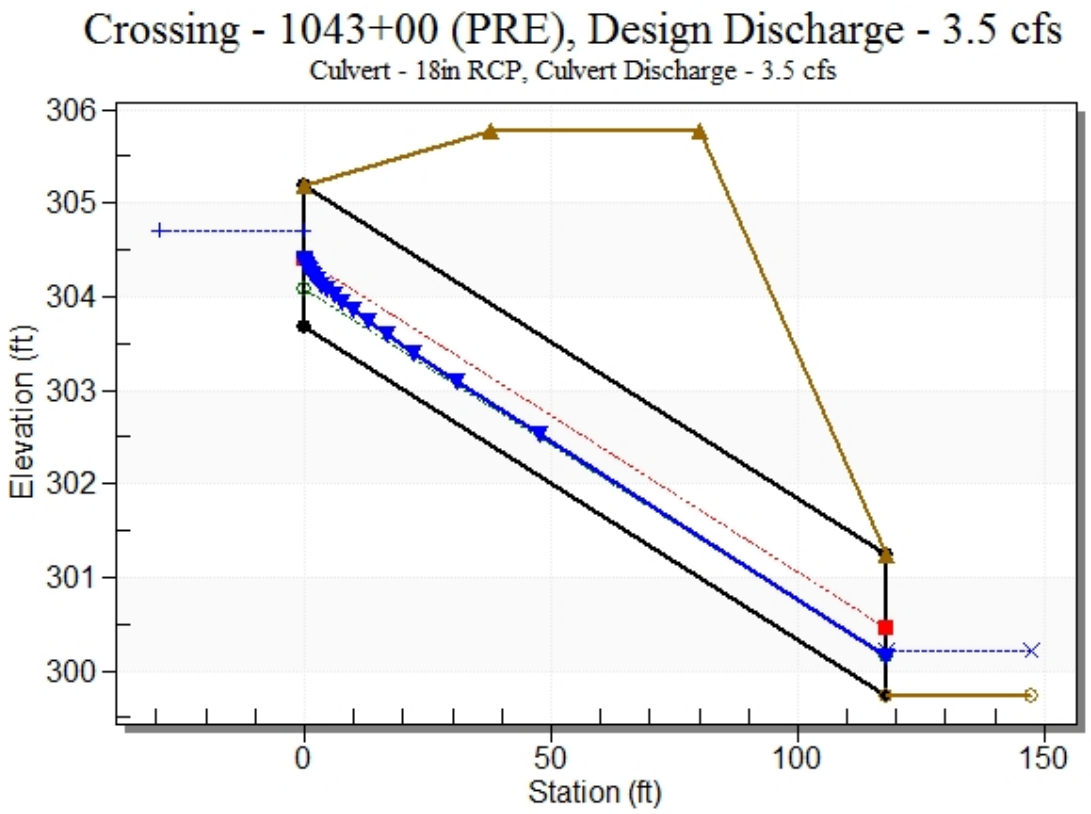
Straight Culvert

Inlet Elevation (invert): 303.68 ft, Outlet Elevation (invert): 299.74 ft

Culvert Length: 118.07 ft, Culvert Slope: 0.0334

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 303.68 ft

Outlet Station: 118.00 ft

Outlet Elevation: 299.74 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1043+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.98	300.17	0.43	7.88	10.85	2.98
3.08	300.18	0.44	7.95	10.99	2.99
3.19	300.19	0.45	8.02	11.13	2.99
3.29	300.19	0.45	8.08	11.26	3.00
3.39	300.20	0.46	8.14	11.39	3.00
3.50	300.20	0.46	8.21	11.52	3.01
3.55	300.20	0.46	8.24	11.59	3.01
3.70	300.21	0.47	8.32	11.77	3.02
3.80	300.22	0.48	8.38	11.89	3.03
3.91	300.22	0.48	8.44	12.01	3.03
4.01	300.23	0.49	8.49	12.13	3.04

Tailwater Channel Data - 1043+00 (PRE)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.4000

Channel Manning's n: 0.0400

Channel Invert Elevation: 299.74 ft

Roadway Data for Crossing: 1043+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 305.78 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.44 cfs

Design Flow: 4.1 cfs

Maximum Flow: 4.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1043+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
304.69	3.44	3.44	0.00	1
304.71	3.56	3.56	0.00	1
304.73	3.68	3.68	0.00	1
304.75	3.80	3.80	0.00	1
304.77	3.92	3.92	0.00	1
304.79	4.04	4.04	0.00	1
304.81	4.10	4.10	0.00	1
304.84	4.27	4.27	0.00	1
304.86	4.39	4.39	0.00	1
304.88	4.51	4.51	0.00	1
304.89	4.63	4.63	0.00	1
305.78	9.39	9.39	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.44	3.44	304.69	1.009	0.0*	1-S2n	0.401	0.708	0.413	0.459	8.405	8.173
3.56	3.56	304.71	1.031	0.0*	1-S2n	0.408	0.720	0.421	0.465	8.488	8.243
3.68	3.68	304.73	1.052	0.0*	1-S2n	0.415	0.733	0.428	0.470	8.576	8.311
3.80	3.80	304.75	1.073	0.0*	1-S2n	0.422	0.745	0.435	0.476	8.625	8.377
3.92	3.92	304.77	1.094	0.0*	1-S2n	0.429	0.757	0.442	0.482	8.686	8.442
4.04	4.04	304.79	1.114	0.0*	1-S2n	0.436	0.768	0.450	0.487	8.752	8.506
4.10	4.10	304.81	1.126	0.0*	1-S2n	0.439	0.775	0.454	0.490	8.789	8.540
4.27	4.27	304.84	1.155	0.0*	1-S2n	0.449	0.791	0.449	0.498	9.296	8.628
4.39	4.39	304.86	1.175	0.0*	1-S2n	0.455	0.802	0.455	0.503	9.371	8.688
4.51	4.51	304.88	1.195	0.0*	1-S2n	0.462	0.813	0.482	0.508	8.875	8.746
4.63	4.63	304.89	1.215	0.0*	1-S2n	0.468	0.824	0.484	0.513	9.059	8.803

* Full Flow Headwater elevation is below inlet invert.

****

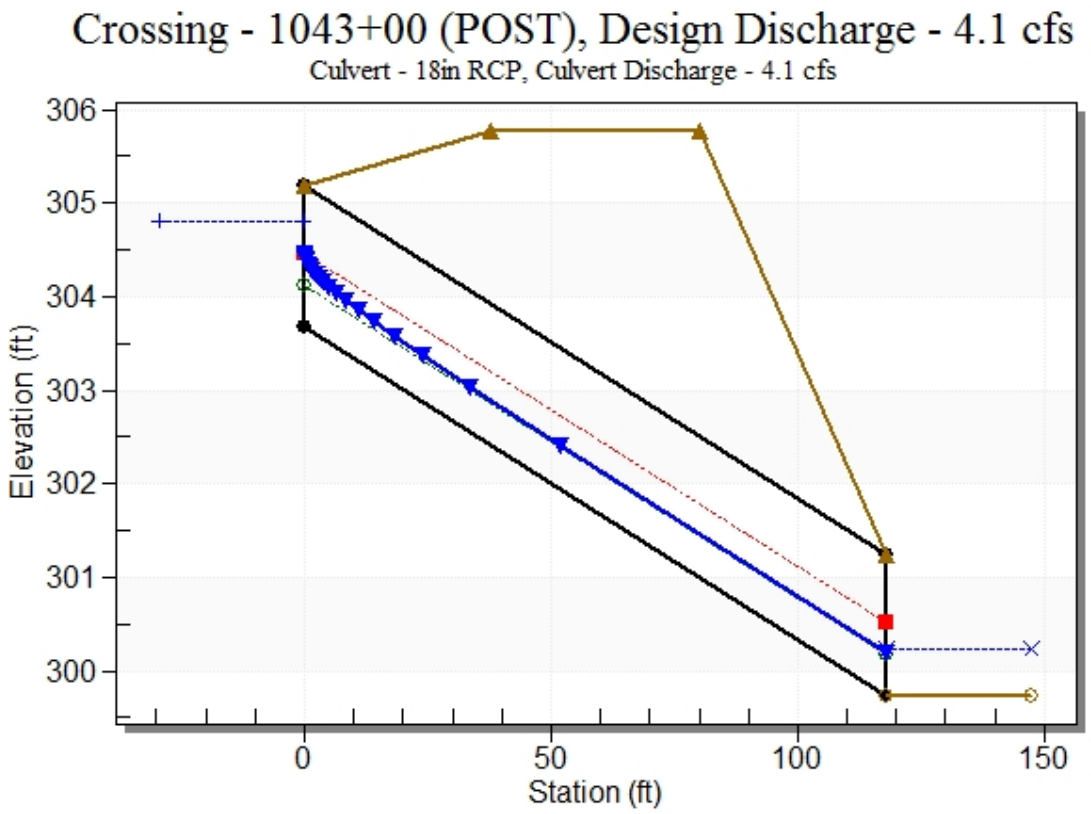
Straight Culvert

Inlet Elevation (invert): 303.68 ft, Outlet Elevation (invert): 299.74 ft

Culvert Length: 118.07 ft, Culvert Slope: 0.0334

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 303.68 ft

Outlet Station: 118.00 ft

Outlet Elevation: 299.74 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1043+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.44	300.20	0.46	8.17	11.45	3.01
3.56	300.20	0.46	8.24	11.60	3.01
3.68	300.21	0.47	8.31	11.74	3.02
3.80	300.22	0.48	8.38	11.88	3.03
3.92	300.22	0.48	8.44	12.02	3.03
4.04	300.23	0.49	8.51	12.16	3.04
4.10	300.23	0.49	8.54	12.23	3.04
4.27	300.24	0.50	8.63	12.42	3.05
4.39	300.24	0.50	8.69	12.55	3.05
4.51	300.25	0.51	8.75	12.68	3.06
4.63	300.25	0.51	8.80	12.80	3.06

Tailwater Channel Data - 1043+00 (POST)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.4000

Channel Manning's n: 0.0400

Channel Invert Elevation: 299.74 ft

Roadway Data for Crossing: 1043+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 305.78 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

CULVERT 67

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 67**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.93	0.8349
Grass	0.25	0.72	0.1803
Offsite	0.15	6.48	0.9719
	Σ	**8.13**	1.9870

$C_{ave} = \frac{1.9870}{8.13} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.15	1.0334
Grass	0.25	0.29	0.0735
Offsite	0.15	6.48	0.9719
	Σ	**7.92**	2.0787

$C_{ave} = \frac{2.0787}{7.92} = 0.26$

T_c =	38.53	min.								
I_{05} =	3.32	in / hr								
I_{10} =	3.65	in / hr								
I_{25} =	4.13	in / hr								
I_{50} =	4.50	in / hr								
I_{100} =	4.86	in / hr								

Pre Construction Runoff:

Q_{05} =	0.24	x	3.32	x	8.13	x	1	=	**6.59**	cfs
Q_{10} =	0.24	x	3.65	x	8.13	x	1	=	**7.25**	cfs
Q_{25} =	0.24	x	4.13	x	8.13	x	1.1	=	**9.02**	cfs
Q_{50} =	0.24	x	4.50	x	8.13	x	1.2	=	**10.73**	cfs
Q_{100} =	0.24	x	4.86	x	8.13	x	1.25	=	**12.08**	cfs

Post Construction Runoff:

Q_{05} =	0.26	x	3.32	x	7.92	x	1	=	**6.90**	cfs
Q_{10} =	0.26	x	3.65	x	7.92	x	1	=	**7.58**	cfs
Q_{25} =	0.26	x	4.13	x	7.92	x	1.1	=	**9.43**	cfs
Q_{50} =	0.26	x	4.50	x	7.92	x	1.2	=	**11.22**	cfs
Q_{100} =	0.26	x	4.86	x	7.92	x	1.25	=	**12.63**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site 67	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)		Segment ID						
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**

Shallow Concentrated Flow		Segment ID						
7	Surface Desciption (paved or unpaved)			Unpaved		Unpaved		
8	Flow length, L		ft	**230**		**40**		
9	Watercourse slope, s		ft/ft	**0.0600**		**0.4000**		
10	Average velocity, V (figure 3-1)		ft/s	**3.95**		**10.20**		
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.016**	+	**0.001**	=	**0.017**

Channel Flow		Segment ID						
	Front Slope, (_ : 1)			**10**				
	Back Slope, (_ : 1)			**4**				
	Bottom Width		ft	**0**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**		**0.00**		
13	Wetted perimeter, p_w		ft	**7.09**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.25**		**#DIV/0!**		
15	Channel Slope, s		ft/ft	**0.0175**				
16	Manning's roughness coeff., n			**0.05**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**1.55**		**#DIV/0!**		
18	Flow length, L		ft	**200**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.036**	+		=	**0.036**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.642**
							min	**38.53**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site 67c	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			Unpaved				
8	Flow length, L		ft	**760**				
9	Watercourse slope, s		ft/ft	**0.0600**				
10	Average velocity, V (figure 3-1)		ft/s	**3.95**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.053**	+		=	**0.053**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)					hr		**0.554**
						min		**33.26**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.02 cfs

Design Flow: 10.73 cfs

Maximum Flow: 12.08 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1046+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
315.33	9.02	9.02	0.00	1
315.36	9.33	9.33	0.00	1
315.39	9.63	9.63	0.00	1
315.42	9.94	9.94	0.00	1
315.45	10.24	10.24	0.00	1
315.48	10.55	10.55	0.00	1
315.50	10.73	10.73	0.00	1
315.54	11.16	11.16	0.00	1
315.56	11.47	11.47	0.00	1
315.59	11.77	11.77	0.00	1
315.62	12.08	12.08	0.00	1
317.26	31.80	31.80	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.02	9.02	315.33	1.374	0.0*	1-S2n	0.538	0.996	0.538	0.274	11.241	9.291
9.33	9.33	315.36	1.405	0.0*	1-S2n	0.547	1.015	0.547	0.279	11.362	9.394
9.63	9.63	315.39	1.434	0.0*	1-S2n	0.556	1.033	0.556	0.284	11.478	9.497
9.94	9.94	315.42	1.463	0.0*	1-S2n	0.565	1.051	0.565	0.289	11.522	9.595
10.24	10.24	315.45	1.492	0.0*	1-S2n	0.574	1.068	0.613	0.294	10.594	9.695
10.55	10.55	315.48	1.520	0.0*	1-S2n	0.582	1.085	0.590	0.300	11.516	9.784
10.73	10.73	315.50	1.537	0.0*	1-S2n	0.587	1.095	0.587	0.302	11.789	9.844
11.16	11.16	315.54	1.576	0.0*	1-S2n	0.598	1.118	0.598	0.309	11.941	9.972
11.47	11.47	315.56	1.603	0.0*	1-S2n	0.606	1.135	0.606	0.314	12.044	10.056
11.77	11.77	315.59	1.630	0.0*	1-S2n	0.615	1.151	0.615	0.319	12.143	10.143
12.08	12.08	315.62	1.656	0.0*	1-S2n	0.623	1.166	0.623	0.324	12.239	10.232

* Full Flow Headwater elevation is below inlet invert.

****

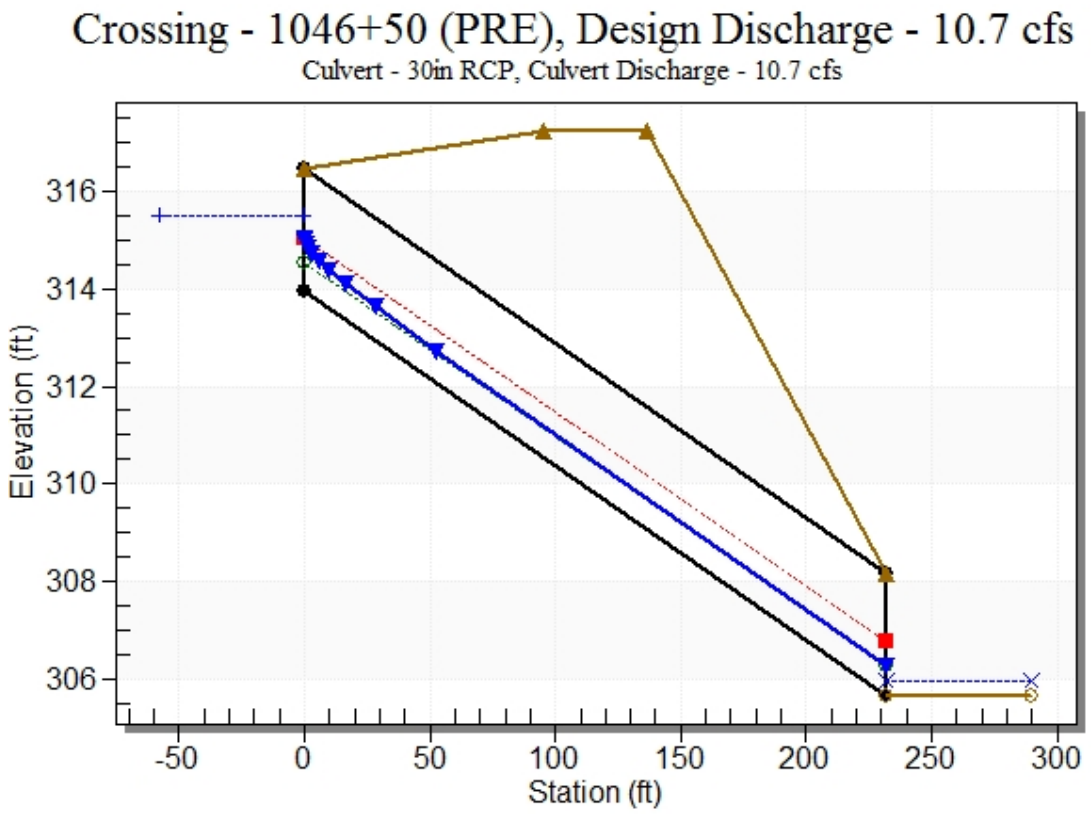
Straight Culvert

Inlet Elevation (invert): 313.96 ft, Outlet Elevation (invert): 305.66 ft

Culvert Length: 232.15 ft, Culvert Slope: 0.0358

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 313.96 ft

Outlet Station: 232.00 ft

Outlet Elevation: 305.66 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1046+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.02	305.93	0.27	9.29	0.68	3.36
9.33	305.94	0.28	9.39	0.70	3.37
9.63	305.94	0.28	9.50	0.71	3.38
9.94	305.95	0.29	9.60	0.72	3.39
10.24	305.95	0.29	9.70	0.73	3.40
10.55	305.96	0.30	9.78	0.75	3.40
10.73	305.96	0.30	9.84	0.75	3.41
11.16	305.97	0.31	9.97	0.77	3.42
11.47	305.97	0.31	10.06	0.78	3.42
11.77	305.98	0.32	10.14	0.80	3.43
12.08	305.98	0.32	10.23	0.81	3.44

Tailwater Channel Data - 1046+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 305.66 ft

Roadway Data for Crossing: 1046+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 317.26 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.43 cfs

Design Flow: 11.22 cfs

Maximum Flow: 12.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1046+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
315.37	9.43	9.43	0.00	1
315.41	9.75	9.75	0.00	1
315.44	10.07	10.07	0.00	1
315.47	10.39	10.39	0.00	1
315.50	10.71	10.71	0.00	1
315.52	11.03	11.03	0.00	1
315.54	11.22	11.22	0.00	1
315.58	11.67	11.67	0.00	1
315.61	11.99	11.99	0.00	1
315.64	12.31	12.31	0.00	1
315.66	12.63	12.63	0.00	1
317.26	31.80	31.80	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.43	9.43	315.37	1.415	0.0*	1-S2n	0.550	1.021	0.550	0.281	11.402	9.431
9.75	9.75	315.41	1.445	0.0*	1-S2n	0.559	1.040	0.559	0.286	11.521	9.533
10.07	10.07	315.44	1.476	0.0*	1-S2n	0.568	1.058	0.568	0.292	11.564	9.636
10.39	10.39	315.47	1.506	0.0*	1-S2n	0.578	1.076	0.602	0.297	11.014	9.740
10.71	10.71	315.50	1.535	0.0*	1-S2n	0.586	1.094	0.586	0.302	11.782	9.833
11.03	11.03	315.52	1.564	0.0*	1-S2n	0.595	1.111	0.595	0.307	11.896	9.934
11.22	11.22	315.54	1.581	0.0*	1-S2n	0.600	1.122	0.600	0.310	11.961	9.984
11.67	11.67	315.58	1.621	0.0*	1-S2n	0.612	1.145	0.612	0.317	12.110	10.113
11.99	11.99	315.61	1.649	0.0*	1-S2n	0.620	1.162	0.620	0.322	12.211	10.202
12.31	12.31	315.64	1.676	0.0*	1-S2n	0.629	1.178	0.662	0.327	11.417	10.294
12.63	12.63	315.66	1.703	0.0*	1-S2n	0.637	1.194	0.646	0.332	12.114	10.382

* Full Flow Headwater elevation is below inlet invert.

****

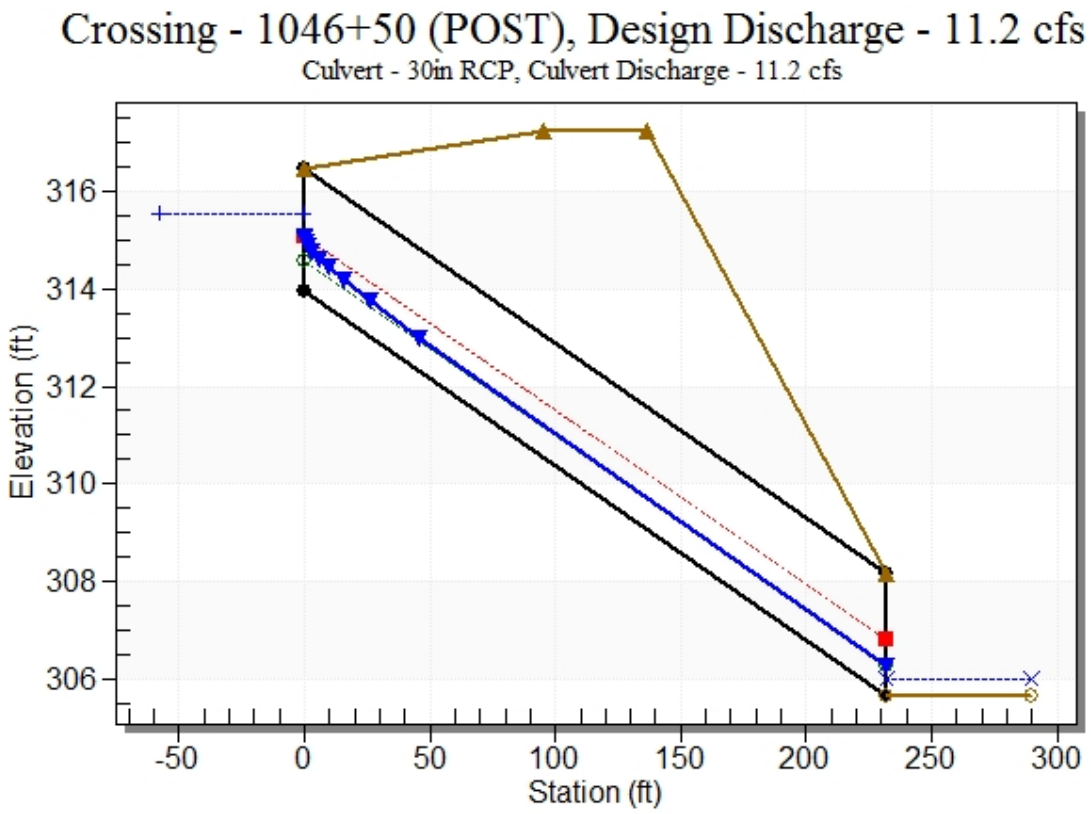
Straight Culvert

Inlet Elevation (invert): 313.96 ft, Outlet Elevation (invert): 305.66 ft

Culvert Length: 232.15 ft, Culvert Slope: 0.0358

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 313.96 ft

Outlet Station: 232.00 ft

Outlet Elevation: 305.66 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1046+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.43	305.94	0.28	9.43	0.70	3.37
9.75	305.95	0.29	9.53	0.71	3.38
10.07	305.95	0.29	9.64	0.73	3.39
10.39	305.96	0.30	9.74	0.74	3.40
10.71	305.96	0.30	9.83	0.75	3.41
11.03	305.97	0.31	9.93	0.77	3.42
11.22	305.97	0.31	9.98	0.77	3.42
11.67	305.98	0.32	10.11	0.79	3.43
11.99	305.98	0.32	10.20	0.80	3.43
12.31	305.99	0.33	10.29	0.82	3.44
12.63	305.99	0.33	10.38	0.83	3.45

Tailwater Channel Data - 1046+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 305.66 ft

Roadway Data for Crossing: 1046+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 317.26 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

CULVERT 68

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 68**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.35	0.3172
Grass	0.25	0.56	0.1390
Woods	0.15	0.13	0.0191
	Σ	**1.04**	0.4752

$C_{ave} = \frac{0.4752}{1.04} = 0.46$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.73	0.6541
Grass	0.25	0.18	0.0454
Woods	0.15	0.13	0.0191
	Σ	**1.04**	0.7186

$C_{ave} = \frac{0.7186}{1.04} = 0.69$

T_c =	10.22	min.
I_{05} =	5.55	in / hr
I_{10} =	6.15	in / hr
I_{25} =	7.05	in / hr
I_{50} =	7.75	in / hr
I_{100} =	8.46	in / hr

Pre Construction Runoff:

Q_{05} =	0.46	x	5.55	x	1.04	x	1	=	**2.64**	cfs
Q_{10} =	0.46	x	6.15	x	1.04	x	1	=	**2.92**	cfs
Q_{25} =	0.46	x	7.05	x	1.04	x	1.1	=	**3.68**	cfs
Q_{50} =	0.46	x	7.75	x	1.04	x	1.2	=	**4.42**	cfs
Q_{100} =	0.46	x	8.46	x	1.04	x	1.25	=	**5.02**	cfs

Post Construction Runoff:

Q_{05} =	0.69	x	5.55	x	1.04	x	1	=	**3.99**	cfs
Q_{10} =	0.69	x	6.15	x	1.04	x	1	=	**4.42**	cfs
Q_{25} =	0.69	x	7.05	x	1.04	x	1.1	=	**5.57**	cfs
Q_{50} =	0.69	x	7.75	x	1.04	x	1.2	=	**6.69**	cfs
Q_{100} =	0.69	x	8.46	x	1.04	x	1.25	=	**7.60**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	JEN	Date	11/20/17
Location	Site 68	Checked		Date	

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**30**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.170**	+		=	**0.170**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)							
8	Flow length, L		ft					
9	Watercourse slope, s		ft/ft					
10	Average velocity, V (figure 3-1)		ft/s					
11	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.170**
							min	**10.22**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.68 cfs

Design Flow: 4.42 cfs

Maximum Flow: 5.02 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1050+80 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
335.85	3.68	3.68	0.00	1
335.87	3.81	3.81	0.00	1
335.89	3.95	3.95	0.00	1
335.92	4.08	4.08	0.00	1
335.94	4.22	4.22	0.00	1
335.96	4.35	4.35	0.00	1
335.98	4.42	4.42	0.00	1
336.01	4.62	4.62	0.00	1
336.03	4.75	4.75	0.00	1
336.05	4.89	4.89	0.00	1
336.07	5.02	5.02	0.00	1
336.50	7.50	7.50	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.68	3.68	335.85	1.058	0.0*	1-S2n	0.442	0.733	0.442	0.203	8.168	7.536
3.81	3.81	335.87	1.081	0.0*	1-S2n	0.450	0.747	0.450	0.207	8.255	7.625
3.95	3.95	335.89	1.105	0.0*	1-S2n	0.459	0.760	0.459	0.211	8.338	7.714
4.08	4.08	335.92	1.128	0.0*	1-S2n	0.467	0.773	0.467	0.215	8.425	7.797
4.22	4.22	335.94	1.151	0.0*	1-S2n	0.475	0.786	0.475	0.219	8.479	7.881
4.35	4.35	335.96	1.173	0.0*	1-S2n	0.482	0.798	0.482	0.223	8.558	7.960
4.42	4.42	335.98	1.185	0.0*	1-S2n	0.487	0.805	0.487	0.225	8.598	8.001
4.62	4.62	336.01	1.218	0.0*	1-S2n	0.498	0.823	0.498	0.231	8.706	8.115
4.75	4.75	336.03	1.240	0.0*	1-S2n	0.506	0.834	0.506	0.235	8.783	8.191
4.89	4.89	336.05	1.263	0.0*	1-S2n	0.513	0.846	0.513	0.239	8.832	8.263
5.02	5.02	336.07	1.285	0.0*	1-S2n	0.520	0.857	0.520	0.242	8.902	8.337

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 334.79 ft, Outlet Elevation (invert): 325.22 ft

Culvert Length: 365.13 ft, Culvert Slope: 0.0262

****

Water Surface Profile Plot for Culvert: 18in RCP

Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 334.79 ft

Outlet Station: 365.00 ft

Outlet Elevation: 325.22 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1050+80 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.68	325.42	0.20	7.54	0.51	3.19
3.81	325.43	0.21	7.63	0.52	3.20
3.95	325.43	0.21	7.71	0.53	3.20
4.08	325.44	0.22	7.80	0.54	3.21
4.22	325.44	0.22	7.88	0.55	3.22
4.35	325.44	0.22	7.96	0.56	3.23
4.42	325.45	0.23	8.00	0.56	3.23
4.62	325.45	0.23	8.11	0.58	3.24
4.75	325.45	0.23	8.19	0.59	3.25
4.89	325.46	0.24	8.26	0.60	3.26
5.02	325.46	0.24	8.34	0.60	3.26

Tailwater Channel Data - 1050+80 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 325.22 ft

Roadway Data for Crossing: 1050+80 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.50 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.57 cfs

Design Flow: 6.69 cfs

Maximum Flow: 7.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1050+80 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
336.16	5.57	5.57	0.00	1
336.20	5.77	5.77	0.00	1
336.23	5.98	5.98	0.00	1
336.27	6.18	6.18	0.00	1
336.30	6.38	6.38	0.00	1
336.34	6.59	6.59	0.00	1
336.35	6.69	6.69	0.00	1
336.41	6.99	6.99	0.00	1
336.44	7.19	7.19	0.00	1
336.48	7.40	7.40	0.00	1
336.50	7.60	7.51	0.03	10
336.50	7.50	7.50	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.57	5.57	336.16	1.375	0.0*	1-S2n	0.550	0.907	0.550	0.257	9.154	8.616
5.77	5.77	336.20	1.408	0.0*	1-S2n	0.561	0.923	0.571	0.262	9.041	8.713
5.98	5.98	336.23	1.442	0.0*	1-S2n	0.572	0.940	0.582	0.268	9.131	8.809
6.18	6.18	336.27	1.476	0.0*	1-S2n	0.582	0.956	0.593	0.273	9.185	8.903
6.38	6.38	336.30	1.511	0.0*	5-S2n	0.593	0.971	0.605	0.278	9.237	8.996
6.59	6.59	336.34	1.546	0.0*	5-S2n	0.603	0.990	0.615	0.283	9.331	9.084
6.69	6.69	336.35	1.564	0.0*	5-S2n	0.608	0.998	0.621	0.285	9.372	9.127
6.99	6.99	336.41	1.617	0.0*	5-S2n	0.623	1.021	0.623	0.292	9.738	9.254
7.19	7.19	336.44	1.654	0.0*	5-S2n	0.633	1.036	0.649	0.297	9.504	9.336
7.40	7.40	336.48	1.691	0.0*	5-S2n	0.643	1.050	0.659	0.302	9.565	9.418
7.60	7.51	336.50	1.713	0.0*	5-S2n	0.649	1.059	0.665	0.306	9.596	9.496

* Full Flow Headwater elevation is below inlet invert.

****

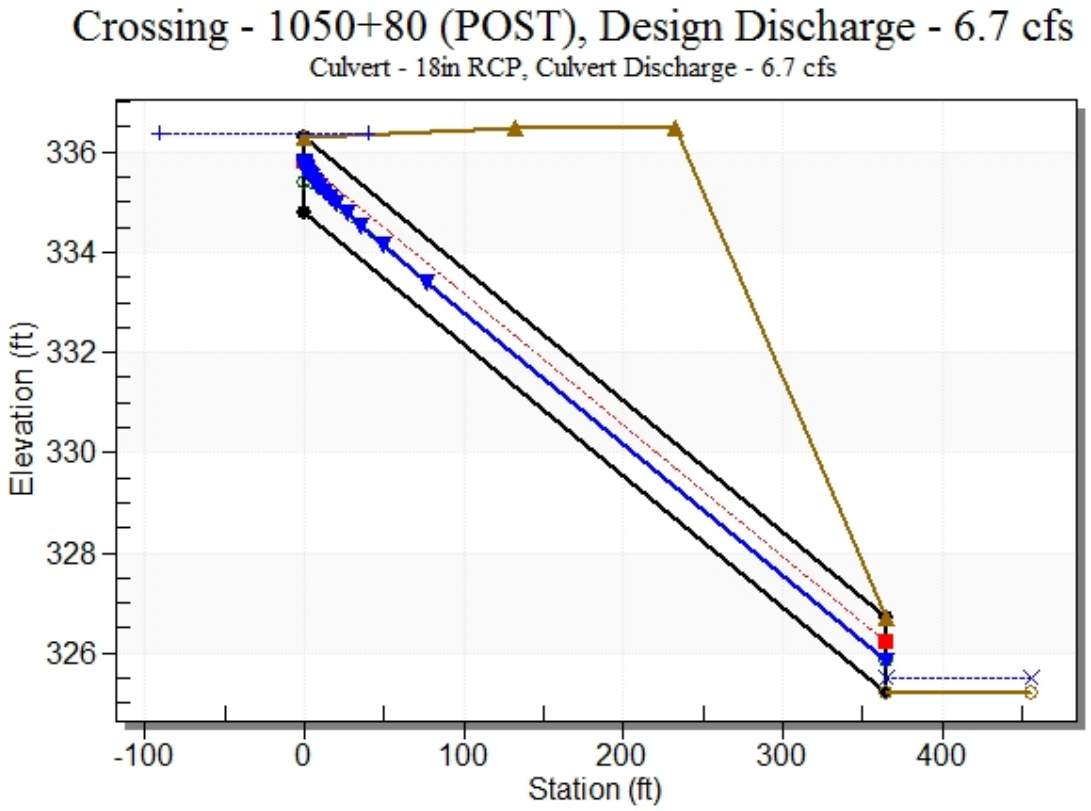
Straight Culvert

Inlet Elevation (invert): 334.79 ft, Outlet Elevation (invert): 325.22 ft

Culvert Length: 365.13 ft, Culvert Slope: 0.0262

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 334.79 ft

Outlet Station: 365.00 ft

Outlet Elevation: 325.22 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1050+80 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.57	325.48	0.26	8.62	0.64	3.29
5.77	325.48	0.26	8.71	0.65	3.29
5.98	325.49	0.27	8.81	0.67	3.30
6.18	325.49	0.27	8.90	0.68	3.31
6.38	325.50	0.28	9.00	0.69	3.32
6.59	325.50	0.28	9.08	0.71	3.33
6.69	325.51	0.29	9.13	0.71	3.33
6.99	325.51	0.29	9.25	0.73	3.34
7.19	325.52	0.30	9.34	0.74	3.35
7.40	325.52	0.30	9.42	0.75	3.35
7.60	325.53	0.31	9.50	0.76	3.36

Tailwater Channel Data - 1050+80 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 325.22 ft

Roadway Data for Crossing: 1050+80 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.50 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 69

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 69**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4320
Grass	0.25	0.52	0.1300
Woods	0.15	1.35	0.2025
	Σ	**2.35**	0.7645

$C_{ave} = \frac{0.7645}{2.35} = 0.33$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.82	0.7367
Grass	0.25	0.10	0.0254
Woods	0.15	1.35	0.2025
	Σ	**2.27**	0.9645

$C_{ave} = \frac{0.9645}{2.27} = 0.42$

T_c =	36.50	min.								
I_{05} =	3.42	in / hr								
I_{10} =	3.76	in / hr								
I_{25} =	4.25	in / hr								
I_{50} =	4.64	in / hr								
I_{100} =	5.01	in / hr								

Pre Construction Runoff:

Q_{05} =	0.33	x	3.42	x	2.35	x	1	=	**2.61**	cfs
Q_{10} =	0.33	x	3.76	x	2.35	x	1	=	**2.87**	cfs
Q_{25} =	0.33	x	4.25	x	2.35	x	1.1	=	**3.58**	cfs
Q_{50} =	0.33	x	4.64	x	2.35	x	1.2	=	**4.26**	cfs
Q_{100} =	0.33	x	5.01	x	2.35	x	1.25	=	**4.79**	cfs

Post Construction Runoff:

Q_{05} =	0.42	x	3.42	x	2.27	x	1	=	**3.30**	cfs
Q_{10} =	0.42	x	3.76	x	2.27	x	1	=	**3.62**	cfs
Q_{25} =	0.42	x	4.25	x	2.27	x	1.1	=	**4.51**	cfs
Q_{50} =	0.42	x	4.64	x	2.27	x	1.2	=	**5.37**	cfs
Q_{100} =	0.42	x	5.01	x	2.27	x	1.25	=	**6.05**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site 69	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)		Segment ID						
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**

Shallow Concentrated Flow		Segment ID						
7	Surface Desciption (paved or unpaved)			Unpaved				
8	Flow length, L		ft	**250**				
9	Watercourse slope, s		ft/ft	**0.0500**				
10	Average velocity, V (figure 3-1)		ft/s	**3.61**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.019**	+		=	**0.019**

Channel Flow		Segment ID						
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.608**
							min	**36.50**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.58 cfs

Design Flow: 4.26 cfs

Maximum Flow: 4.79 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1058+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
334.17	3.58	3.58	0.00	1
334.19	3.70	3.70	0.00	1
334.21	3.82	3.82	0.00	1
334.23	3.94	3.94	0.00	1
334.25	4.06	4.06	0.00	1
334.28	4.19	4.19	0.00	1
334.29	4.26	4.26	0.00	1
334.32	4.43	4.43	0.00	1
334.34	4.55	4.55	0.00	1
334.36	4.67	4.67	0.00	1
334.38	4.79	4.79	0.00	1
336.47	13.63	13.63	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.58	3.58	334.17	0.999	0.0*	1-S2n	0.328	0.722	0.328	0.406	12.095	3.134
3.70	3.70	334.19	1.021	0.0*	1-S2n	0.334	0.735	0.334	0.414	12.222	3.165
3.82	3.82	334.21	1.042	0.0*	1-S2n	0.339	0.747	0.339	0.421	12.343	3.195
3.94	3.94	334.23	1.064	0.0*	1-S2n	0.345	0.759	0.345	0.428	12.459	3.225
4.06	4.06	334.25	1.085	0.0*	1-S2n	0.350	0.771	0.350	0.435	12.590	3.254
4.19	4.19	334.28	1.105	0.0*	1-S2n	0.355	0.783	0.355	0.442	12.722	3.281
4.26	4.26	334.29	1.118	0.0*	1-S2n	0.358	0.790	0.358	0.446	12.689	3.299
4.43	4.43	334.32	1.146	0.0*	1-S2n	0.365	0.805	0.401	0.456	11.243	3.336
4.55	4.55	334.34	1.166	0.0*	1-S2n	0.370	0.816	0.370	0.462	12.952	3.362
4.67	4.67	334.36	1.186	0.0*	1-S2n	0.375	0.827	0.375	0.469	13.056	3.388
4.79	4.79	334.38	1.206	0.0*	1-S2n	0.380	0.838	0.380	0.476	13.156	3.413

* Full Flow Headwater elevation is below inlet invert.

****

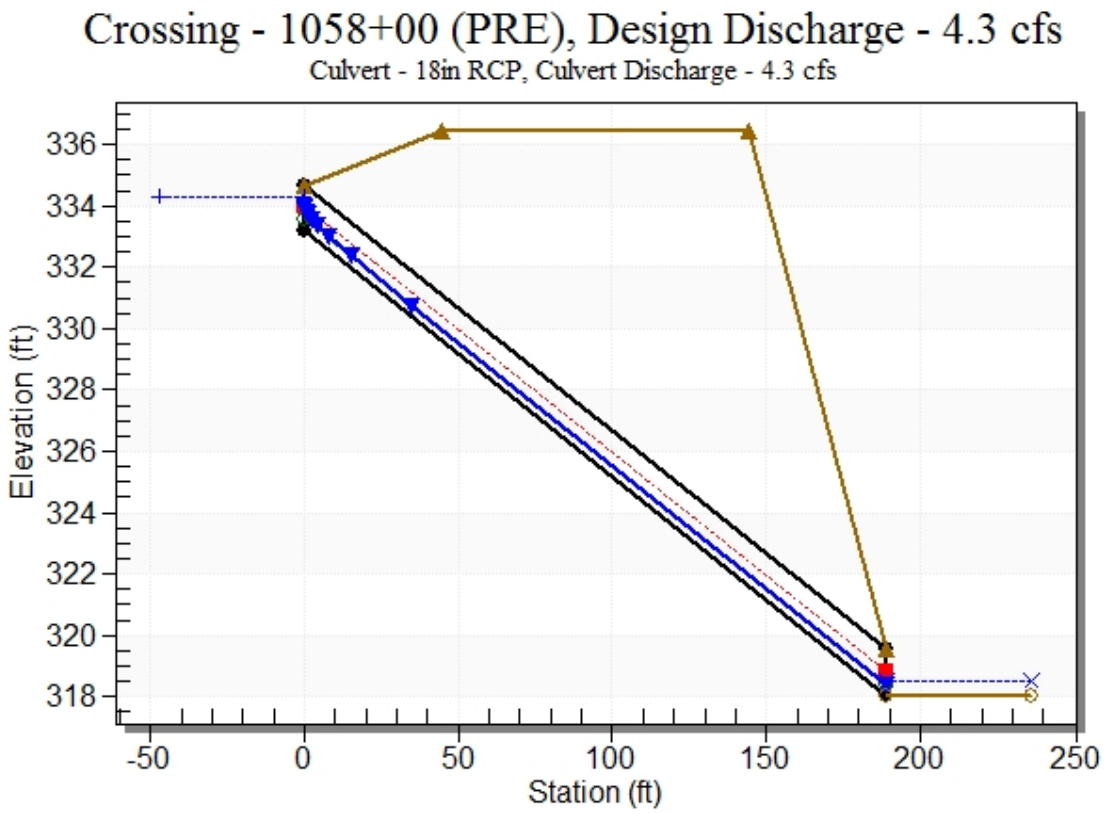
Straight Culvert

Inlet Elevation (invert): 333.17 ft, Outlet Elevation (invert): 318.05 ft

Culvert Length: 189.60 ft, Culvert Slope: 0.0800

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 333.17 ft

Outlet Station: 189.00 ft

Outlet Elevation: 318.05 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1058+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.58	318.46	0.41	3.13	2.03	0.98
3.70	318.46	0.41	3.16	2.06	0.99
3.82	318.47	0.42	3.20	2.10	0.99
3.94	318.48	0.43	3.23	2.14	0.99
4.06	318.49	0.44	3.25	2.17	0.99
4.19	318.49	0.44	3.28	2.21	0.99
4.26	318.50	0.45	3.30	2.23	1.00
4.43	318.51	0.46	3.34	2.28	1.00
4.55	318.51	0.46	3.36	2.31	1.00
4.67	318.52	0.47	3.39	2.34	1.00
4.79	318.53	0.48	3.41	2.37	1.00

Tailwater Channel Data - 1058+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 318.05 ft

Roadway Data for Crossing: 1058+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.47 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.51 cfs

Design Flow: 5.37 cfs

Maximum Flow: 6.05 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1058+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
334.33	4.51	4.51	0.00	1
334.36	4.66	4.66	0.00	1
334.38	4.82	4.82	0.00	1
334.41	4.97	4.97	0.00	1
334.43	5.13	5.13	0.00	1
334.46	5.28	5.28	0.00	1
334.47	5.37	5.37	0.00	1
334.51	5.59	5.59	0.00	1
334.53	5.74	5.74	0.00	1
334.56	5.90	5.90	0.00	1
334.58	6.05	6.05	0.00	1
336.47	13.64	13.64	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.51	4.51	334.33	1.160	0.0*	1-S2n	0.369	0.813	0.377	0.460	12.531	3.354
4.66	4.66	334.36	1.186	0.0*	1-S2n	0.375	0.827	0.375	0.469	13.052	3.387
4.82	4.82	334.38	1.211	0.0*	1-S2n	0.382	0.840	0.382	0.477	13.179	3.419
4.97	4.97	334.41	1.236	0.0*	1-S2n	0.388	0.853	0.388	0.485	13.313	3.450
5.13	5.13	334.43	1.262	0.0*	1-S2n	0.394	0.866	0.394	0.493	13.453	3.480
5.28	5.28	334.46	1.287	0.0*	1-S2n	0.400	0.883	0.400	0.501	13.494	3.510
5.37	5.37	334.47	1.302	0.0*	1-S2n	0.403	0.890	0.403	0.506	13.564	3.527
5.59	5.59	334.51	1.337	0.0*	1-S2n	0.411	0.908	0.413	0.516	13.652	3.567
5.74	5.74	334.53	1.363	0.0*	1-S2n	0.417	0.921	0.417	0.524	13.839	3.595
5.90	5.90	334.56	1.388	0.0*	1-S2n	0.423	0.933	0.423	0.531	13.947	3.622
6.05	6.05	334.58	1.414	0.0*	1-S2n	0.429	0.945	0.429	0.539	14.067	3.649

* Full Flow Headwater elevation is below inlet invert.

****

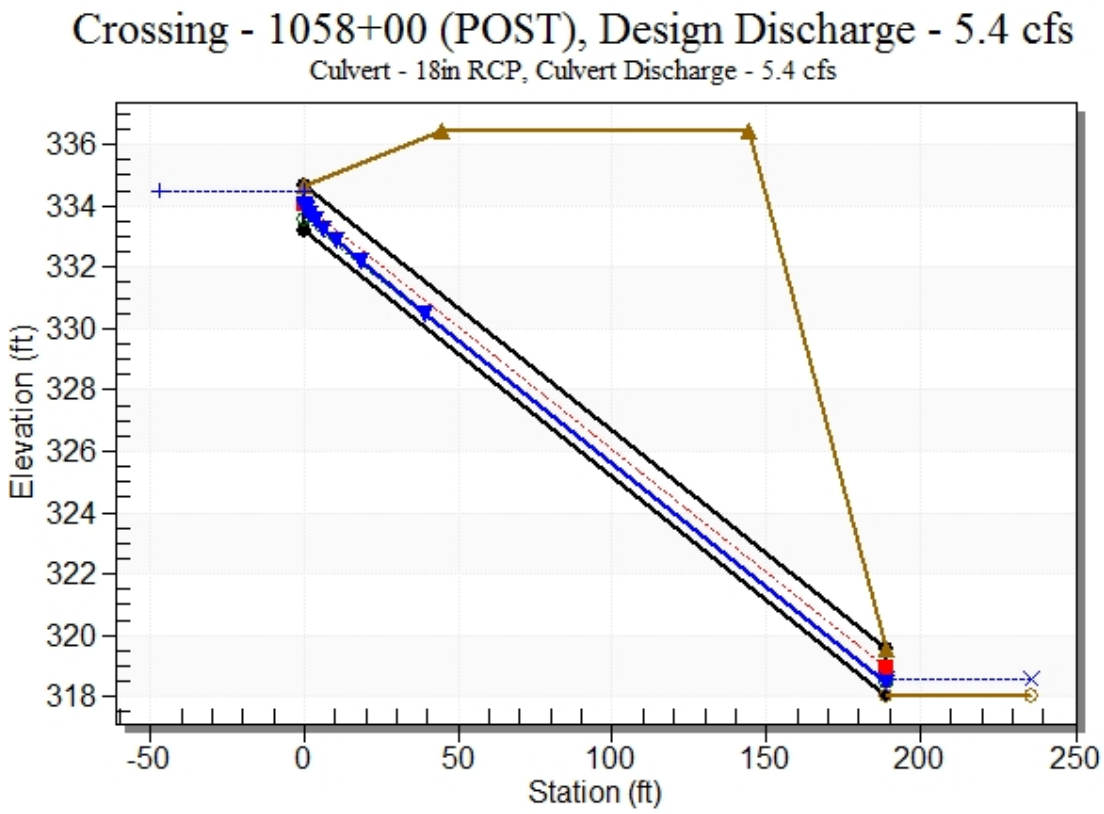
Straight Culvert

Inlet Elevation (invert): 333.17 ft, Outlet Elevation (invert): 318.05 ft

Culvert Length: 189.60 ft, Culvert Slope: 0.0800

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 333.17 ft

Outlet Station: 189.00 ft

Outlet Elevation: 318.05 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1058+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.51	318.51	0.46	3.35	2.30	1.00
4.66	318.52	0.47	3.39	2.34	1.00
4.82	318.53	0.48	3.42	2.38	1.00
4.97	318.54	0.49	3.45	2.42	1.01
5.13	318.54	0.49	3.48	2.46	1.01
5.28	318.55	0.50	3.51	2.50	1.01
5.37	318.56	0.51	3.53	2.52	1.01
5.59	318.57	0.52	3.57	2.58	1.01
5.74	318.57	0.52	3.60	2.62	1.01
5.90	318.58	0.53	3.62	2.65	1.02
6.05	318.59	0.54	3.65	2.69	1.02

Tailwater Channel Data - 1058+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 318.05 ft

Roadway Data for Crossing: 1058+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.47 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 70

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 70**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.14	1.0287
Grass	0.25	3.83	0.9570
Woods	0.15	22.73	3.4100
	Σ	**27.70**	5.3957

$C_{ave} = \frac{5.3957}{27.70} = 0.19$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.57	1.4157
Grass	0.25	3.40	0.8495
Woods	0.15	22.73	3.4100
	Σ	**27.70**	5.6752

$C_{ave} = \frac{5.6752}{27.70} = 0.20$

T_c =	40.28	min.								
I_{05} =	3.24	in / hr								
I_{10} =	3.56	in / hr								
I_{25} =	4.02	in / hr								
I_{50} =	4.39	in / hr								
I_{100} =	4.74	in / hr								

Pre Construction Runoff:

Q_{05} =	0.19	x	3.24	x	27.70	x	1	=	**17.47**	cfs
Q_{10} =	0.19	x	3.56	x	27.70	x	1	=	**19.19**	cfs
Q_{25} =	0.19	x	4.02	x	27.70	x	1.1	=	**23.88**	cfs
Q_{50} =	0.19	x	4.39	x	27.70	x	1.2	=	**28.40**	cfs
Q_{100} =	0.19	x	4.74	x	27.70	x	1.25	=	**31.96**	cfs

Post Construction Runoff:

Q_{05} =	0.20	x	3.24	x	27.70	x	1	=	**18.37**	cfs
Q_{10} =	0.20	x	3.56	x	27.70	x	1	=	**20.19**	cfs
Q_{25} =	0.20	x	4.02	x	27.70	x	1.1	=	**25.11**	cfs
Q_{50} =	0.20	x	4.39	x	27.70	x	1.2	=	**29.87**	cfs
Q_{100} =	0.20	x	4.74	x	27.70	x	1.25	=	**33.61**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site 70	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0250**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.539**	+		=	**0.539**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		Unpaved				
8	Flow length, L	----------	ft	**300**				
9	Watercourse slope, s	----------	ft/ft	**0.0930**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.92**	**0.00**			
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.017**	+		=	**0.017**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------		**2**				
	Back Slope, (_ : 1)	----------		**2**				
	Bottom Width	----------	ft	**5**				
	Flow Depth	----------	ft	**0.5**				
12	Cross sectional flow area, a	----------	ft^2	**3.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**7.24**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**0.41**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft	**0.0303**				
16	Manning's roughness coeff., n	----------		**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**2.40**	**#DIV/0!**			
18	Flow length, L	----------	ft	**1000**				
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.116**	+		=	**0.116**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.671**
						min		**40.28**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 23.88 cfs

Design Flow: 28.4 cfs

Maximum Flow: 31.96 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1066+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
300.88	23.88	23.88	0.00	1
300.92	24.69	24.69	0.00	1
300.96	25.50	25.50	0.00	1
301.00	26.30	26.30	0.00	1
301.04	27.11	27.11	0.00	1
301.09	27.92	27.92	0.00	1
301.11	28.40	28.40	0.00	1
301.17	29.54	29.54	0.00	1
301.21	30.34	30.34	0.00	1
301.25	31.15	31.15	0.00	1
301.29	31.96	31.96	0.00	1
312.00	127.44	127.44	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
23.88	23.88	300.88	2.235	0.0*	1-S2n	0.982	1.573	0.982	1.325	11.456	2.356
24.69	24.69	300.92	2.278	0.0*	1-S2n	1.000	1.599	1.000	1.349	11.559	2.378
25.50	25.50	300.96	2.321	0.0*	1-S2n	1.016	1.625	1.062	1.372	10.993	2.400
26.30	26.30	301.00	2.363	0.0*	1-S2n	1.033	1.651	1.060	1.395	11.368	2.421
27.11	27.11	301.04	2.405	0.0*	1-S2n	1.050	1.680	1.050	1.417	11.867	2.442
27.92	27.92	301.09	2.446	0.0*	1-S2n	1.067	1.706	1.067	1.439	11.961	2.463
28.40	28.40	301.11	2.470	0.0*	1-S2n	1.077	1.721	1.077	1.452	12.015	2.474
29.54	29.54	301.17	2.528	0.0*	1-S2n	1.099	1.755	1.099	1.482	12.153	2.502
30.34	30.34	301.21	2.569	0.0*	1-S2n	1.116	1.780	1.162	1.503	11.592	2.521
31.15	31.15	301.25	2.609	0.0*	1-S2n	1.132	1.807	1.132	1.524	12.325	2.539
31.96	31.96	301.29	2.650	0.0*	1-S2n	1.148	1.831	1.148	1.545	12.409	2.558

* Full Flow Headwater elevation is below inlet invert.

****

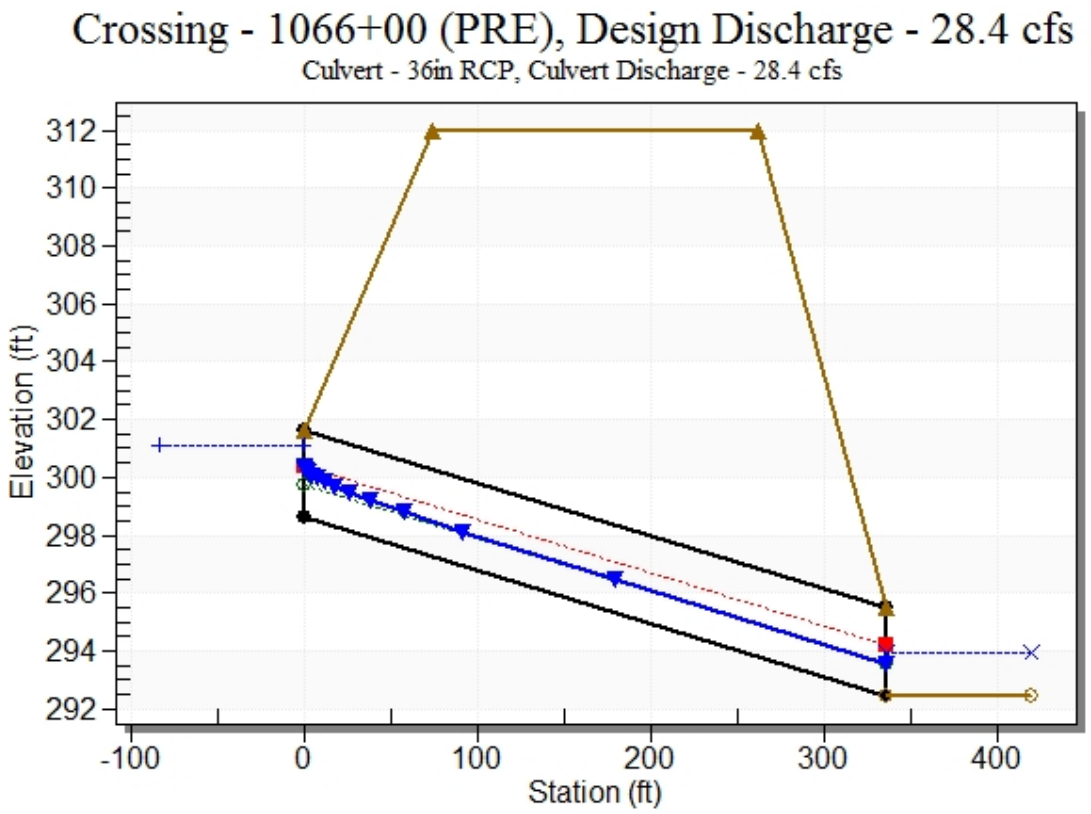
Straight Culvert

Inlet Elevation (invert): 298.64 ft, Outlet Elevation (invert): 292.47 ft

Culvert Length: 336.06 ft, Culvert Slope: 0.0184

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 298.64 ft

Outlet Station: 336.00 ft

Outlet Elevation: 292.47 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1066+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
23.88	293.79	1.32	2.36	0.83	0.42
24.69	293.82	1.35	2.38	0.84	0.42
25.50	293.84	1.37	2.40	0.86	0.42
26.30	293.86	1.39	2.42	0.87	0.42
27.11	293.89	1.42	2.44	0.88	0.42
27.92	293.91	1.44	2.46	0.90	0.42
28.40	293.92	1.45	2.47	0.91	0.42
29.54	293.95	1.48	2.50	0.92	0.42
30.34	293.97	1.50	2.52	0.94	0.42
31.15	293.99	1.52	2.54	0.95	0.43
31.96	294.01	1.54	2.56	0.96	0.43

Tailwater Channel Data - 1066+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 292.47 ft

Roadway Data for Crossing: 1066+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 312.00 ft

Roadway Surface: Paved

Roadway Top Width: 188.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 25.11 cfs

Design Flow: 29.87 cfs

Maximum Flow: 33.61 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1066+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
300.94	25.11	25.11	0.00	1
300.99	25.96	25.96	0.00	1
301.03	26.81	26.81	0.00	1
301.07	27.66	27.66	0.00	1
301.12	28.51	28.51	0.00	1
301.16	29.36	29.36	0.00	1
301.18	29.87	29.87	0.00	1
301.24	31.06	31.06	0.00	1
301.29	31.91	31.91	0.00	1
301.33	32.76	32.76	0.00	1
301.37	33.61	33.61	0.00	1
312.00	127.44	127.44	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
25.11	25.11	300.94	2.301	0.0*	1-S2n	1.008	1.613	1.062	1.361	10.823	2.390
25.96	25.96	300.99	2.345	0.0*	1-S2n	1.026	1.640	1.061	1.385	11.206	2.413
26.81	26.81	301.03	2.389	0.0*	1-S2n	1.044	1.671	1.044	1.409	11.843	2.434
27.66	27.66	301.07	2.433	0.0*	1-S2n	1.061	1.698	1.061	1.432	11.931	2.456
28.51	28.51	301.12	2.476	0.0*	1-S2n	1.079	1.724	1.079	1.455	12.029	2.477
29.36	29.36	301.16	2.519	0.0*	1-S2n	1.096	1.750	1.096	1.478	12.132	2.498
29.87	29.87	301.18	2.545	0.0*	1-S2n	1.106	1.765	1.160	1.491	11.437	2.510
31.06	31.06	301.24	2.605	0.0*	1-S2n	1.130	1.804	1.155	1.522	11.954	2.537
31.91	31.91	301.29	2.647	0.0*	1-S2n	1.147	1.830	1.147	1.543	12.404	2.557
32.76	32.76	301.33	2.690	0.0*	1-S2n	1.163	1.855	1.163	1.565	12.494	2.575
33.61	33.61	301.37	2.732	0.0*	1-S2n	1.179	1.879	1.179	1.586	12.585	2.593

* Full Flow Headwater elevation is below inlet invert.

****

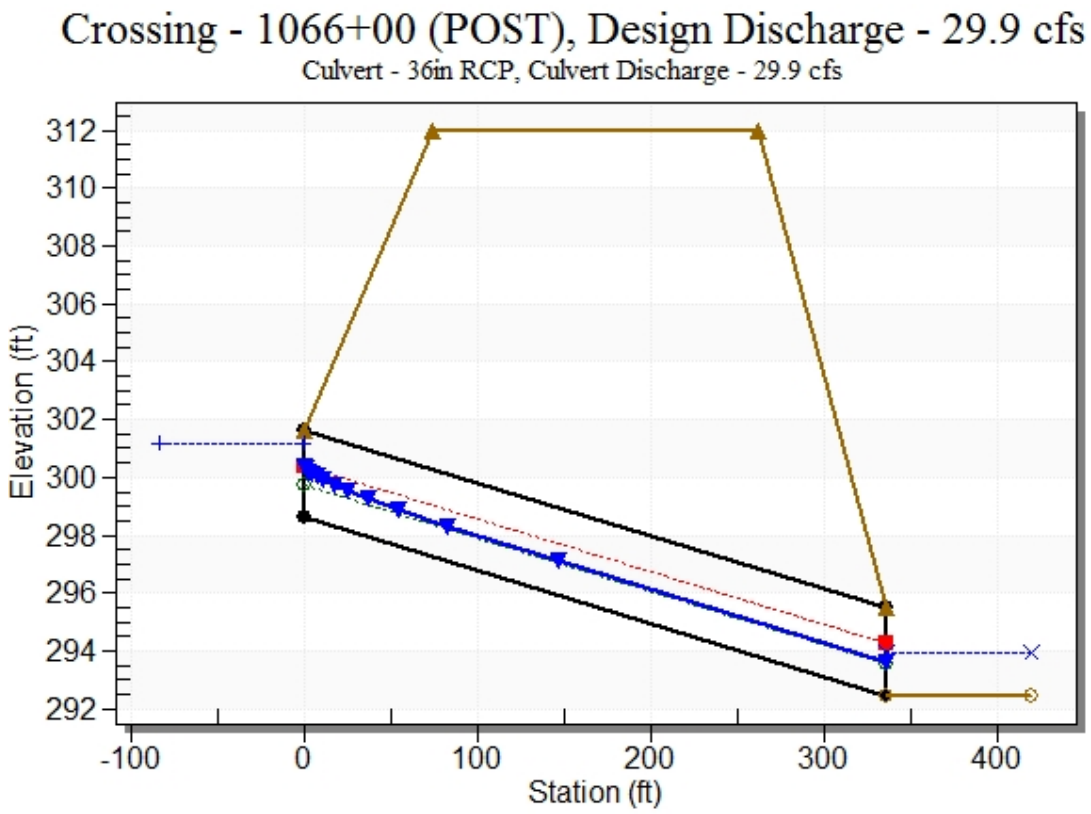
Straight Culvert

Inlet Elevation (invert): 298.64 ft, Outlet Elevation (invert): 292.47 ft

Culvert Length: 336.06 ft, Culvert Slope: 0.0184

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 298.64 ft

Outlet Station: 336.00 ft

Outlet Elevation: 292.47 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1066+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
25.11	293.83	1.36	2.39	0.85	0.42
25.96	293.85	1.38	2.41	0.86	0.42
26.81	293.88	1.41	2.43	0.88	0.42
27.66	293.90	1.43	2.46	0.89	0.42
28.51	293.93	1.46	2.48	0.91	0.42
29.36	293.95	1.48	2.50	0.92	0.42
29.87	293.96	1.49	2.51	0.93	0.42
31.06	293.99	1.52	2.54	0.95	0.43
31.91	294.01	1.54	2.56	0.96	0.43
32.76	294.03	1.56	2.58	0.98	0.43
33.61	294.06	1.59	2.59	0.99	0.43

Tailwater Channel Data - 1066+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 292.47 ft

Roadway Data for Crossing: 1066+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 312.00 ft

Roadway Surface: Paved

Roadway Top Width: 188.00 ft

CULVERT 71

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site71**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.24	0.2138
Grass	0.25	0.12	0.0290
Woods	0.15	2.89	0.4330
	Σ	**3.24**	0.6758

$C_{ave} = \frac{0.6758}{3.24} = 0.21$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.34	0.3038
Grass	0.25	0.12	0.0290
Woods	0.15	2.89	0.4330
	Σ	**3.34**	0.7658

$C_{ave} = \frac{0.7658}{3.34} = 0.23$

T_c =	27.51	min.								
I_{05} =	3.94	in / hr								
I_{10} =	4.34	in / hr								
I_{25} =	4.92	in / hr								
I_{50} =	5.38	in / hr								
I_{100} =	5.82	in / hr								

Pre Construction Runoff:

Q_{05} =	0.21	**x**	3.94	**x**	3.24	**x**	1	=	**2.66**	cfs
Q_{10} =	0.21	**x**	4.34	**x**	3.24	**x**	1	=	**2.93**	cfs
Q_{25} =	0.21	**x**	4.92	**x**	3.24	**x**	1.1	=	**3.66**	cfs
Q_{50} =	0.21	**x**	5.38	**x**	3.24	**x**	1.2	=	**4.36**	cfs
Q_{100} =	0.21	**x**	5.82	**x**	3.24	**x**	1.25	=	**4.92**	cfs

Post Construction Runoff:

Q_{05} =	0.23	**x**	3.94	**x**	3.34	**x**	1	=	**3.01**	cfs
Q_{10} =	0.23	**x**	4.34	**x**	3.34	**x**	1	=	**3.32**	cfs
Q_{25} =	0.23	**x**	4.92	**x**	3.34	**x**	1.1	=	**4.14**	cfs
Q_{50} =	0.23	**x**	5.38	**x**	3.34	**x**	1.2	=	**4.94**	cfs
Q_{100} =	0.23	**x**	5.82	**x**	3.34	**x**	1.25	=	**5.57**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site71	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		Unpaved				
8	Flow length, L	----------	ft	**185**				
9	Watercourse slope, s	----------	ft/ft	**0.0700**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.27**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.459**
							min	**27.51**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site 71b	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0800**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.338**	+		=	**0.338**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		Unpaved		Unpaved		
8	Flow length, L	----------	ft	**150**		**50**		
9	Watercourse slope, s	----------	ft/ft	**0.1067**		**0.4000**		
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.27**		**10.20**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.008**	+	**0.001**	=	**0.009**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.348**
							min	**20.86**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.66 cfs

Design Flow: 4.36 cfs

Maximum Flow: 4.92 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1069+20 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
300.84	3.66	3.66	0.00	1
300.86	3.79	3.79	0.00	1
300.88	3.91	3.91	0.00	1
300.91	4.04	4.04	0.00	1
300.93	4.16	4.16	0.00	1
300.95	4.29	4.29	0.00	1
300.96	4.36	4.36	0.00	1
300.99	4.54	4.54	0.00	1
301.01	4.67	4.67	0.00	1
301.03	4.79	4.79	0.00	1
301.05	4.92	4.92	0.00	1
302.58	10.27	10.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.66	3.66	300.84	1.069	0.0*	1-S2n	0.659	0.731	0.659	0.247	4.735	5.951
3.79	3.79	300.86	1.092	0.0*	1-S2n	0.672	0.744	0.672	0.251	4.774	6.017
3.91	3.91	300.88	1.114	0.0*	1-S2n	0.685	0.756	0.685	0.256	4.815	6.079
4.04	4.04	300.91	1.136	0.0*	1-S2n	0.697	0.769	0.697	0.261	4.855	6.140
4.16	4.16	300.93	1.157	0.0*	1-S2n	0.710	0.781	0.710	0.265	4.891	6.202
4.29	4.29	300.95	1.179	0.0*	1-S2n	0.722	0.793	0.722	0.270	4.928	6.259
4.36	4.36	300.96	1.190	0.0*	1-S2n	0.729	0.799	0.729	0.272	4.948	6.291
4.54	4.54	300.99	1.221	0.0*	1-S2n	0.747	0.816	0.747	0.279	4.998	6.372
4.67	4.67	301.01	1.242	0.0*	1-S2n	0.759	0.827	0.759	0.283	5.032	6.428
4.79	4.79	301.03	1.263	0.0*	1-S2n	0.772	0.838	0.772	0.287	5.064	6.483
4.92	4.92	301.05	1.283	0.0*	1-S2n	0.784	0.849	0.784	0.292	5.096	6.533

* Full Flow Headwater elevation is below inlet invert.

****

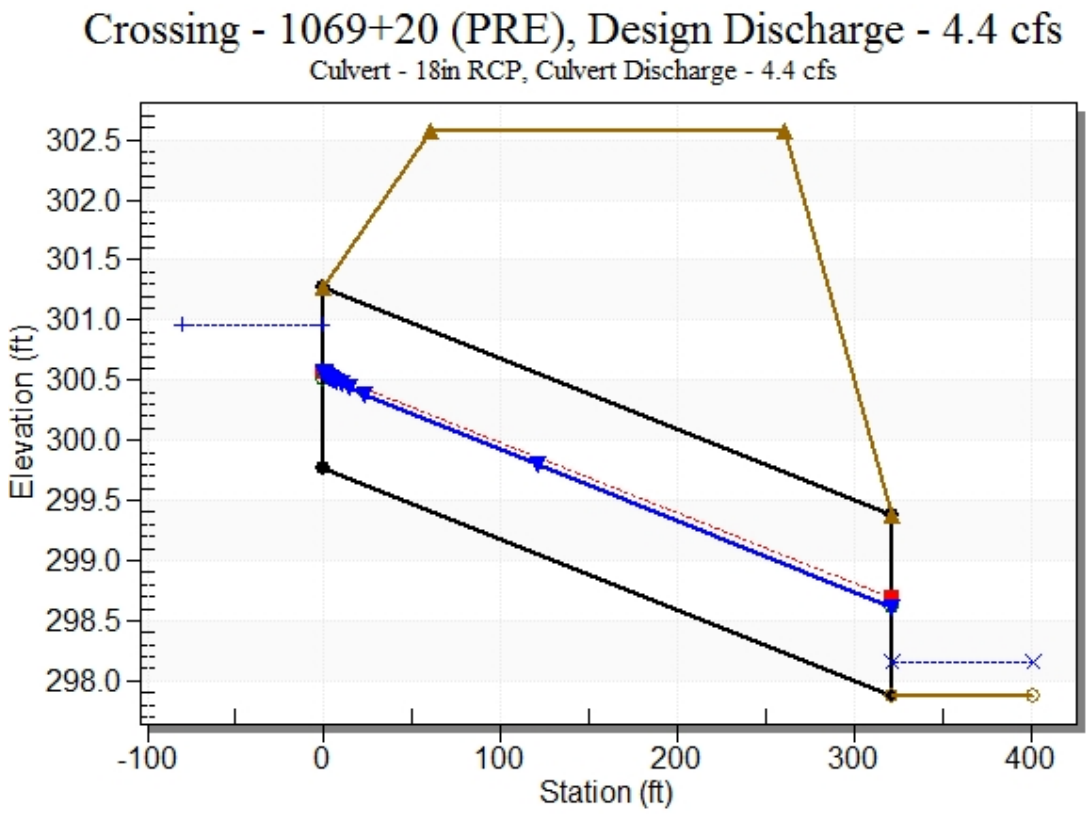
Straight Culvert

Inlet Elevation (invert): 299.77 ft, Outlet Elevation (invert): 297.88 ft

Culvert Length: 321.01 ft, Culvert Slope: 0.0059

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 299.77 ft

Outlet Station: 321.00 ft

Outlet Elevation: 297.88 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1069+20 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.66	298.13	0.25	5.95	0.31	2.31
3.79	298.13	0.25	6.02	0.31	2.32
3.91	298.14	0.26	6.08	0.32	2.32
4.04	298.14	0.26	6.14	0.33	2.33
4.16	298.15	0.27	6.20	0.33	2.33
4.29	298.15	0.27	6.26	0.34	2.34
4.36	298.15	0.27	6.29	0.34	2.34
4.54	298.16	0.28	6.37	0.35	2.35
4.67	298.16	0.28	6.43	0.35	2.35
4.79	298.17	0.29	6.48	0.36	2.36
4.92	298.17	0.29	6.53	0.36	2.36

Tailwater Channel Data - 1069+20 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0120

Channel Invert Elevation: 297.88 ft

Roadway Data for Crossing: 1069+20 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 302.58 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.14 cfs

Design Flow: 4.94 cfs

Maximum Flow: 5.57 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1069+20 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
300.92	4.14	4.14	0.00	1
300.95	4.28	4.28	0.00	1
300.97	4.43	4.43	0.00	1
301.00	4.57	4.57	0.00	1
301.02	4.71	4.71	0.00	1
301.04	4.86	4.86	0.00	1
301.06	4.94	4.94	0.00	1
301.09	5.14	5.14	0.00	1
301.11	5.28	5.28	0.00	1
301.14	5.43	5.43	0.00	1
301.16	5.57	5.57	0.00	1
302.58	10.27	10.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.14	4.14	300.92	1.153	0.0*	1-S2n	0.707	0.779	0.707	0.264	4.884	6.190
4.28	4.28	300.95	1.177	0.0*	1-S2n	0.722	0.792	0.722	0.270	4.926	6.255
4.43	4.43	300.97	1.201	0.0*	1-S2n	0.736	0.805	0.756	0.275	4.796	6.323
4.57	4.57	301.00	1.225	0.0*	1-S2n	0.750	0.818	0.750	0.280	5.005	6.386
4.71	4.71	301.02	1.249	0.0*	1-S2n	0.764	0.831	0.764	0.285	5.043	6.446
4.86	4.86	301.04	1.273	0.0*	1-S2n	0.778	0.843	0.778	0.289	5.080	6.509
4.94	4.94	301.06	1.287	0.0*	1-S2n	0.786	0.850	0.786	0.292	5.101	6.542
5.14	5.14	301.09	1.320	0.0*	1-S2n	0.805	0.867	0.805	0.299	5.149	6.624
5.28	5.28	301.11	1.343	0.0*	1-S2n	0.819	0.883	0.819	0.303	5.183	6.681
5.43	5.43	301.14	1.367	0.0*	1-S2n	0.833	0.895	0.833	0.308	5.214	6.737
5.57	5.57	301.16	1.390	0.013	1-S2n	0.847	0.907	0.847	0.312	5.245	6.791

* Full Flow Headwater elevation is below inlet invert.

****

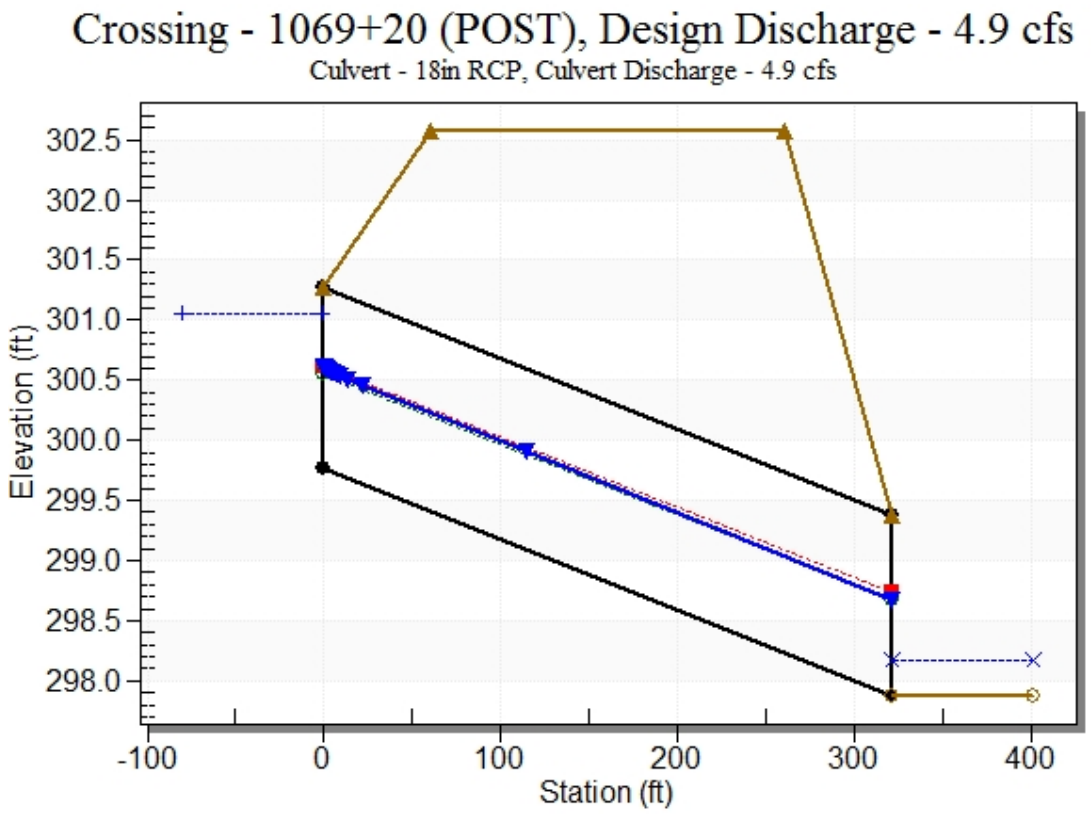
Straight Culvert

Inlet Elevation (invert): 299.77 ft, Outlet Elevation (invert): 297.88 ft

Culvert Length: 321.01 ft, Culvert Slope: 0.0059

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 299.77 ft

Outlet Station: 321.00 ft

Outlet Elevation: 297.88 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1069+20 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.14	298.14	0.26	6.19	0.33	2.33
4.28	298.15	0.27	6.26	0.34	2.34
4.43	298.15	0.27	6.32	0.34	2.34
4.57	298.16	0.28	6.39	0.35	2.35
4.71	298.16	0.28	6.45	0.36	2.35
4.86	298.17	0.29	6.51	0.36	2.36
4.94	298.17	0.29	6.54	0.36	2.36
5.14	298.18	0.30	6.62	0.37	2.37
5.28	298.18	0.30	6.68	0.38	2.37
5.43	298.19	0.31	6.74	0.38	2.38
5.57	298.19	0.31	6.79	0.39	2.38

Tailwater Channel Data - 1069+20 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0120

Channel Invert Elevation: 297.88 ft

Roadway Data for Crossing: 1069+20 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 302.58 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

CULVERT 13

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 13 (US), South_Carolina
User:
Date: Friday, December 15, 2017 09:55 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 13 (US)
   Basin Drainage Area: 2.21 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 2.21 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

Results for: Site 13 (US)

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCT

REG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	265	152	461	35
PK5	485	281	838	34
PK10	649	370	1140	35
PK25	868	477	1580	38
PK50	1060	566	2000	40
PK100	1240	640	2420	42
PK200	1420	706	2860	44
PK500	1700	805	3600	48

maximum: 9640 (for C&B region 2)

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 13 (DS), South_Carolina
User:
Date: Friday, December 15, 2017 09:52 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 13 (DS)
   Basin Drainage Area: 2.42 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 2.42 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

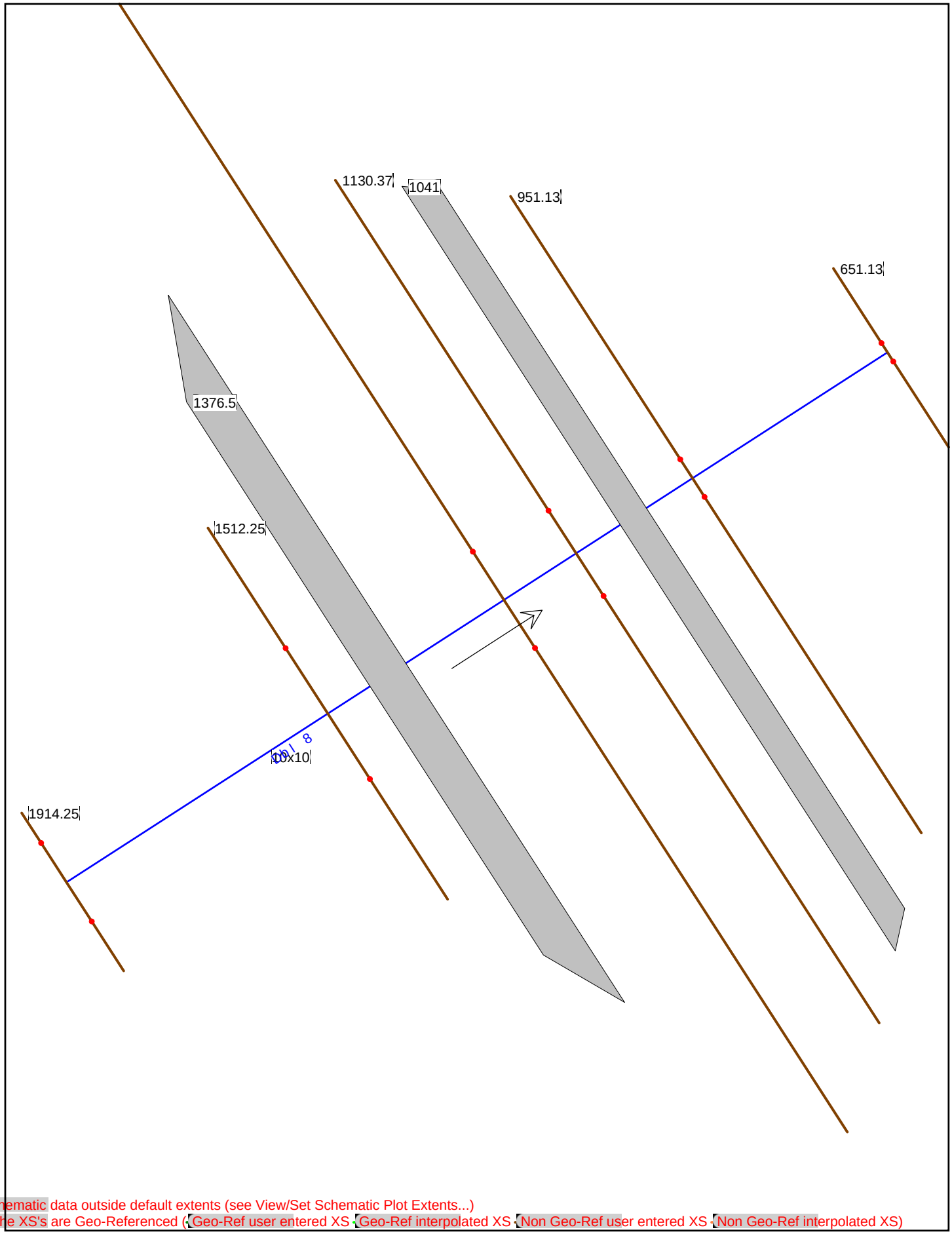
Results for: Site 13 (DS)

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

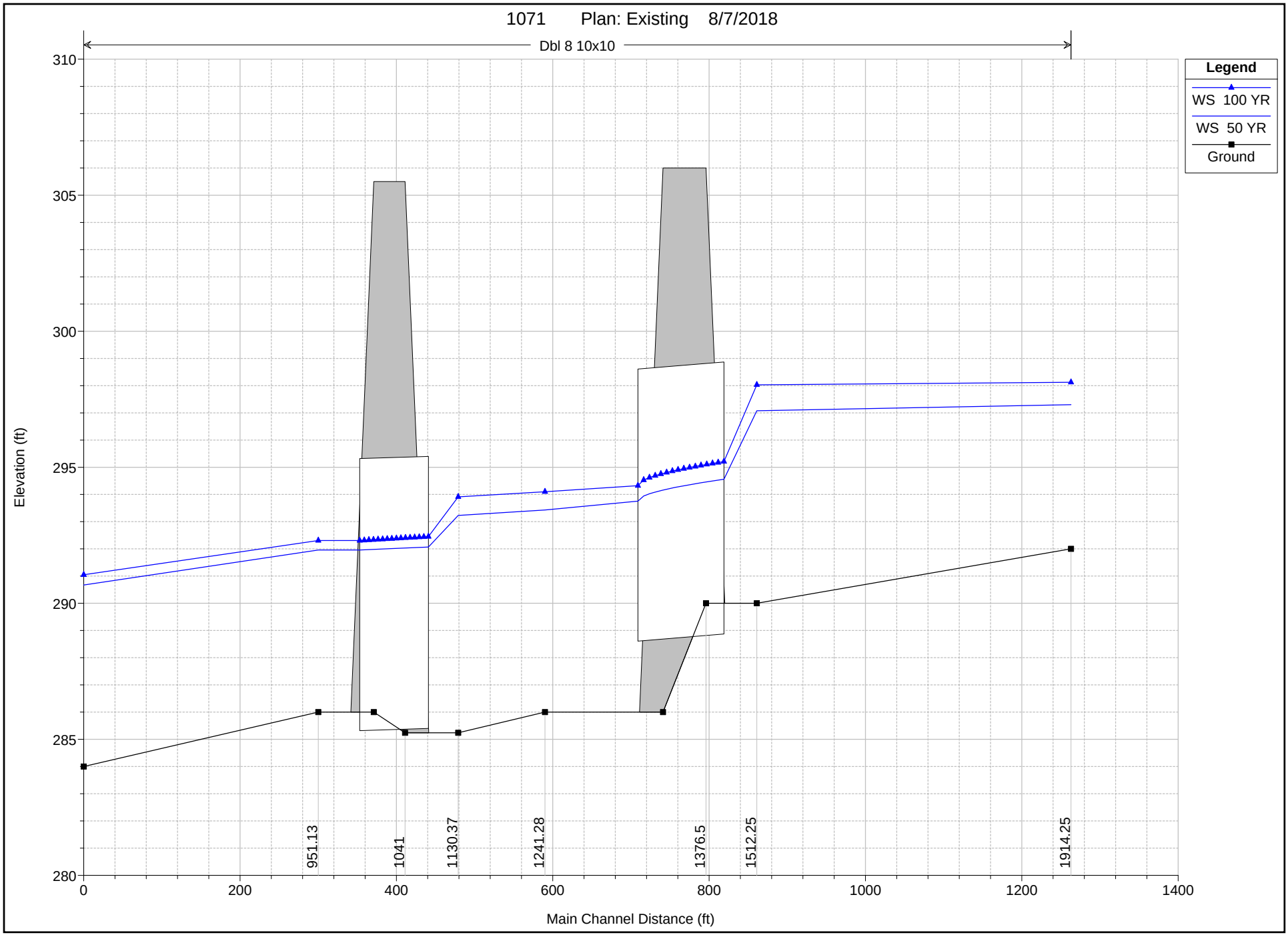
00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	281	162	489	35
PK5	514	297	887	34
PK10	687	391	1210	35
PK25	917	504	1670	38
PK50	1120	598	2110	40
PK100	1310	675	2550	42
PK200	1500	745	3020	44
PK500	1790	849	3790	48

maximum: 10200 (for C&B region 2)



Some schematic data outside default extents (see View/Set Schematic Plot Extents...)
None of the XS's are Geo-Referenced (Geo-Ref user entered XS Geo-Ref interpolated XS Non Geo-Ref user entered XS Non Geo-Ref interpolated XS)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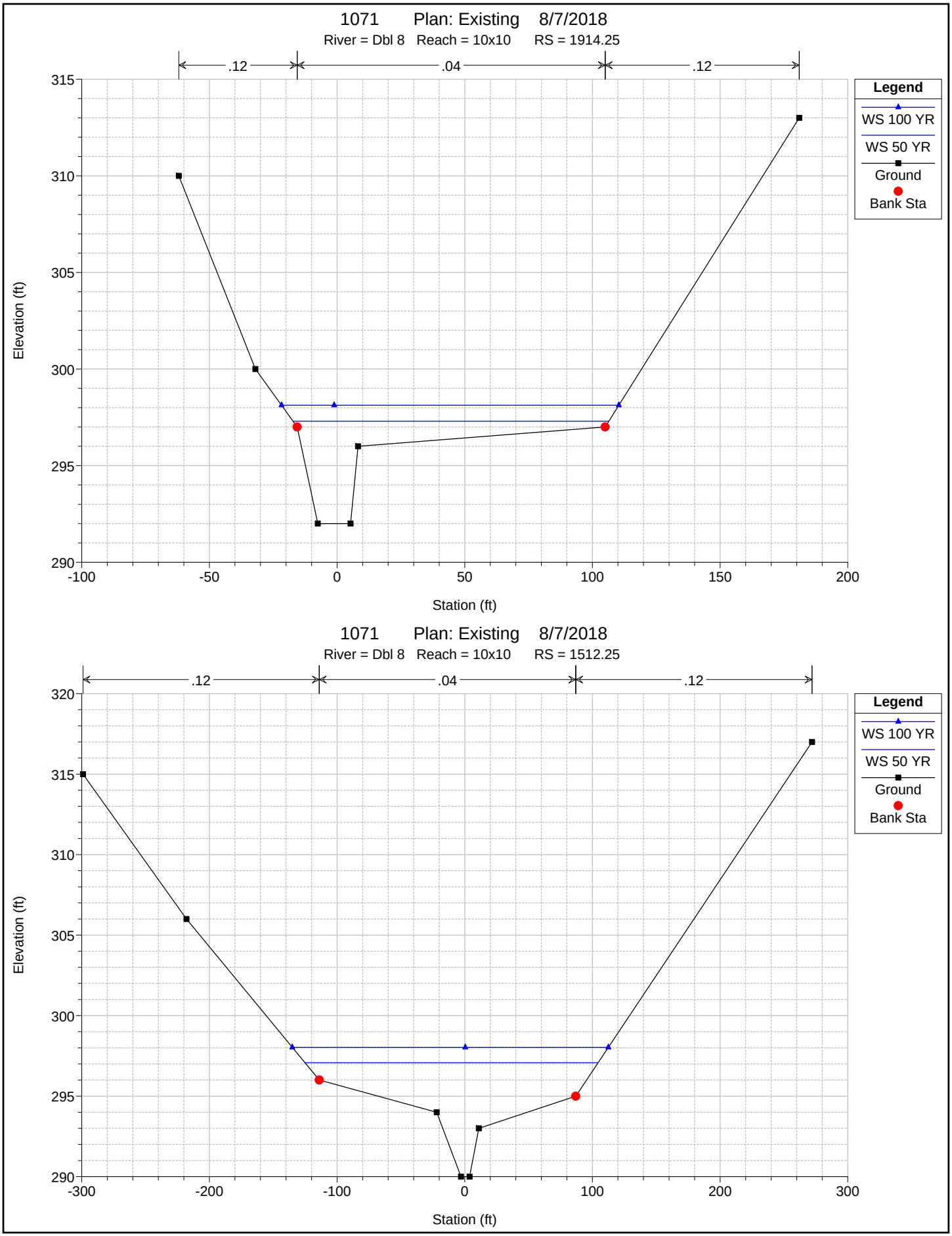
Dbl 8 10x10
Legend
WS 100 YR
WS 50 YR
Ground
Elevation (ft)
Main Channel Distance (ft)
310
305
300
295
290
285
280
0
200
400
600
800
1000
1200
1400
951.13
1041
1130.37
1241.28
1376.5
1512.25
1914.25


1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1914.25
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
315
310
305
300
295
290
-100
-50
0
50
100
150
200
Station (ft)
1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1512.25
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
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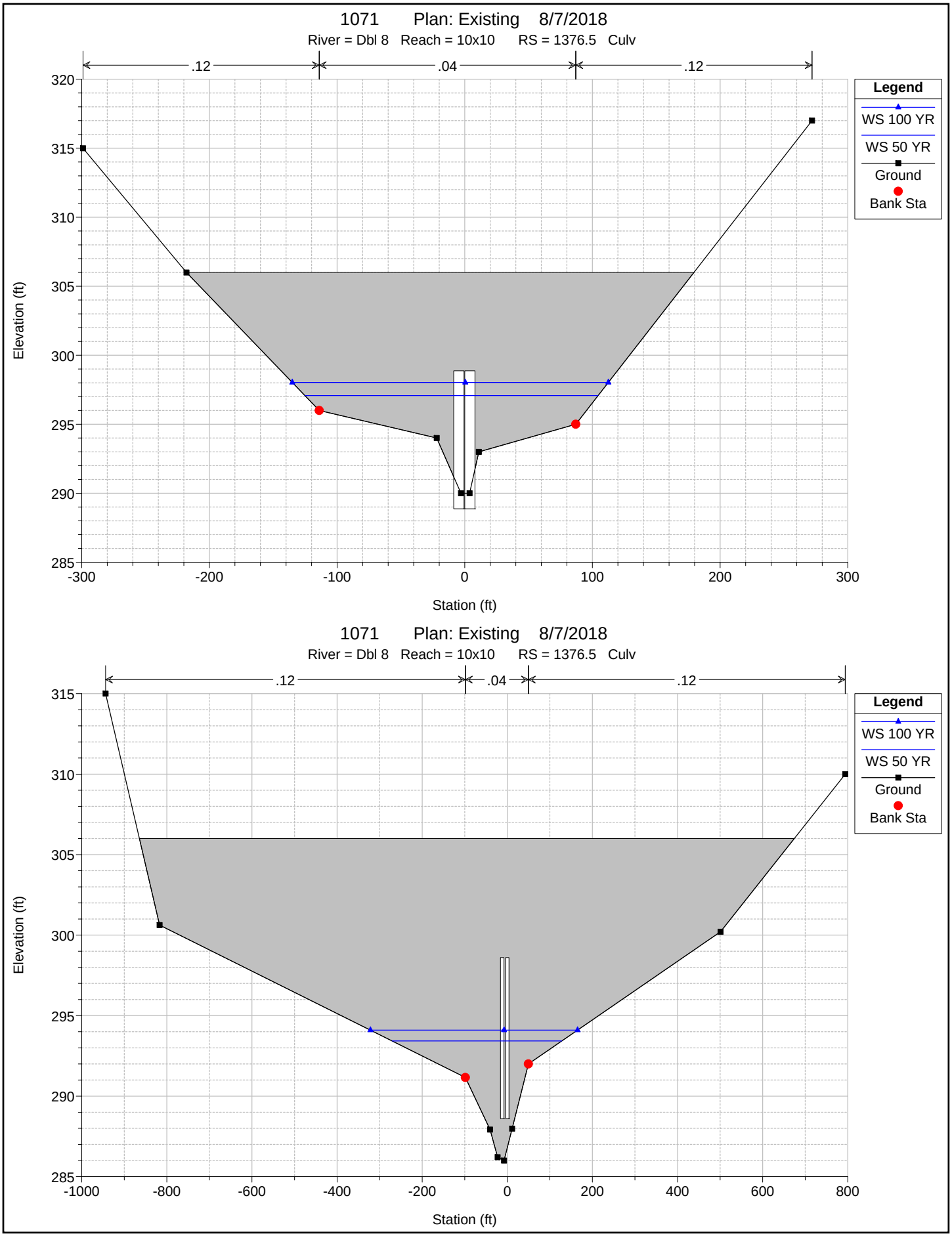
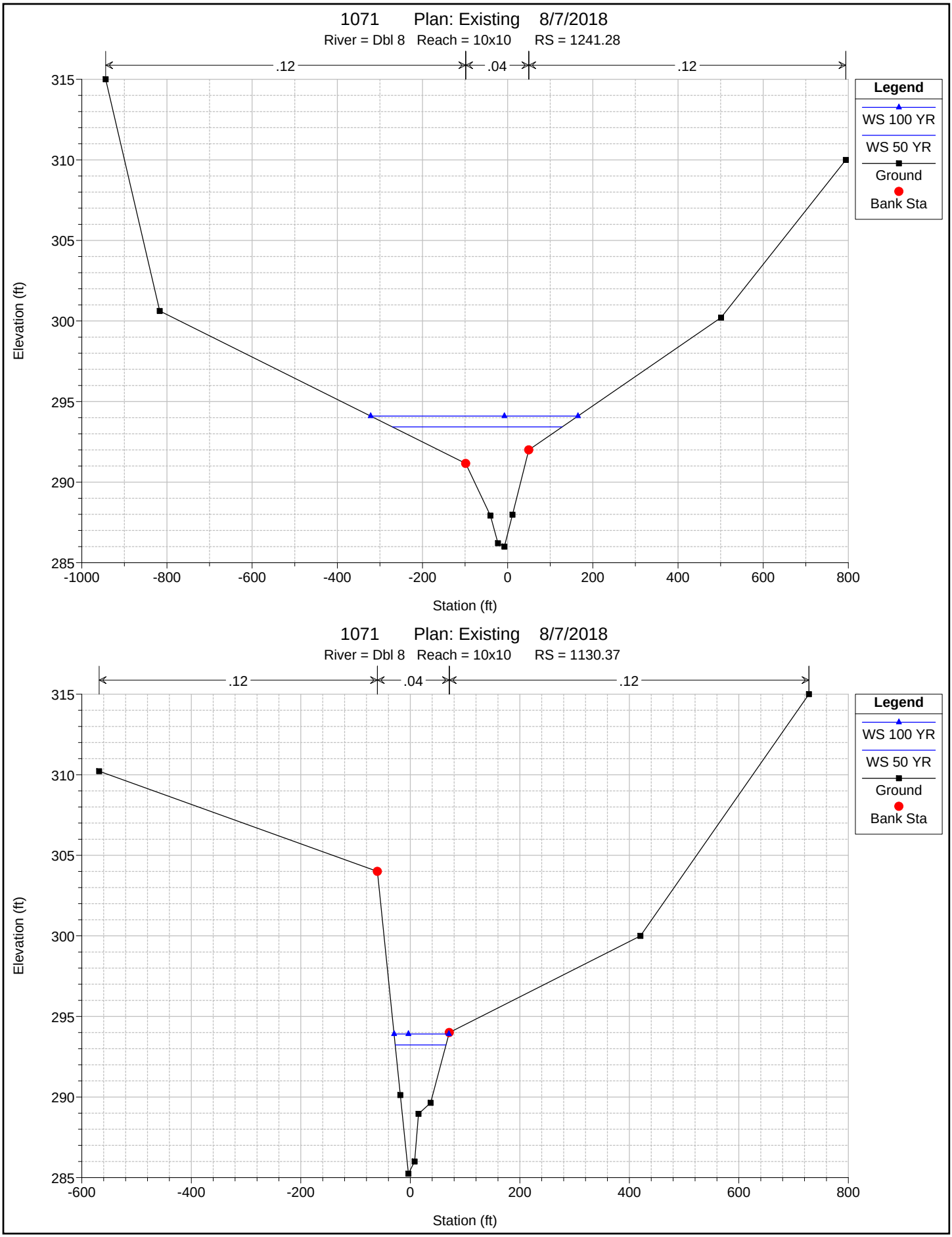
315
310
305
300
295
290
-300
-200
-100
0
100
200
300
Station (ft)


1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1376.5 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
320
315
310
305
300
295
290
285
-300
-200
-100
0
100
200
300
Station (ft)
1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1376.5 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
315
310
305
300
295
290
285
-1000
-800
-600
-400
-200
0
200
400
600
800
Station (ft)


1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1241.28
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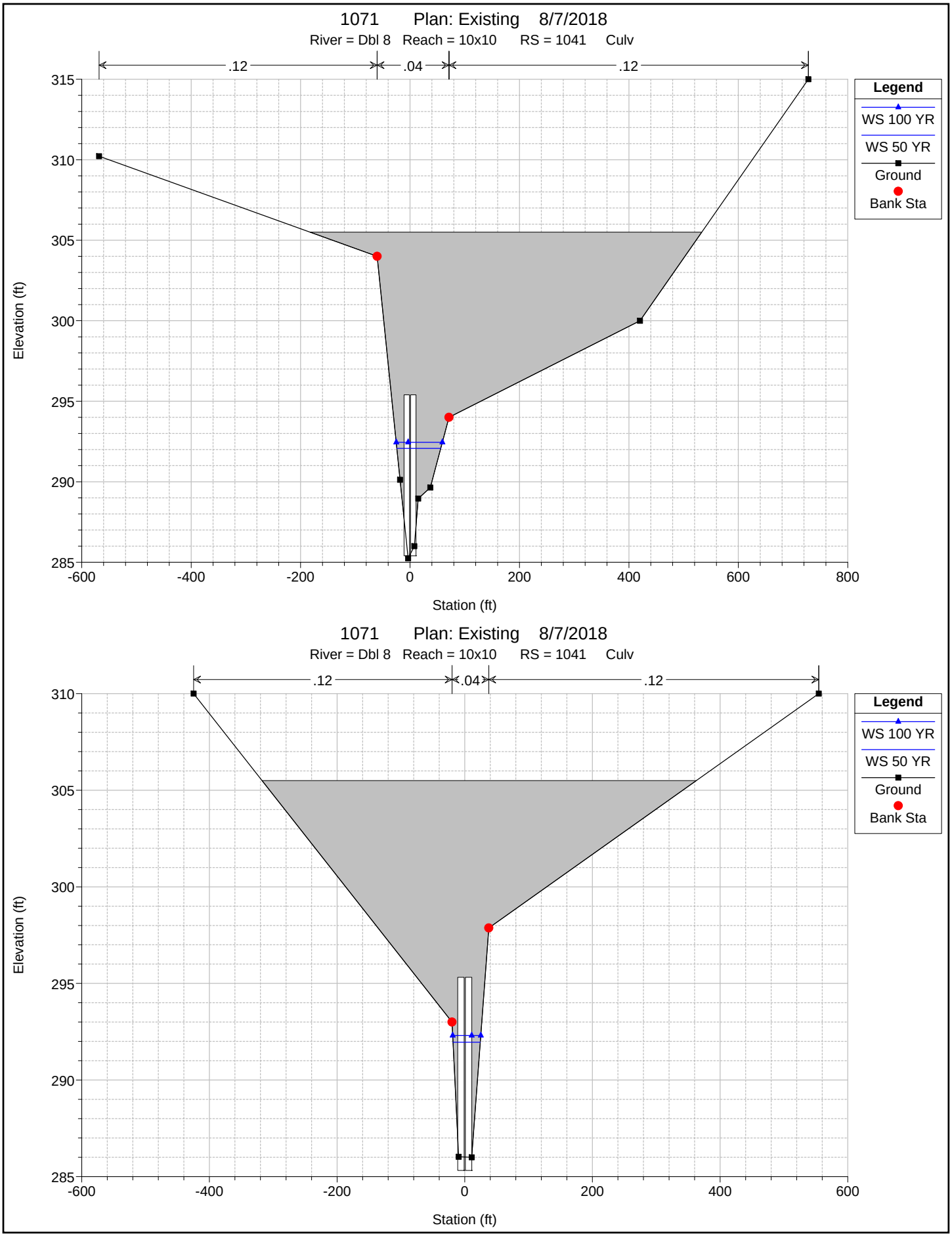
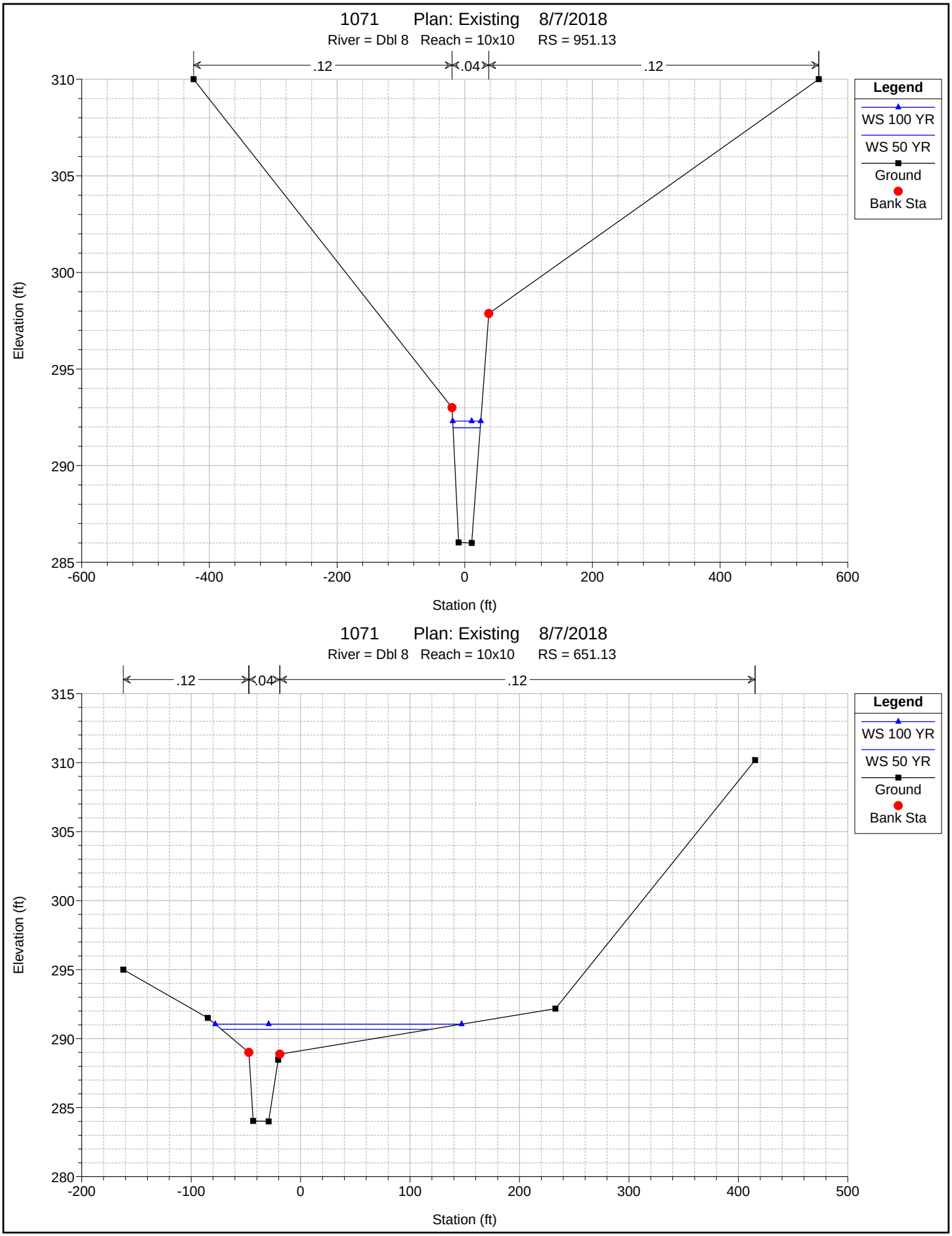
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
315
310
305
300
295
290
285
-1000
-800
-600
-400
-200
0
200
400
600
800
Station (ft)
1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1130.37
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
315
310
305
300
295
290
285
-600
-400
-200
0
200
400
600
800
Station (ft)


1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1041 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
315
310
305
300
295
290
285
-600
-400
-200
0
200
400
600
800
Station (ft)
1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 1041 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
310
305
300
295
290
285
-600
-400
-200
0
200
400
600
Station (ft)


1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 951.13
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1071 Plan: Existing 8/7/2018
River = Dbl 8 Reach = 10x10 RS = 651.13
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS Plan: Existing River: Dbl 8 Reach: 10x10

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
10x10	1914.25	50 YR	1060.00	292.00	297.30	297.13	297.85	0.015999	5.97	178.05	123.66	0.87
10x10	1914.25	100 YR	1240.00	292.00	298.12		298.43	0.004938	4.46	283.60	132.09	0.52
10x10	1512.25	50 YR	1060.00	290.00	297.08	294.62	297.12	0.000497	1.73	633.58	229.65	0.17
10x10	1512.25	100 YR	1240.00	290.00	298.03	294.81	298.07	0.000270	1.53	861.20	247.59	0.13
10x10	1376.5		Culvert									
10x10	1241.28	50 YR	1060.00	286.00	293.43		293.46	0.000191	1.45	954.18	398.83	0.12
10x10	1241.28	100 YR	1240.00	286.00	294.10		294.13	0.000159	1.44	1250.99	486.59	0.11
10x10	1130.37	50 YR	1120.00	285.24	293.23	290.24	293.38	0.001173	3.10	361.18	92.78	0.28
10x10	1130.37	100 YR	1310.00	285.24	293.91	290.52	294.06	0.001019	3.07	426.76	100.16	0.26
10x10	1041		Culvert									
10x10	951.13	50 YR	1120.00	286.00	291.96		292.51	0.003944	5.97	187.55	42.74	0.50
10x10	951.13	100 YR	1310.00	286.00	292.31		292.96	0.004349	6.46	202.65	44.05	0.53
10x10	651.13	50 YR	1120.00	284.00	290.67	288.93	291.30	0.004005	6.67	297.10	190.92	0.51
10x10	651.13	100 YR	1310.00	284.00	291.05	289.66	291.70	0.004003	6.97	375.02	225.12	0.51

HEC-RAS Plan: Existing River: Dbl 8 Reach: 10x10

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
10x10	1376.5 Culvert #1	50 YR	297.12	297.08	297.12	297.09	306.01	1060.00		3.65	11.64	12.87
10x10	1376.5 Culvert #1	100 YR	298.07	298.03	298.07	297.99	306.01	1240.00		3.93	12.22	13.56
10x10	1041 Culvert #1	50 YR	293.38	293.23	292.76	293.38	305.51	1120.00		1.27	8.40	8.44
10x10	1041 Culvert #1	100 YR	294.06	293.91	293.60	294.06	305.51	1310.00		1.60	9.29	9.37

CULVERT 14

Hydrograph Report

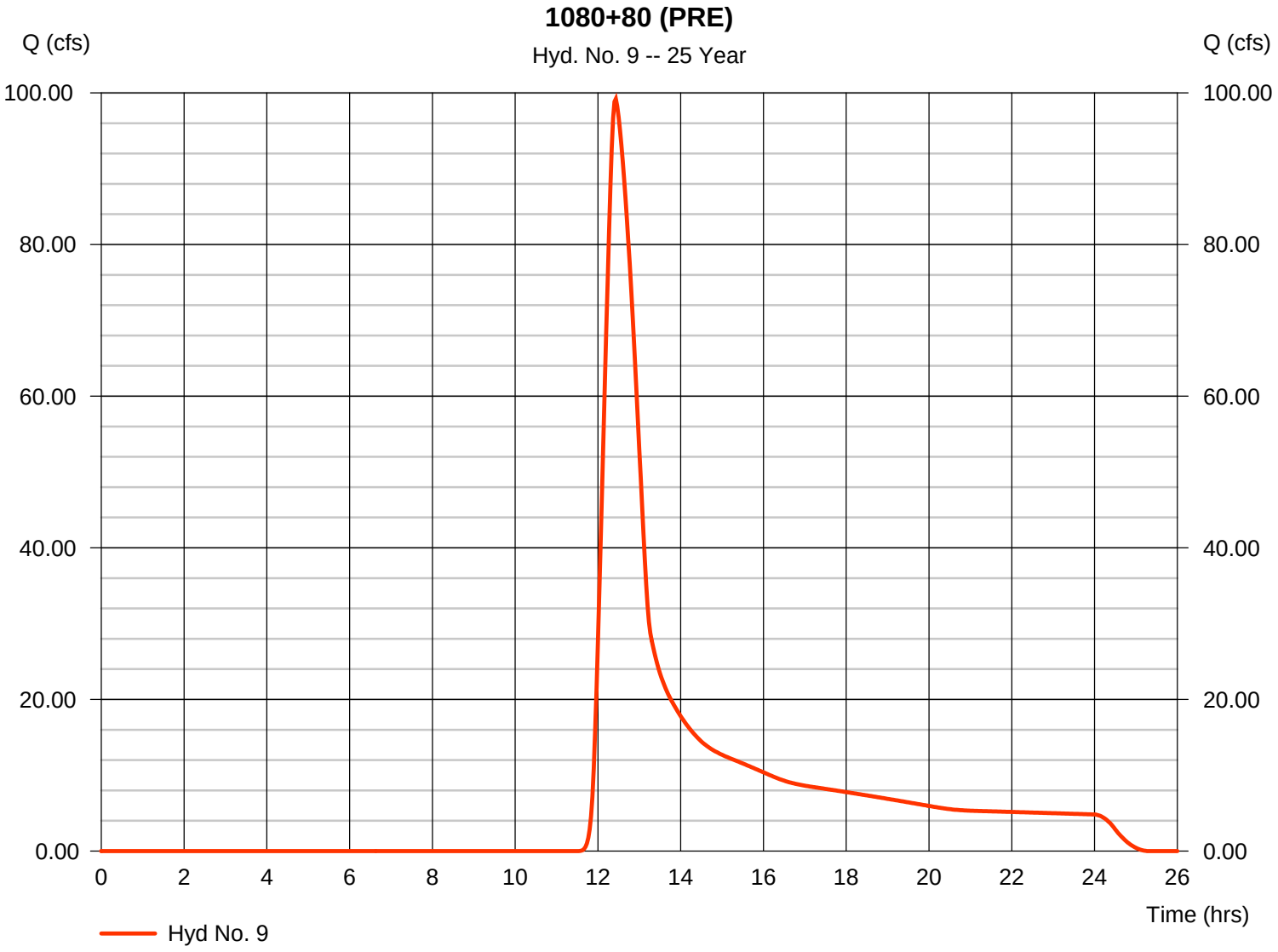
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 9

1080+80 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 99.21 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 669,749 cuft
Drainage area	= 119.740 ac	Curve number	= 53*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 48.00 min
Total precip.	= 6.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



Hydrograph Report

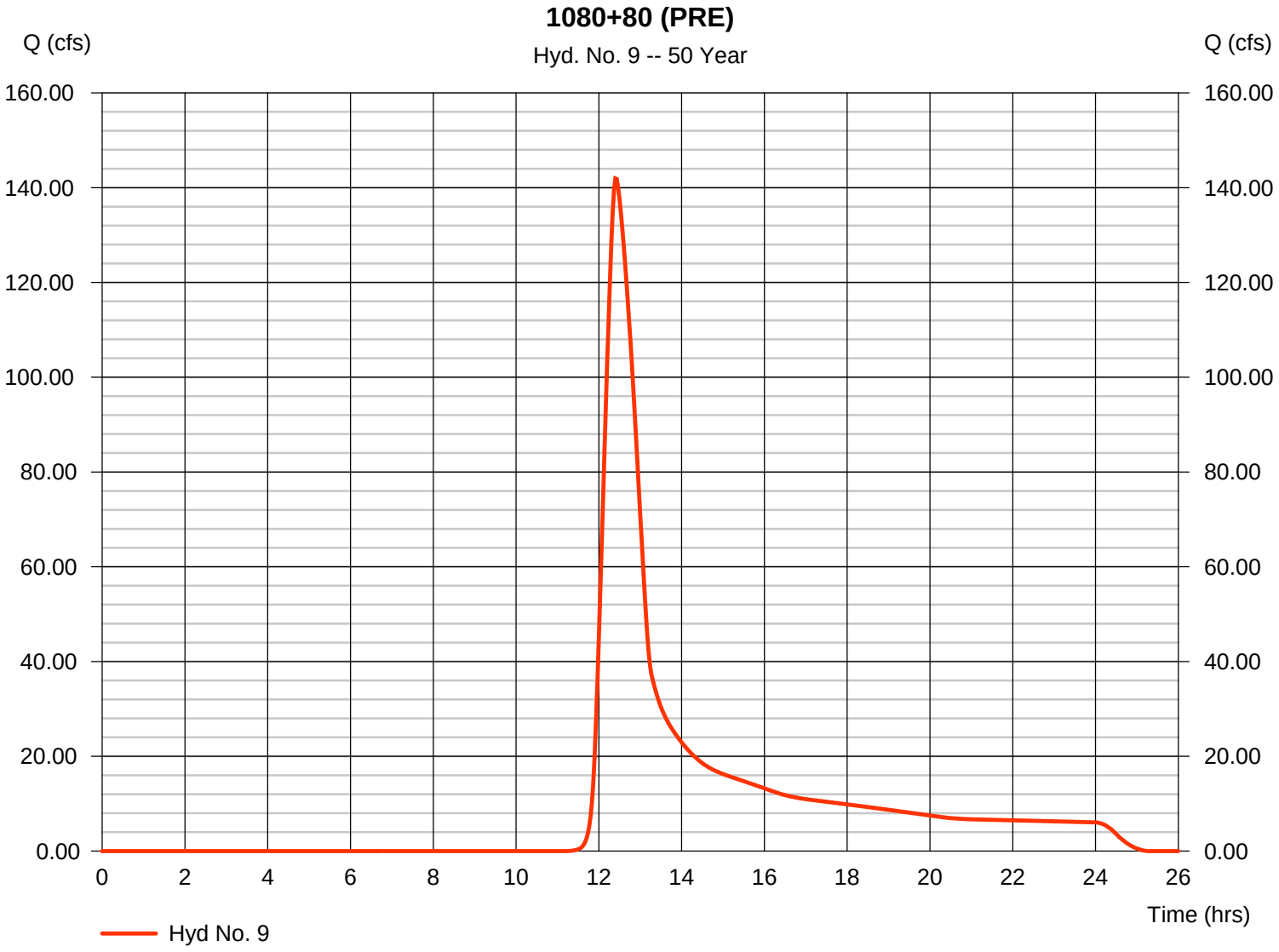
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 9

1080+80 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	141.94 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	903,413 cuft
Drainage area	=	119.740 ac	Curve number	=	53*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	48.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



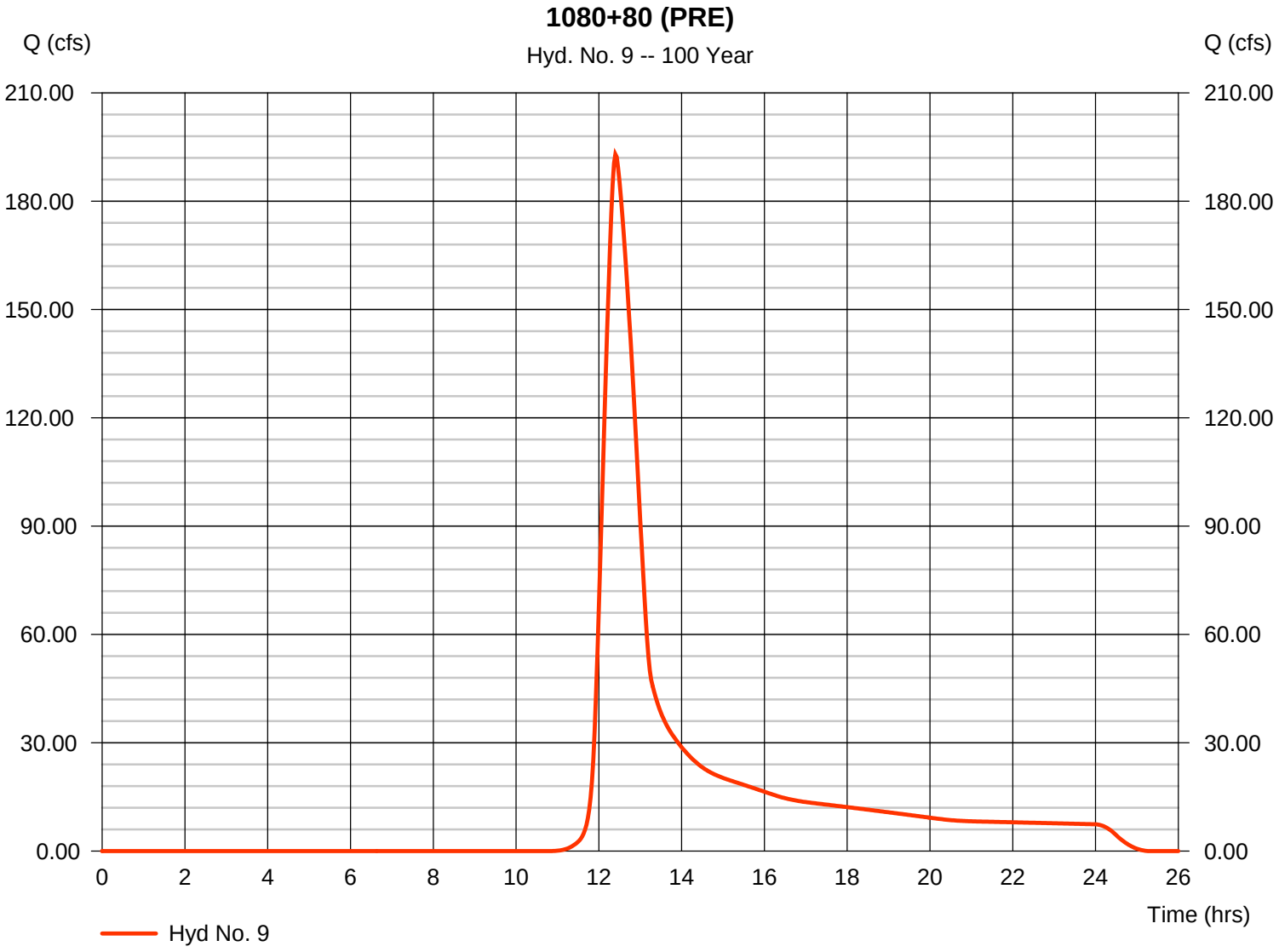
Hydrograph Report

Hyd. No. 9

1080+80 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 192.99 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 1,179,462 cuft
Drainage area	= 119.740 ac	Curve number	= 53*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 48.00 min
Total precip.	= 8.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



Hydrograph Report

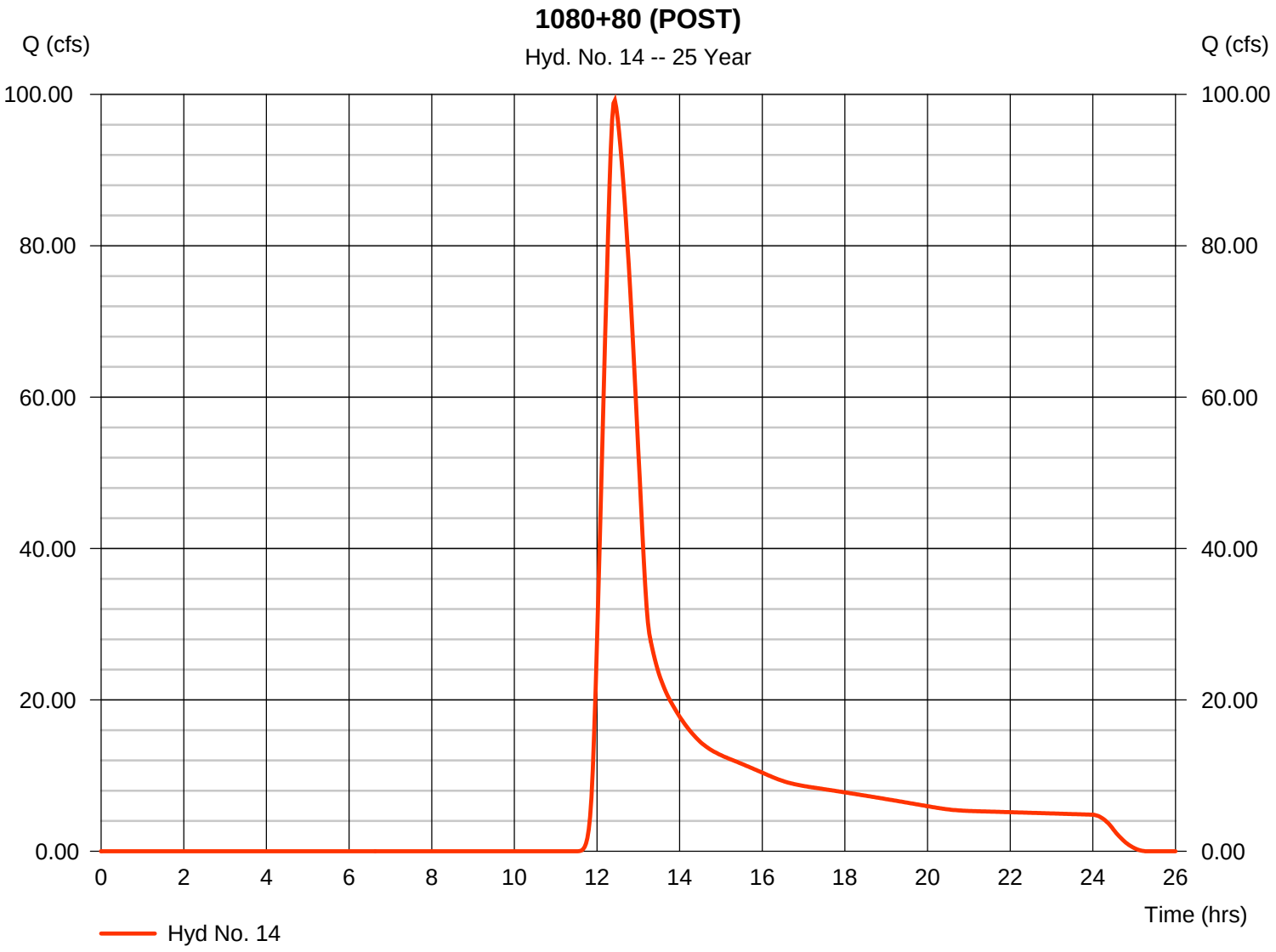
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 14

1080+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	99.21 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.43 hrs
Time interval	=	2 min	Hyd. volume	=	669,749 cuft
Drainage area	=	119.740 ac	Curve number	=	53*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	48.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 14

1080+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	141.94 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	903,413 cuft
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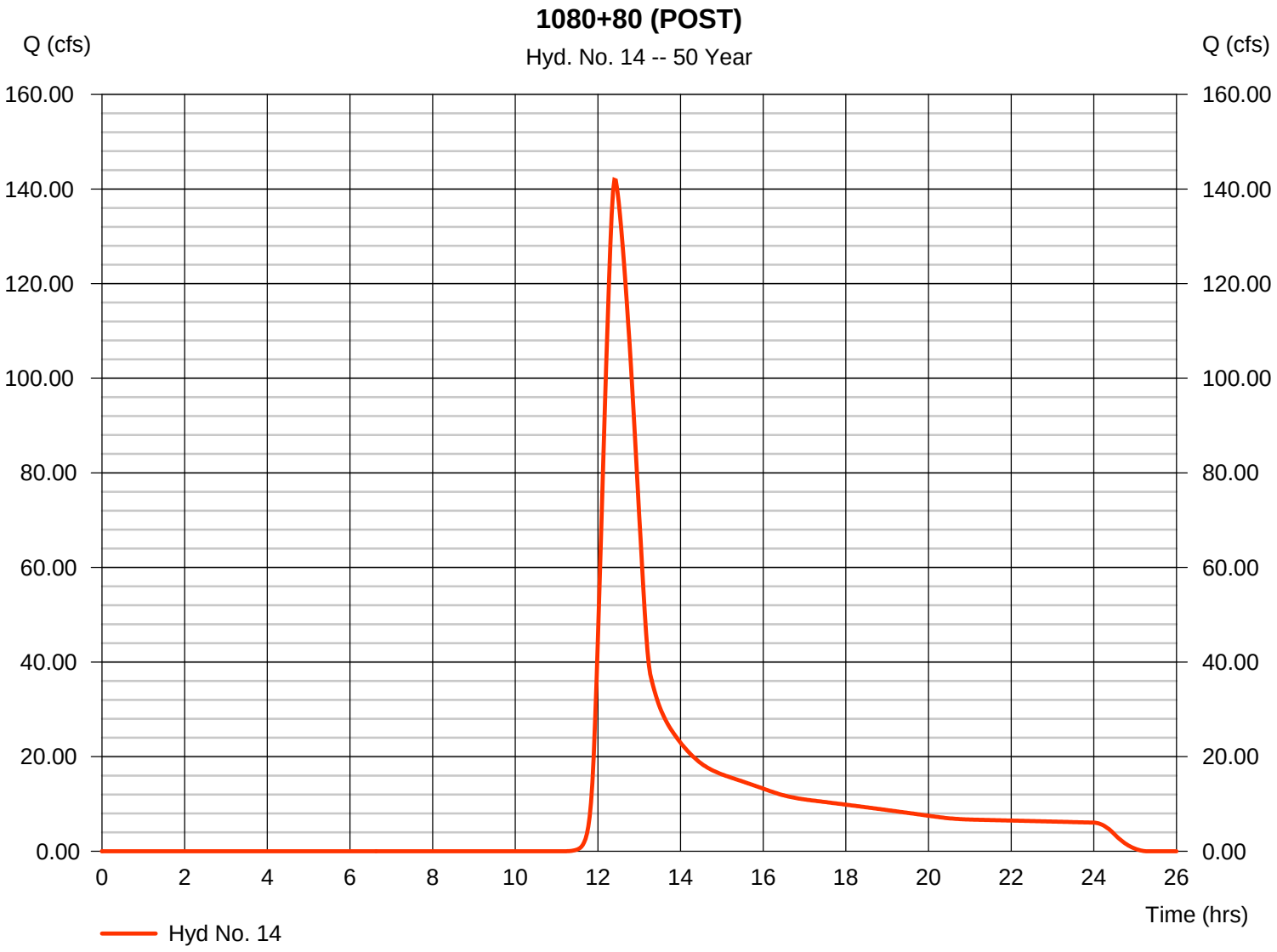
Tc method	=	User	Time of conc. (Tc)	=	48.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



Hydrograph Report

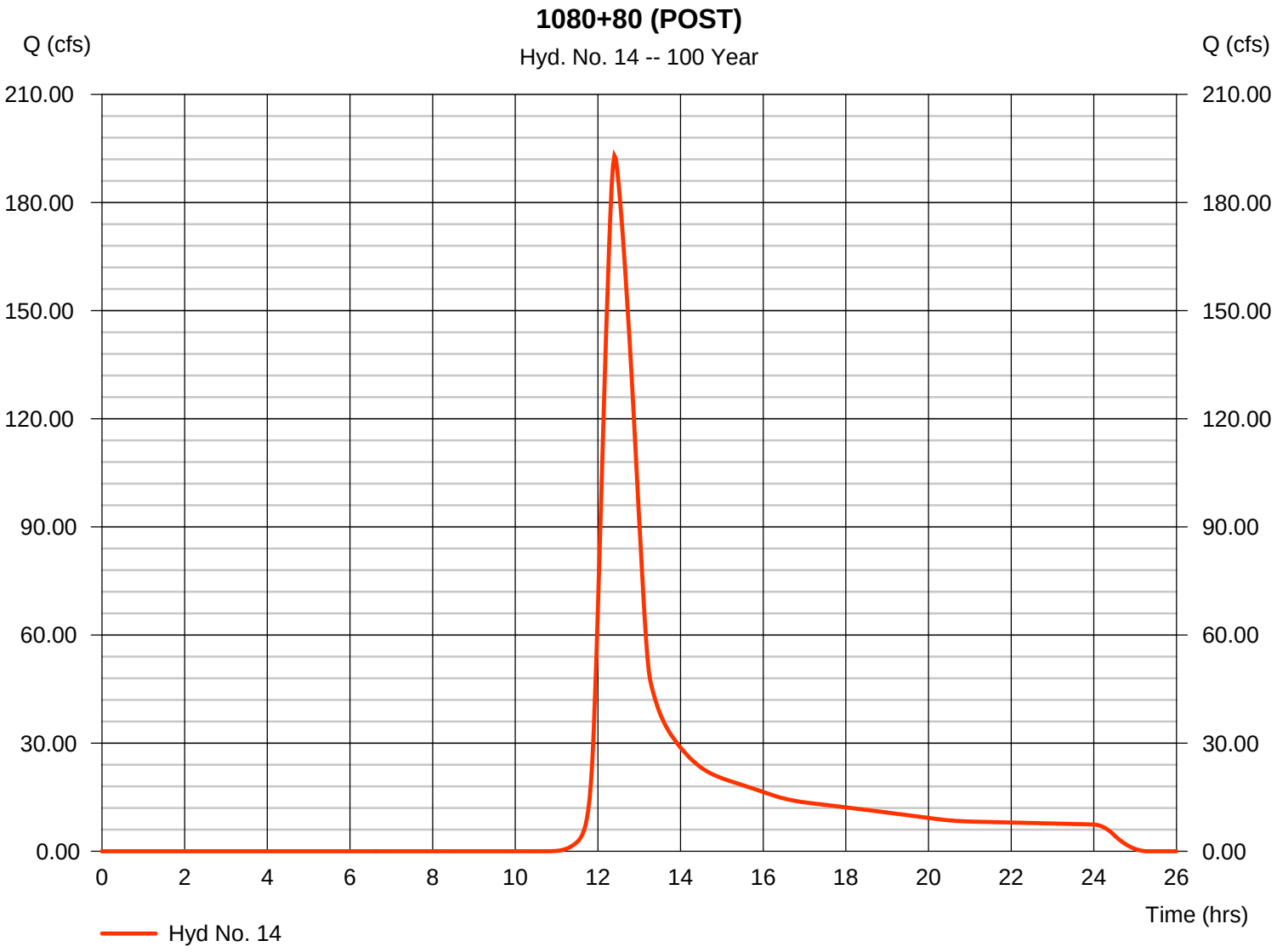
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 14

1080+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	192.99 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	1,179,462 cuft
Drainage area	=	119.740 ac	Curve number	=	53*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	48.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(8.370 x 98) + (39.220 x 70) + (51.080 x 55) + (21.070 x 61)] / 119.740



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 99.21 cfs

Design Flow: 141.94 cfs

Maximum Flow: 192.99 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1080+80 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
303.59	99.21	99.21	0.00	1
303.79	108.59	108.59	0.00	1
303.98	117.97	117.97	0.00	1
304.17	127.34	127.34	0.00	1
304.35	136.72	136.72	0.00	1
304.45	141.94	141.94	0.00	1
304.70	155.48	155.48	0.00	1
304.87	164.86	164.86	0.00	1
305.04	174.23	174.23	0.00	1
305.20	183.61	183.61	0.00	1
305.36	192.99	192.99	0.00	1
315.00	695.77	695.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
99.21	99.21	303.59	3.173	2.012	1-JS1t	1.535	2.040	2.580	2.580	6.410	3.446
108.59	108.59	303.79	3.370	2.165	1-JS1t	1.634	2.167	2.698	2.698	6.707	3.531
117.97	117.97	303.98	3.562	2.316	1-S2n	1.733	2.290	1.859	2.812	10.578	3.610
127.34	127.34	304.17	3.749	2.464	1-S2n	1.829	2.410	1.961	2.920	10.820	3.684
136.72	136.72	304.35	3.931	2.611	1-S2n	1.924	2.526	2.068	3.024	11.017	3.754
141.94	141.94	304.45	4.030	2.693	1-S2n	1.976	2.590	2.126	3.079	11.125	3.791
155.48	155.48	304.70	4.281	2.903	1-S2n	2.110	2.752	2.273	3.219	11.402	3.883
164.86	164.86	304.87	4.450	3.048	1-S2n	2.201	2.862	2.371	3.312	11.589	3.943
174.23	174.23	305.04	4.615	3.194	1-S2n	2.291	2.970	2.468	3.402	11.765	4.001
183.61	183.61	305.20	4.777	3.339	1-S2n	2.380	3.075	2.567	3.489	11.921	4.056
192.99	192.99	305.36	4.936	3.486	1-S2n	2.469	3.179	2.664	3.573	12.074	4.109

****

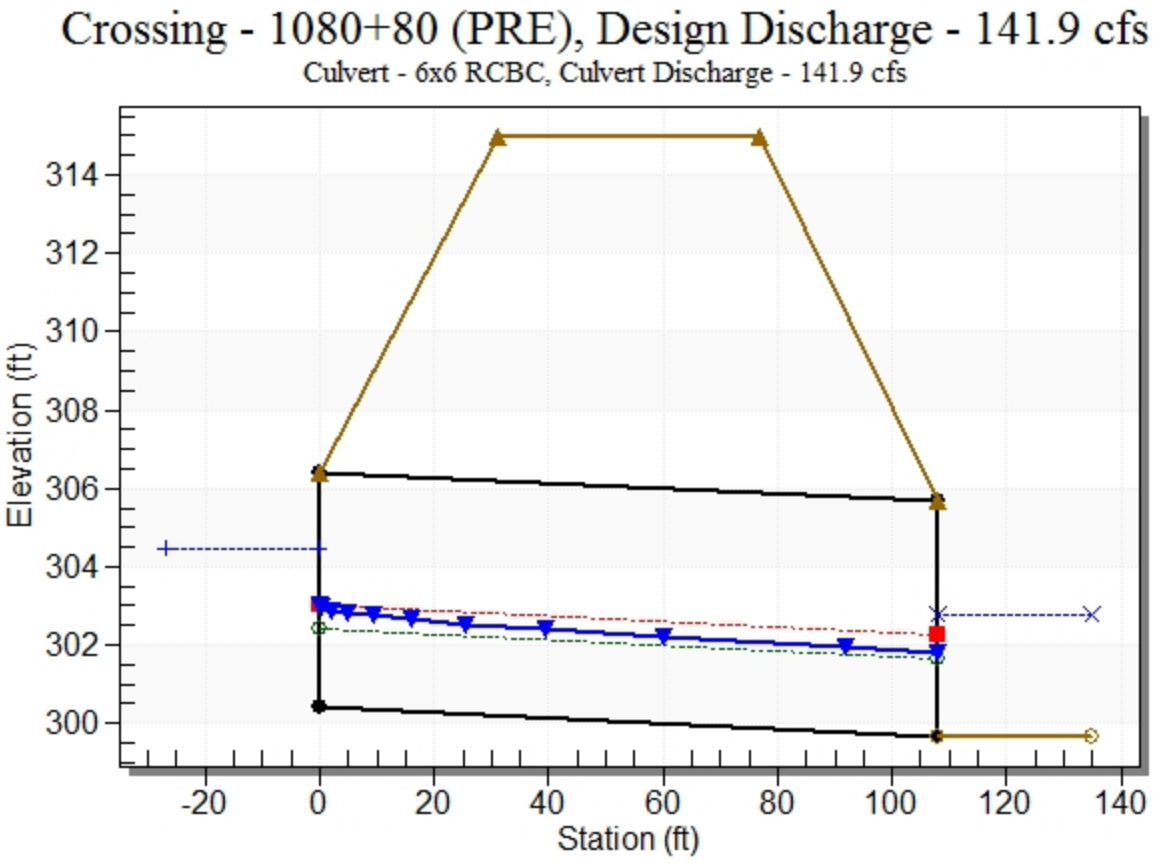
Straight Culvert

Inlet Elevation (invert): 300.42 ft, Outlet Elevation (invert): 299.68 ft

Culvert Length: 108.00 ft, Culvert Slope: 0.0069

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 300.42 ft

Outlet Station: 108.00 ft

Outlet Elevation: 299.68 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1080+80 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
99.21	302.26	2.58	3.45	1.61	0.46
108.59	302.38	2.70	3.53	1.68	0.46
117.97	302.49	2.81	3.61	1.75	0.46
127.34	302.60	2.92	3.68	1.82	0.46
136.72	302.70	3.02	3.75	1.89	0.47
141.94	302.76	3.08	3.79	1.92	0.47
155.48	302.90	3.22	3.88	2.01	0.47
164.86	302.99	3.31	3.94	2.07	0.47
174.23	303.08	3.40	4.00	2.12	0.47
183.61	303.17	3.49	4.06	2.18	0.47
192.99	303.25	3.57	4.11	2.23	0.48

Tailwater Channel Data - 1080+80 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 299.68 ft

Roadway Data for Crossing: 1080+80 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 315.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 99.21 cfs

Design Flow: 141.94 cfs

Maximum Flow: 192.99 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1080+80 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
303.59	99.21	99.21	0.00	1
303.79	108.59	108.59	0.00	1
303.98	117.97	117.97	0.00	1
304.17	127.34	127.34	0.00	1
304.35	136.72	136.72	0.00	1
304.45	141.94	141.94	0.00	1
304.70	155.48	155.48	0.00	1
304.87	164.86	164.86	0.00	1
305.04	174.23	174.23	0.00	1
305.20	183.61	183.61	0.00	1
305.36	192.99	192.99	0.00	1
315.00	695.77	695.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
99.21	99.21	303.59	3.173	2.012	1-JS1t	1.535	2.040	2.580	2.580	6.410	3.446
108.59	108.59	303.79	3.370	2.165	1-JS1t	1.634	2.167	2.698	2.698	6.707	3.531
117.97	117.97	303.98	3.562	2.316	1-S2n	1.733	2.290	1.859	2.812	10.578	3.610
127.34	127.34	304.17	3.749	2.464	1-S2n	1.829	2.410	1.961	2.920	10.820	3.684
136.72	136.72	304.35	3.931	2.611	1-S2n	1.924	2.526	2.068	3.024	11.017	3.754
141.94	141.94	304.45	4.030	2.693	1-S2n	1.976	2.590	2.126	3.079	11.125	3.791
155.48	155.48	304.70	4.281	2.903	1-S2n	2.110	2.752	2.273	3.219	11.402	3.883
164.86	164.86	304.87	4.450	3.048	1-S2n	2.201	2.862	2.371	3.312	11.589	3.943
174.23	174.23	305.04	4.615	3.194	1-S2n	2.291	2.970	2.468	3.402	11.765	4.001
183.61	183.61	305.20	4.777	3.339	1-S2n	2.380	3.075	2.567	3.489	11.921	4.056
192.99	192.99	305.36	4.936	3.486	1-S2n	2.469	3.179	2.664	3.573	12.074	4.109

****

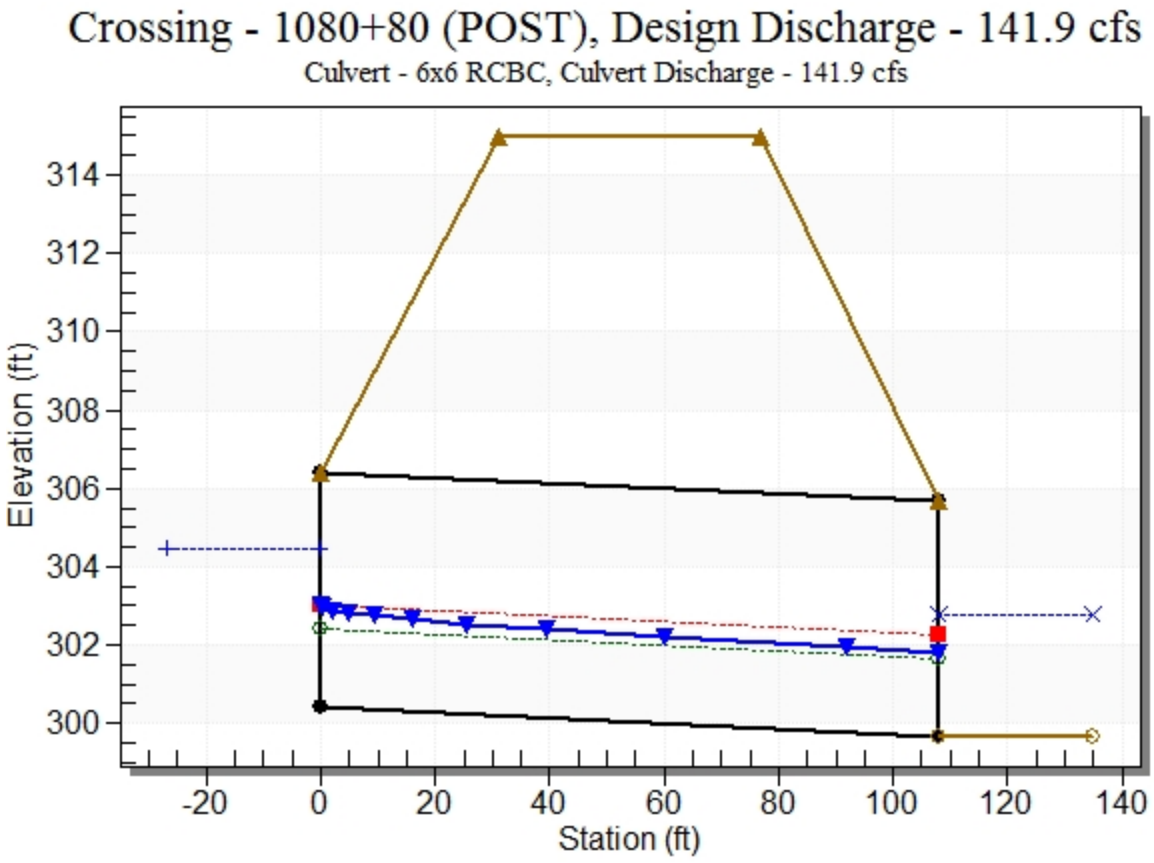
Straight Culvert

Inlet Elevation (invert): 300.42 ft, Outlet Elevation (invert): 299.68 ft

Culvert Length: 108.00 ft, Culvert Slope: 0.0069

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 300.42 ft

Outlet Station: 108.00 ft

Outlet Elevation: 299.68 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1080+80 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
99.21	302.26	2.58	3.45	1.61	0.46
108.59	302.38	2.70	3.53	1.68	0.46
117.97	302.49	2.81	3.61	1.75	0.46
127.34	302.60	2.92	3.68	1.82	0.46
136.72	302.70	3.02	3.75	1.89	0.47
141.94	302.76	3.08	3.79	1.92	0.47
155.48	302.90	3.22	3.88	2.01	0.47
164.86	302.99	3.31	3.94	2.07	0.47
174.23	303.08	3.40	4.00	2.12	0.47
183.61	303.17	3.49	4.06	2.18	0.47
192.99	303.25	3.57	4.11	2.23	0.48

Tailwater Channel Data - 1080+80 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 299.68 ft

Roadway Data for Crossing: 1080+80 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 315.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 72

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 72**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.20	0.1800
Grass	0.25	0.07	0.0163
Woods	0.15	4.48	0.6727
	Σ	**4.75**	0.8690

$C_{ave} = \frac{0.8690}{4.75} = 0.18$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.29	0.2565
Grass	0.25	0.07	0.0163
Woods	0.15	4.48	0.6727
	Σ	**4.84**	0.9455

$C_{ave} = \frac{0.9455}{4.84} = 0.20$

T_c =	38.38	min.
I_{05} =	3.33	in / hr
I_{10} =	3.65	in / hr
I_{25} =	4.14	in / hr
I_{50} =	4.51	in / hr
I_{100} =	4.87	in / hr

Pre Construction Runoff:

Q_{05} =	0.18	x	3.33	x	4.75	x	1	=	**2.89**	cfs
Q_{10} =	0.18	x	3.65	x	4.75	x	1	=	**3.18**	cfs
Q_{25} =	0.18	x	4.14	x	4.75	x	1.1	=	**3.95**	cfs
Q_{50} =	0.18	x	4.51	x	4.75	x	1.2	=	**4.70**	cfs
Q_{100} =	0.18	x	4.87	x	4.75	x	1.25	=	**5.29**	cfs

Post Construction Runoff:

Q_{05} =	0.20	x	3.33	x	4.84	x	1	=	**3.14**	cfs
Q_{10} =	0.20	x	3.65	x	4.84	x	1	=	**3.46**	cfs
Q_{25} =	0.20	x	4.14	x	4.84	x	1.1	=	**4.30**	cfs
Q_{50} =	0.20	x	4.51	x	4.84	x	1.2	=	**5.12**	cfs
Q_{100} =	0.20	x	4.87	x	4.84	x	1.25	=	**5.76**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By JEN	Date 11/20/17
Location	Site72	Checked	Date

Circle one: Present Developed
Circle one: T_c T_t through subarea

Present
T_c

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		Unpaved				
8	Flow length, L	----------	ft	**700**				
9	Watercourse slope, s	----------	ft/ft	**0.0570**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.85**	**0.00**			
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.050**	+		=	**0.050**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.640**
							min	**38.38**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.95 cfs

Design Flow: 4.7 cfs

Maximum Flow: 5.29 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1082+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
311.08	3.95	3.95	0.00	1
311.10	4.08	4.08	0.00	1
311.12	4.22	4.22	0.00	1
311.13	4.35	4.35	0.00	1
311.15	4.49	4.49	0.00	1
311.17	4.62	4.62	0.00	1
311.18	4.70	4.70	0.00	1
311.21	4.89	4.89	0.00	1
311.22	5.02	5.02	0.00	1
311.24	5.16	5.16	0.00	1
311.26	5.29	5.29	0.00	1
317.00	36.97	36.97	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.95	3.95	311.08	0.924	0.0*	1-S2n	0.350	0.693	0.350	0.741	10.399	1.530
4.08	4.08	311.10	0.941	0.0*	1-S2n	0.356	0.705	0.356	0.754	10.507	1.544
4.22	4.22	311.12	0.957	0.0*	1-S2n	0.362	0.718	0.362	0.766	10.482	1.558
4.35	4.35	311.13	0.973	0.0*	1-S2n	0.367	0.730	0.367	0.779	10.597	1.571
4.49	4.49	311.15	0.989	0.0*	1-S2n	0.373	0.742	0.373	0.791	10.708	1.584
4.62	4.62	311.17	1.006	0.0*	1-S2n	0.378	0.753	0.378	0.803	10.815	1.597
4.70	4.70	311.18	1.018	0.0*	1-S2n	0.381	0.760	0.381	0.810	10.877	1.604
4.89	4.89	311.21	1.045	0.0*	1-S2n	0.389	0.773	0.389	0.826	11.017	1.621
5.02	5.02	311.22	1.064	0.0*	1-S2n	0.394	0.785	0.394	0.837	11.112	1.633
5.16	5.16	311.24	1.083	0.0*	1-S2n	0.400	0.796	0.416	0.848	10.494	1.645
5.29	5.29	311.26	1.101	0.0*	1-S2n	0.405	0.808	0.405	0.859	11.293	1.656

* Full Flow Headwater elevation is below inlet invert.

****

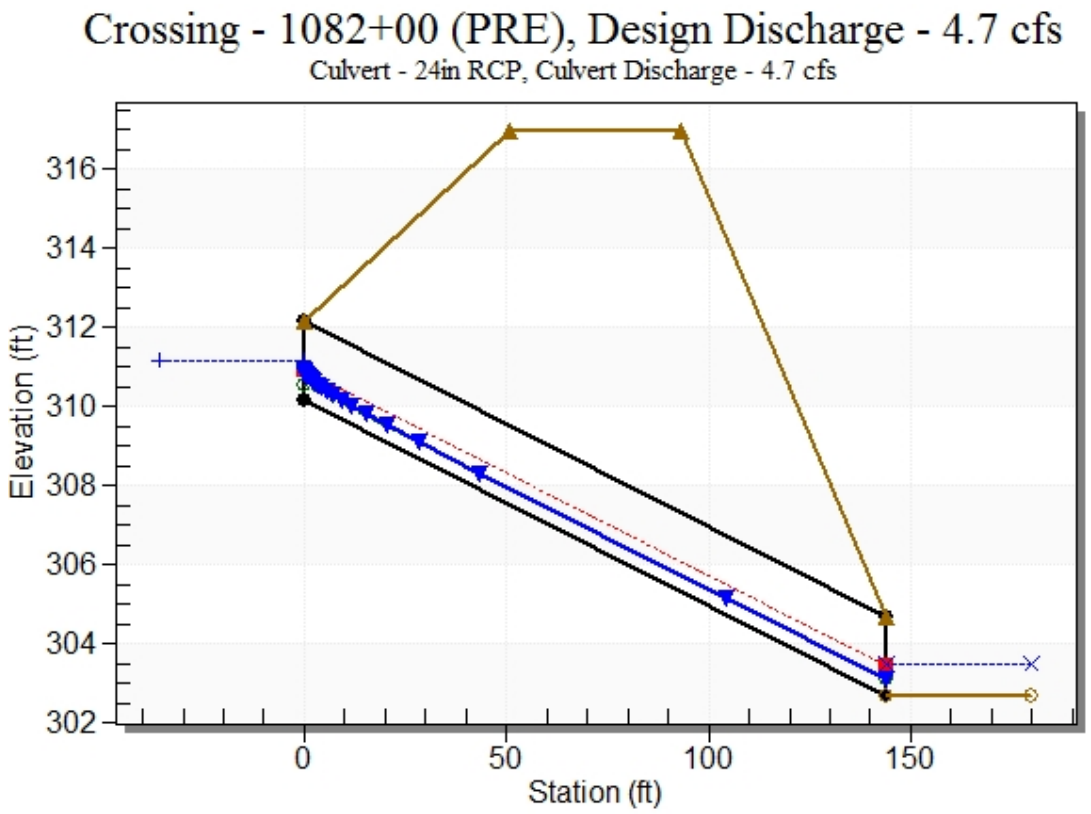
Straight Culvert

Inlet Elevation (invert): 310.16 ft, Outlet Elevation (invert): 302.71 ft

Culvert Length: 144.19 ft, Culvert Slope: 0.0517

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 310.16 ft

Outlet Station: 144.00 ft

Outlet Elevation: 302.71 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1082+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.95	303.45	0.74	1.53	0.46	0.37
4.08	303.46	0.75	1.54	0.47	0.37
4.22	303.48	0.77	1.56	0.48	0.38
4.35	303.49	0.78	1.57	0.49	0.38
4.49	303.50	0.79	1.58	0.49	0.38
4.62	303.51	0.80	1.60	0.50	0.38
4.70	303.52	0.81	1.60	0.51	0.38
4.89	303.54	0.83	1.62	0.52	0.38
5.02	303.55	0.84	1.63	0.52	0.38
5.16	303.56	0.85	1.64	0.53	0.38
5.29	303.57	0.86	1.66	0.54	0.38

Tailwater Channel Data - 1082+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 302.71 ft

Roadway Data for Crossing: 1082+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 317.00 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.3 cfs

Design Flow: 5.12 cfs

Maximum Flow: 5.76 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1082+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
311.13	4.30	4.30	0.00	1
311.14	4.45	4.45	0.00	1
311.16	4.59	4.59	0.00	1
311.18	4.74	4.74	0.00	1
311.20	4.88	4.88	0.00	1
311.23	5.03	5.03	0.00	1
311.24	5.12	5.12	0.00	1
311.27	5.32	5.32	0.00	1
311.29	5.47	5.47	0.00	1
311.30	5.61	5.61	0.00	1
311.32	5.76	5.76	0.00	1
317.00	36.98	36.98	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.30	4.30	311.13	0.967	0.0*	1-S2n	0.365	0.725	0.365	0.774	10.553	1.566
4.45	4.45	311.14	0.984	0.0*	1-S2n	0.371	0.738	0.371	0.787	10.676	1.580
4.59	4.59	311.16	1.002	0.0*	1-S2n	0.377	0.751	0.377	0.800	10.793	1.594
4.74	4.74	311.18	1.024	0.0*	1-S2n	0.383	0.764	0.383	0.813	10.906	1.608
4.88	4.88	311.20	1.044	0.0*	1-S2n	0.389	0.773	0.389	0.825	11.014	1.621
5.03	5.03	311.23	1.065	0.0*	1-S2n	0.394	0.786	0.394	0.838	11.118	1.634
5.12	5.12	311.24	1.078	0.0*	1-S2n	0.398	0.793	0.398	0.845	11.180	1.642
5.32	5.32	311.27	1.105	0.0*	1-S2n	0.406	0.810	0.406	0.862	11.314	1.659
5.47	5.47	311.29	1.125	0.0*	1-S2n	0.412	0.823	0.412	0.873	11.303	1.671
5.61	5.61	311.30	1.145	0.0*	1-S2n	0.417	0.834	0.417	0.885	11.406	1.683
5.76	5.76	311.32	1.164	0.0*	1-S2n	0.422	0.846	0.422	0.896	11.504	1.694

* Full Flow Headwater elevation is below inlet invert.

****

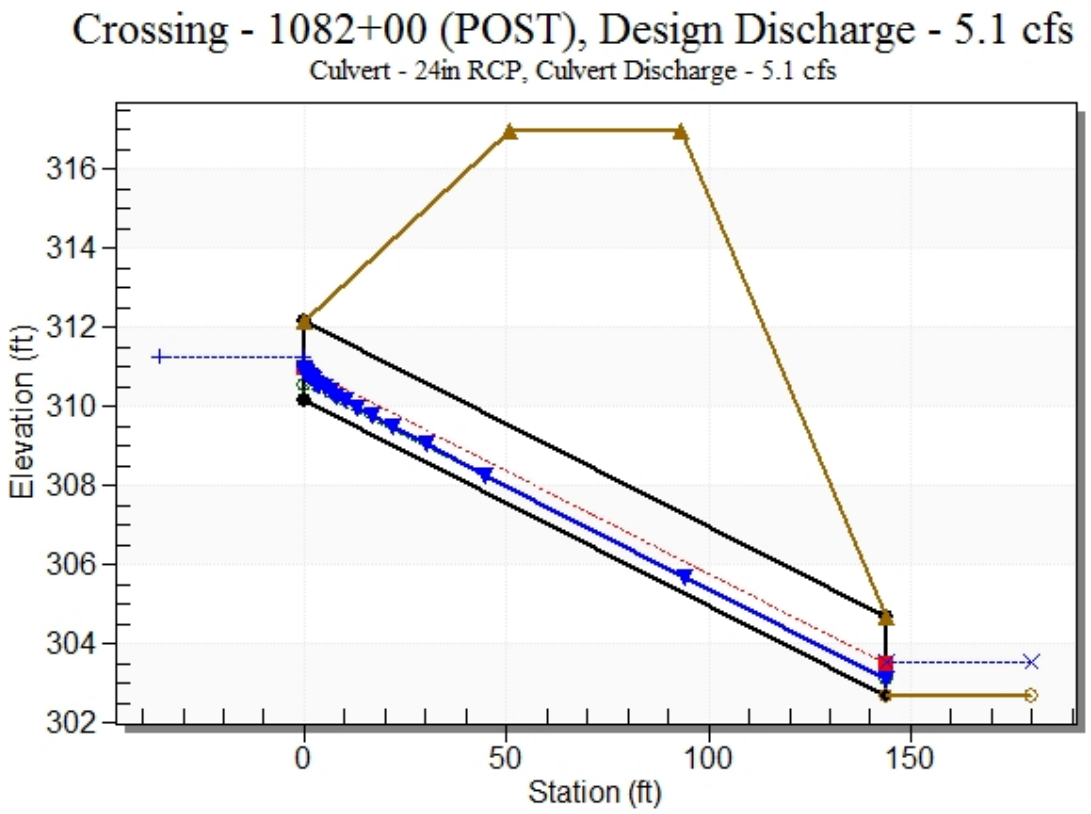
Straight Culvert

Inlet Elevation (invert): 310.16 ft, Outlet Elevation (invert): 302.71 ft

Culvert Length: 144.19 ft, Culvert Slope: 0.0517

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 310.16 ft

Outlet Station: 144.00 ft

Outlet Elevation: 302.71 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1082+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.30	303.48	0.77	1.57	0.48	0.38
4.45	303.50	0.79	1.58	0.49	0.38
4.59	303.51	0.80	1.59	0.50	0.38
4.74	303.52	0.81	1.61	0.51	0.38
4.88	303.54	0.83	1.62	0.52	0.38
5.03	303.55	0.84	1.63	0.52	0.38
5.12	303.56	0.85	1.64	0.53	0.38
5.32	303.57	0.86	1.66	0.54	0.38
5.47	303.58	0.87	1.67	0.54	0.38
5.61	303.59	0.88	1.68	0.55	0.38
5.76	303.61	0.90	1.69	0.56	0.38

Tailwater Channel Data - 1082+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 302.71 ft

Roadway Data for Crossing: 1082+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 317.00 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

CULVERT 73

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 73**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.54	0.4844
Grass	0.25	1.23	0.3068
Woods	0.15	1.32	0.1980
	Σ	**3.09**	0.9892

$C_{ave} = \frac{0.9892}{3.09} = 0.32$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.02	0.9164
Grass	0.25	0.62	0.1543
Woods	0.15	1.32	0.1980
	Σ	**2.96**	1.2687

$C_{ave} = \frac{1.2687}{2.96} = 0.43$

T_c =	35.68	min.
I_{05} =	3.46	in / hr
I_{10} =	3.80	in / hr
I_{25} =	4.31	in / hr
I_{50} =	4.70	in / hr
I_{100} =	5.08	in / hr

Pre Construction Runoff:

Q_{05} =	0.32	x	3.46	x	3.09	x	1	=	**3.42**	cfs
Q_{10} =	0.32	x	3.80	x	3.09	x	1	=	**3.76**	cfs
Q_{25} =	0.32	x	4.31	x	3.09	x	1.1	=	**4.68**	cfs
Q_{50} =	0.32	x	4.70	x	3.09	x	1.2	=	**5.58**	cfs
Q_{100} =	0.32	x	5.08	x	3.09	x	1.25	=	**6.28**	cfs

Post Construction Runoff:

Q_{05} =	0.43	x	3.46	x	2.96	x	1	=	**4.39**	cfs
Q_{10} =	0.43	x	3.80	x	2.96	x	1	=	**4.83**	cfs
Q_{25} =	0.43	x	4.31	x	2.96	x	1.1	=	**6.01**	cfs
Q_{50} =	0.43	x	4.70	x	2.96	x	1.2	=	**7.15**	cfs
Q_{100} =	0.43	x	5.08	x	2.96	x	1.25	=	**8.05**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 73	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**125**				
9	Watercourse slope, s	----------	ft/ft	**0.1500**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**6.25**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.006**	+		=	**0.006**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.595**
							min	**35.68**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.68 cfs

Design Flow: 5.58 cfs

Maximum Flow: 6.28 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1085+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
321.82	4.68	4.68	0.00	1
321.85	4.84	4.84	0.00	1
321.87	5.00	5.00	0.00	1
321.90	5.16	5.16	0.00	1
321.93	5.32	5.32	0.00	1
321.95	5.48	5.48	0.00	1
321.97	5.58	5.58	0.00	1
322.00	5.80	5.80	0.00	1
322.03	5.96	5.96	0.00	1
322.06	6.12	6.12	0.00	1
322.08	6.28	6.28	0.00	1
322.48	8.40	8.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.68	4.68	321.82	1.240	0.0*	1-S2n	0.635	0.828	0.651	0.808	6.158	1.602
4.84	4.84	321.85	1.266	0.0*	1-S2n	0.647	0.842	0.664	0.822	6.204	1.617
5.00	5.00	321.87	1.293	0.0*	1-S2n	0.659	0.856	0.659	0.835	6.467	1.631
5.16	5.16	321.90	1.319	0.0*	1-S2n	0.671	0.869	0.671	0.848	6.517	1.645
5.32	5.32	321.93	1.345	0.0*	1-S2n	0.683	0.886	0.702	0.862	6.338	1.659
5.48	5.48	321.95	1.371	0.0*	1-S2n	0.695	0.899	0.715	0.874	6.376	1.672
5.58	5.58	321.97	1.388	0.0*	1-S2n	0.702	0.908	0.723	0.882	6.397	1.680
5.80	5.80	322.00	1.424	0.0*	1-S2n	0.718	0.926	0.741	0.900	6.446	1.697
5.96	5.96	322.03	1.451	0.0*	1-S2n	0.730	0.938	0.754	0.912	6.482	1.710
6.12	6.12	322.06	1.478	0.0*	1-S2n	0.741	0.951	0.741	0.924	6.805	1.722
6.28	6.28	322.08	1.505	0.0*	5-S2n	0.753	0.963	0.753	0.936	6.847	1.734

* Full Flow Headwater elevation is below inlet invert.

****

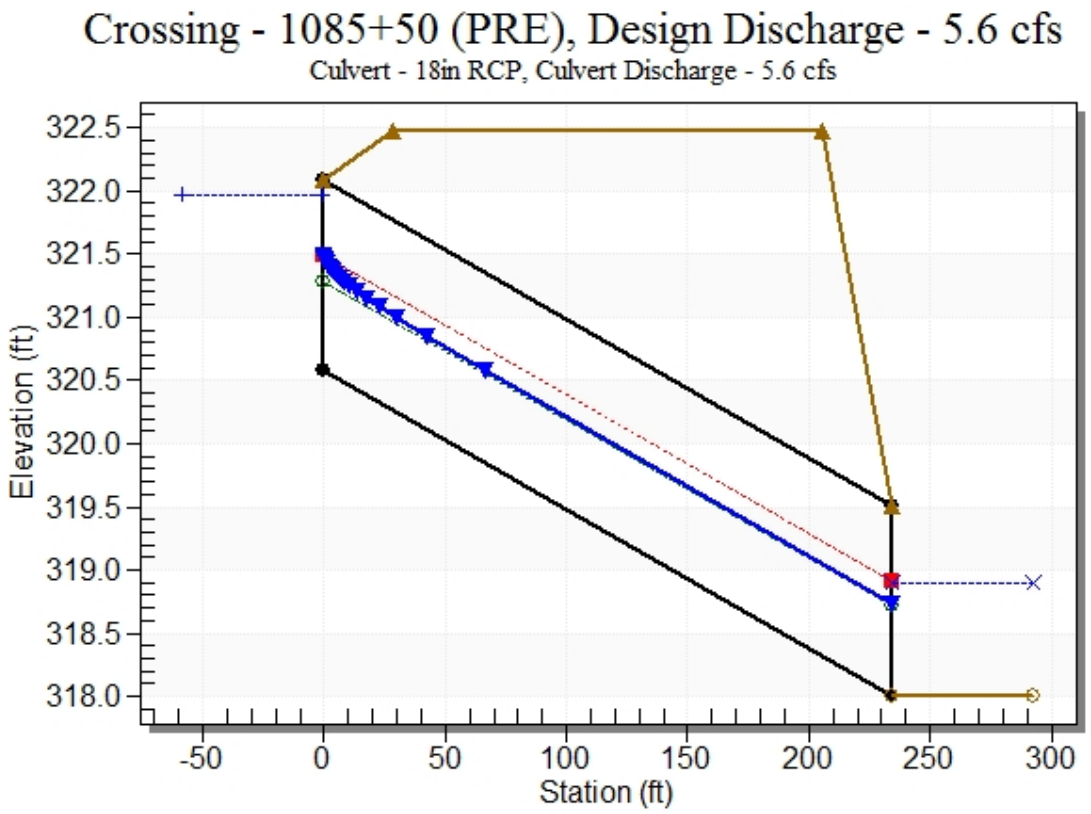
Straight Culvert

Inlet Elevation (invert): 320.58 ft, Outlet Elevation (invert): 318.01 ft

Culvert Length: 234.01 ft, Culvert Slope: 0.0110

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 320.58 ft

Outlet Station: 234.00 ft

Outlet Elevation: 318.01 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1085+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.68	318.82	0.81	1.60	0.50	0.38
4.84	318.83	0.82	1.62	0.51	0.38
5.00	318.85	0.84	1.63	0.52	0.38
5.16	318.86	0.85	1.65	0.53	0.38
5.32	318.87	0.86	1.66	0.54	0.38
5.48	318.88	0.87	1.67	0.55	0.38
5.58	318.89	0.88	1.68	0.55	0.38
5.80	318.91	0.90	1.70	0.56	0.38
5.96	318.92	0.91	1.71	0.57	0.38
6.12	318.93	0.92	1.72	0.58	0.38
6.28	318.95	0.94	1.73	0.58	0.38

Tailwater Channel Data - 1085+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 318.01 ft

Roadway Data for Crossing: 1085+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 322.48 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.01 cfs

Design Flow: 7.15 cfs

Maximum Flow: 8.05 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1085+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
322.04	6.01	6.01	0.00	1
322.07	6.21	6.21	0.00	1
322.11	6.42	6.42	0.00	1
322.14	6.62	6.62	0.00	1
322.18	6.83	6.83	0.00	1
322.22	7.03	7.03	0.00	1
322.24	7.15	7.15	0.00	1
322.29	7.44	7.44	0.00	1
322.33	7.64	7.64	0.00	1
322.37	7.85	7.85	0.00	1
322.41	8.05	8.05	0.00	1
322.48	8.40	8.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.01	6.01	322.04	1.459	0.0*	1-S2n	0.733	0.942	0.758	0.916	6.492	1.713
6.21	6.21	322.07	1.494	0.0*	1-S2n	0.748	0.958	0.748	0.931	6.829	1.729
6.42	6.42	322.11	1.528	0.0*	5-S2n	0.762	0.977	0.762	0.946	6.883	1.744
6.62	6.62	322.14	1.563	0.0*	5-S2n	0.777	0.993	0.777	0.960	6.936	1.758
6.83	6.83	322.18	1.599	0.0*	5-S2n	0.792	1.009	0.792	0.975	6.986	1.773
7.03	7.03	322.22	1.635	0.0*	5-S2n	0.806	1.024	0.806	0.989	7.034	1.786
7.15	7.15	322.24	1.657	0.0*	5-S2n	0.815	1.032	0.815	0.997	7.062	1.794
7.44	7.44	322.29	1.710	0.0*	5-S2n	0.835	1.053	0.835	1.017	7.127	1.813
7.64	7.64	322.33	1.749	0.0*	5-S2n	0.849	1.067	0.849	1.030	7.170	1.826
7.85	7.85	322.37	1.788	0.077	5-S2n	0.864	1.081	0.864	1.044	7.214	1.839
8.05	8.05	322.41	1.828	0.173	5-S2n	0.878	1.095	0.878	1.057	7.254	1.851

* Full Flow Headwater elevation is below inlet invert.

****

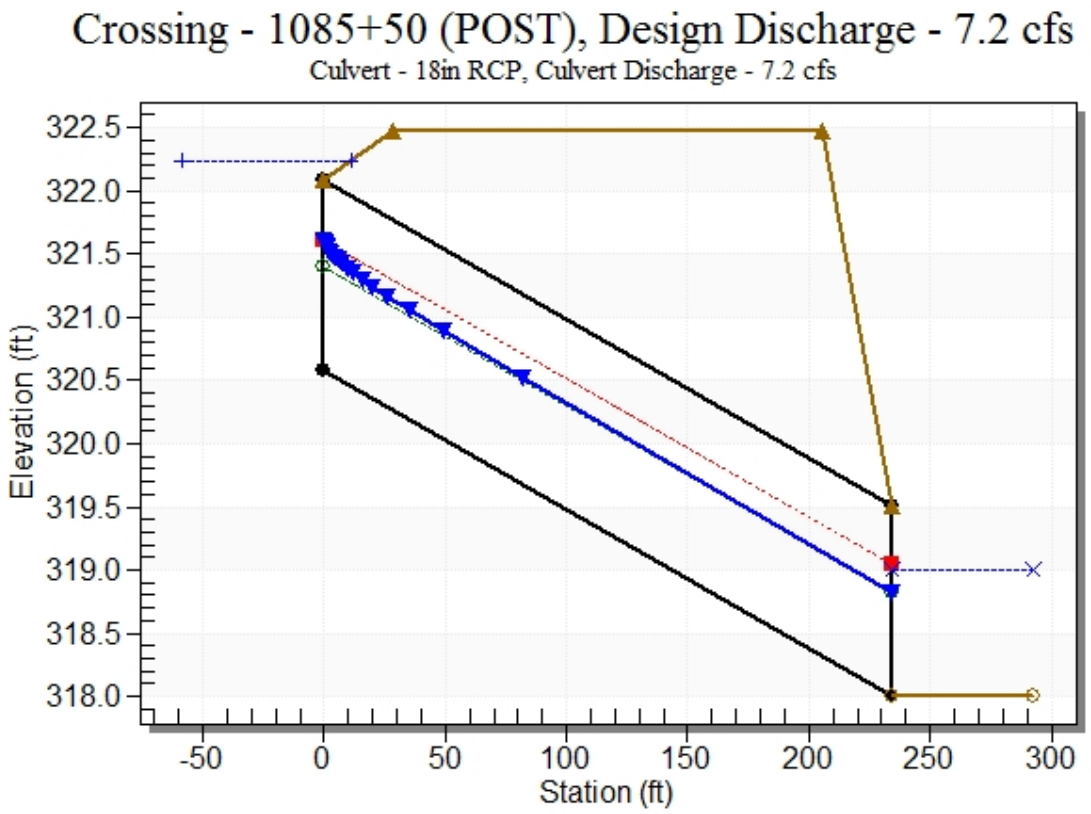
Straight Culvert

Inlet Elevation (invert): 320.58 ft, Outlet Elevation (invert): 318.01 ft

Culvert Length: 234.01 ft, Culvert Slope: 0.0110

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 320.58 ft

Outlet Station: 234.00 ft

Outlet Elevation: 318.01 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1085+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.01	318.93	0.92	1.71	0.57	0.38
6.21	318.94	0.93	1.73	0.58	0.38
6.42	318.96	0.95	1.74	0.59	0.39
6.62	318.97	0.96	1.76	0.60	0.39
6.83	318.98	0.97	1.77	0.61	0.39
7.03	319.00	0.99	1.79	0.62	0.39
7.15	319.01	1.00	1.79	0.62	0.39
7.44	319.03	1.02	1.81	0.63	0.39
7.64	319.04	1.03	1.83	0.64	0.39
7.85	319.05	1.04	1.84	0.65	0.39
8.05	319.07	1.06	1.85	0.66	0.39

Tailwater Channel Data - 1085+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 318.01 ft

Roadway Data for Crossing: 1085+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 322.48 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

CULVERT 74

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 74**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.20	0.1843
Grass	0.25	0.38	0.0945
Woods	0.15	0.47	0.0712
	Σ	**1.06**	0.3501

$C_{ave} = \frac{0.3501}{1.06} = 0.33$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.36	0.3283
Grass	0.25	0.18	0.0460
Woods	0.15	0.47	0.0712
	Σ	**1.02**	0.4456

$C_{ave} = \frac{0.4456}{1.02} = 0.44$

T_c =	35.78	min.								
I_{05} =	3.45	in / hr								
I_{10} =	3.80	in / hr								
I_{25} =	4.30	in / hr								
I_{50} =	4.69	in / hr								
I_{100} =	5.07	in / hr								

Pre Construction Runoff:

Q_{05} =	0.33	**x**	3.45	**x**	1.06	**x**	1	=	**1.21**	cfs
Q_{10} =	0.33	**x**	3.80	**x**	1.06	**x**	1	=	**1.33**	cfs
Q_{25} =	0.33	**x**	4.30	**x**	1.06	**x**	1.1	=	**1.66**	cfs
Q_{50} =	0.33	**x**	4.69	**x**	1.06	**x**	1.2	=	**1.97**	cfs
Q_{100} =	0.33	**x**	5.07	**x**	1.06	**x**	1.25	=	**2.22**	cfs

Post Construction Runoff:

Q_{05} =	0.44	**x**	3.45	**x**	1.02	**x**	1	=	**1.54**	cfs
Q_{10} =	0.44	**x**	3.80	**x**	1.02	**x**	1	=	**1.69**	cfs
Q_{25} =	0.44	**x**	4.30	**x**	1.02	**x**	1.1	=	**2.11**	cfs
Q_{50} =	0.44	**x**	4.69	**x**	1.02	**x**	1.2	=	**2.51**	cfs
Q_{100} =	0.44	**x**	5.07	**x**	1.02	**x**	1.25	=	**2.82**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 74	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**150**				
9	Watercourse slope, s	----------	ft/ft	**0.1300**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.82**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.007**	+		=	**0.007**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.596**
							min	**35.78**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.66 cfs

Design Flow: 1.97 cfs

Maximum Flow: 2.22 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1090+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
330.57	1.66	1.66	0.00	1
330.58	1.72	1.72	0.00	1
330.59	1.77	1.77	0.00	1
330.60	1.83	1.83	0.00	1
330.61	1.88	1.88	0.00	1
330.62	1.94	1.94	0.00	1
330.63	1.97	1.97	0.00	1
330.64	2.05	2.05	0.00	1
330.65	2.11	2.11	0.00	1
330.66	2.16	2.16	0.00	1
330.68	2.22	2.22	0.00	1
332.14	9.92	9.92	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.66	1.66	330.57	0.645	0.0*	1-S2n	0.263	0.480	0.263	0.470	7.761	1.200
1.72	1.72	330.58	0.657	0.0*	1-S2n	0.268	0.488	0.268	0.479	7.841	1.211
1.77	1.77	330.59	0.669	0.0*	1-S2n	0.272	0.497	0.272	0.487	7.931	1.222
1.83	1.83	330.60	0.680	0.0*	1-S2n	0.276	0.505	0.276	0.495	8.027	1.234
1.88	1.88	330.61	0.690	0.0*	1-S2n	0.280	0.514	0.280	0.504	8.119	1.244
1.94	1.94	330.62	0.702	0.0*	1-S2n	0.284	0.522	0.284	0.511	8.070	1.255
1.97	1.97	330.63	0.707	0.0*	1-S2n	0.286	0.526	0.286	0.516	8.111	1.260
2.05	2.05	330.64	0.723	0.0*	1-S2n	0.292	0.538	0.292	0.527	8.219	1.275
2.11	2.11	330.65	0.734	0.0*	1-S2n	0.296	0.546	0.296	0.535	8.290	1.285
2.16	2.16	330.66	0.745	0.0*	1-S2n	0.300	0.550	0.300	0.542	8.359	1.294
2.22	2.22	330.68	0.755	0.0*	1-S2n	0.304	0.558	0.304	0.549	8.424	1.304

* Full Flow Headwater elevation is below inlet invert.

****

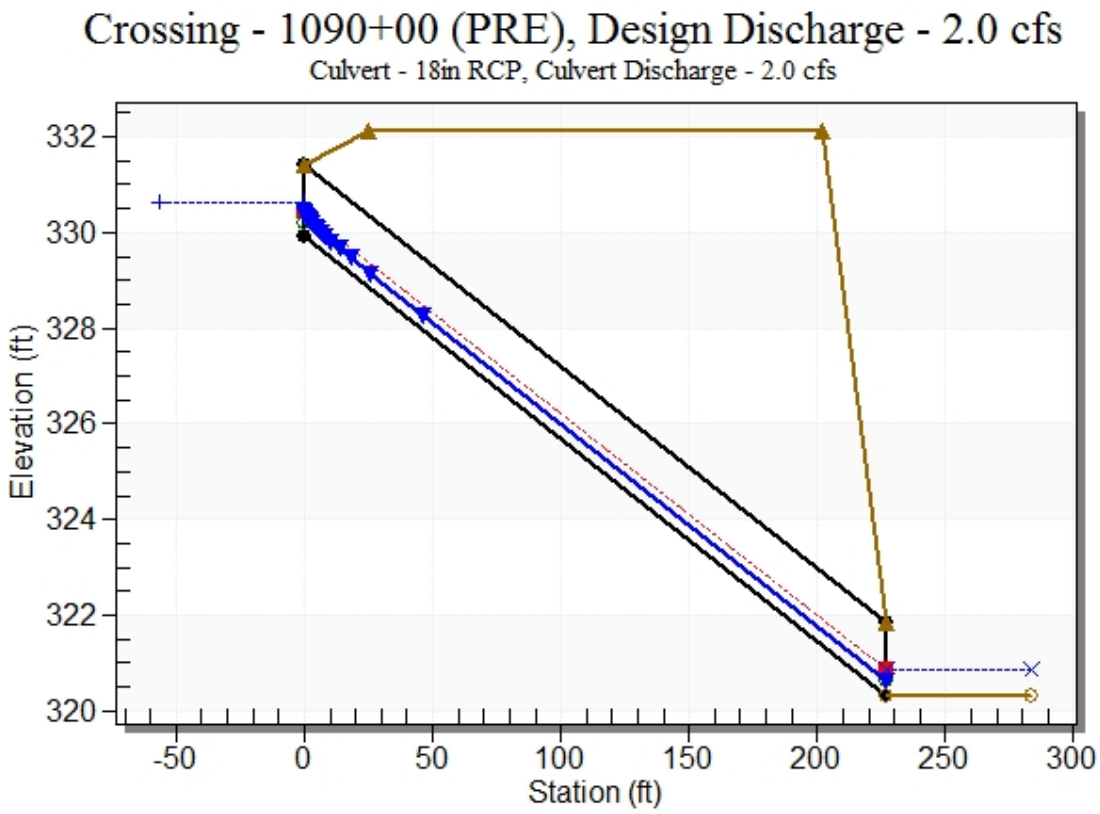
Straight Culvert

Inlet Elevation (invert): 329.92 ft, Outlet Elevation (invert): 320.33 ft

Culvert Length: 227.20 ft, Culvert Slope: 0.0422

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 329.92 ft

Outlet Station: 227.00 ft

Outlet Elevation: 320.33 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1090+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.66	320.80	0.47	1.20	0.29	0.35
1.72	320.81	0.48	1.21	0.30	0.35
1.77	320.82	0.49	1.22	0.30	0.36
1.83	320.83	0.50	1.23	0.31	0.36
1.88	320.83	0.50	1.24	0.31	0.36
1.94	320.84	0.51	1.25	0.32	0.36
1.97	320.85	0.52	1.26	0.32	0.36
2.05	320.86	0.53	1.27	0.33	0.36
2.11	320.86	0.53	1.28	0.33	0.36
2.16	320.87	0.54	1.29	0.34	0.36
2.22	320.88	0.55	1.30	0.34	0.36

Tailwater Channel Data - 1090+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 320.33 ft

Roadway Data for Crossing: 1090+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 332.14 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.11 cfs

Design Flow: 2.51 cfs

Maximum Flow: 2.82 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1090+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
330.65	2.11	2.11	0.00	1
330.67	2.18	2.18	0.00	1
330.68	2.25	2.25	0.00	1
330.70	2.32	2.32	0.00	1
330.71	2.39	2.39	0.00	1
330.73	2.46	2.46	0.00	1
330.74	2.51	2.51	0.00	1
330.76	2.61	2.61	0.00	1
330.77	2.68	2.68	0.00	1
330.79	2.75	2.75	0.00	1
330.80	2.82	2.82	0.00	1
332.14	9.92	9.92	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.11	2.11	330.65	0.735	0.0*	1-S2n	0.296	0.546	0.296	0.535	8.293	1.285
2.18	2.18	330.67	0.747	0.0*	1-S2n	0.301	0.552	0.301	0.544	8.379	1.298
2.25	2.25	330.68	0.762	0.0*	1-S2n	0.306	0.562	0.306	0.554	8.461	1.309
2.32	2.32	330.70	0.778	0.0*	1-S2n	0.311	0.572	0.311	0.563	8.553	1.321
2.39	2.39	330.71	0.794	0.0*	1-S2n	0.315	0.582	0.315	0.572	8.648	1.332
2.46	2.46	330.73	0.809	0.0*	1-S2n	0.320	0.591	0.320	0.581	8.638	1.343
2.51	2.51	330.74	0.819	0.0*	1-S2n	0.322	0.597	0.322	0.586	8.689	1.350
2.61	2.61	330.76	0.839	0.0*	1-S2n	0.329	0.610	0.329	0.598	8.796	1.364
2.68	2.68	330.77	0.854	0.0*	1-S2n	0.333	0.619	0.333	0.606	8.870	1.375
2.75	2.75	330.79	0.869	0.0*	1-S2n	0.338	0.628	0.338	0.615	8.942	1.385
2.82	2.82	330.80	0.883	0.0*	1-S2n	0.342	0.636	0.342	0.623	9.011	1.395

* Full Flow Headwater elevation is below inlet invert.

****

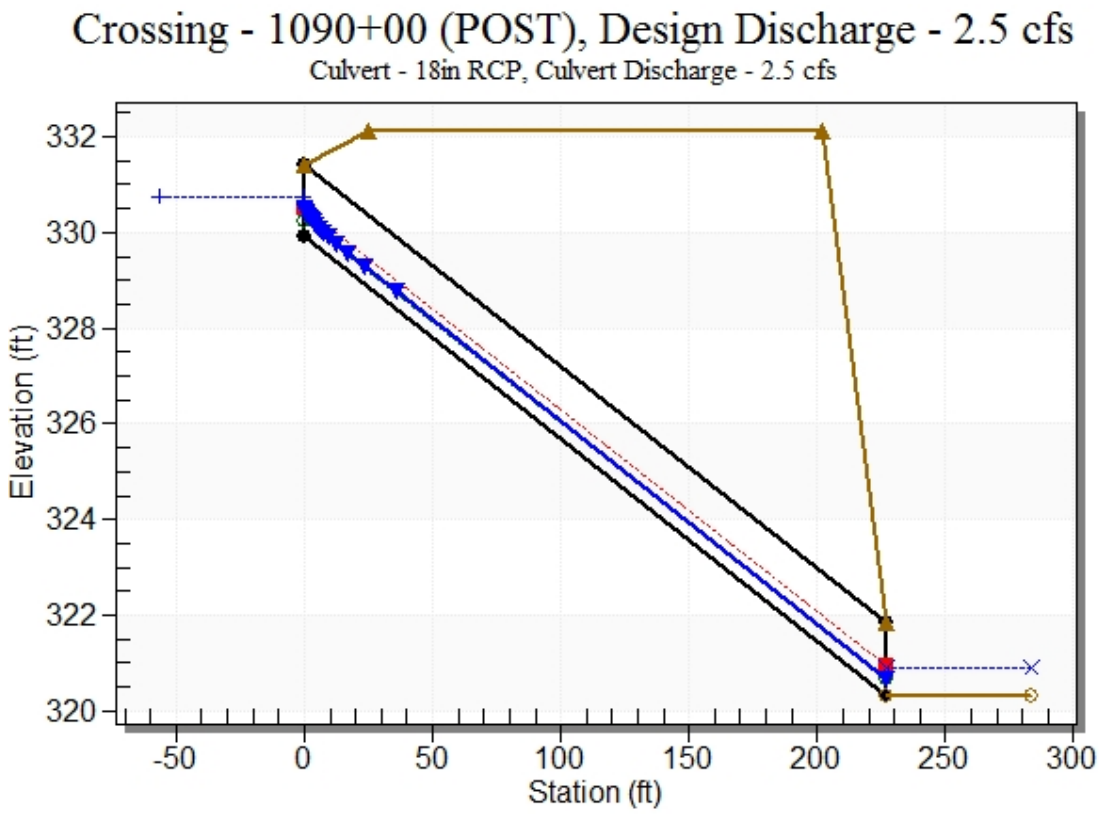
Straight Culvert

Inlet Elevation (invert): 329.92 ft, Outlet Elevation (invert): 320.33 ft

Culvert Length: 227.20 ft, Culvert Slope: 0.0422

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 329.92 ft

Outlet Station: 227.00 ft

Outlet Elevation: 320.33 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1090+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.11	320.86	0.53	1.29	0.33	0.36
2.18	320.87	0.54	1.30	0.34	0.36
2.25	320.88	0.55	1.31	0.35	0.36
2.32	320.89	0.56	1.32	0.35	0.36
2.39	320.90	0.57	1.33	0.36	0.36
2.46	320.91	0.58	1.34	0.36	0.36
2.51	320.92	0.59	1.35	0.37	0.36
2.61	320.93	0.60	1.36	0.37	0.36
2.68	320.94	0.61	1.37	0.38	0.37
2.75	320.94	0.61	1.38	0.38	0.37
2.82	320.95	0.62	1.39	0.39	0.37

Tailwater Channel Data - 1090+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 320.33 ft

Roadway Data for Crossing: 1090+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 332.14 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

CULVERT 75

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 75**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2256
Grass	0.25	1.29	0.3217
Woods	0.15	2.79	0.4191
	Σ	**4.33**	0.9664

$C_{ave} = \frac{0.9664}{4.33} = 0.22$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.55	0.4956
Grass	0.25	5.29	1.3225
Woods	0.15	2.79	0.4191
	Σ	**8.63**	2.2372

$C_{ave} = \frac{2.2372}{8.63} = 0.26$

T_c =	37.08	min.								
I_{05} =	3.39	in / hr								
I_{10} =	3.72	in / hr								
I_{25} =	4.22	in / hr								
I_{50} =	4.60	in / hr								
I_{100} =	4.97	in / hr								

Pre Construction Runoff:

Q_{05} =	0.22	x	3.39	x	4.33	x	1	=	**3.27**	cfs
Q_{10} =	0.22	x	3.72	x	4.33	x	1	=	**3.60**	cfs
Q_{25} =	0.22	x	4.22	x	4.33	x	1.1	=	**4.48**	cfs
Q_{50} =	0.22	x	4.60	x	4.33	x	1.2	=	**5.33**	cfs
Q_{100} =	0.22	x	4.97	x	4.33	x	1.25	=	**6.00**	cfs

Post Construction Runoff:

Q_{05} =	0.26	x	3.39	x	8.63	x	1	=	**7.58**	cfs
Q_{10} =	0.26	x	3.72	x	8.63	x	1	=	**8.33**	cfs
Q_{25} =	0.26	x	4.22	x	8.63	x	1.1	=	**10.37**	cfs
Q_{50} =	0.26	x	4.60	x	8.63	x	1.2	=	**12.34**	cfs
Q_{100} =	0.26	x	4.97	x	8.63	x	1.25	=	**13.90**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 75 Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Woods				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft	**100**					
4 Two-yr 24-hr rainfall, P_2		in	**3.58**					
5 Land slope, s		ft/ft	**0.0200**					
6 $T_t = 0.007 (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**	
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)				unpaved				
8 Flow length, L		ft	**375**					
9 Watercourse slope, s		ft/ft	**0.0500**					
10 Average velocity, V (figure 3-1)		ft/s	**3.61**					
11 $T_t = L / (3600 V)$	Compute T_t	hr	**0.029**	+		=	**0.029**	
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2	**0.00**	**0.00**				
13 Wetted perimeter, p_w		ft	**0.00**	**0.00**				
14 Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**				
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49 r^{2/3} s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**				
18 Flow length, L		ft						
19 $T_t = L / (3600 V)$	Compute T_t	hr		+		=	**0.000**	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.618**	
						min	**37.08**	

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.48 cfs

Design Flow: 5.33 cfs

Maximum Flow: 6 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1091+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
329.84	4.48	4.48	0.00	1
329.86	4.63	4.63	0.00	1
329.89	4.78	4.78	0.00	1
329.91	4.94	4.94	0.00	1
329.93	5.09	5.09	0.00	1
329.95	5.24	5.24	0.00	1
329.96	5.33	5.33	0.00	1
329.99	5.54	5.54	0.00	1
330.01	5.70	5.70	0.00	1
330.03	5.85	5.85	0.00	1
330.05	6.00	6.00	0.00	1
332.34	23.45	23.45	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.48	4.48	329.84	1.012	0.0*	1-S2n	0.443	0.741	0.451	0.790	8.170	1.584
4.63	4.63	329.86	1.034	0.0*	1-S2n	0.450	0.754	0.450	0.804	8.472	1.598
4.78	4.78	329.89	1.056	0.0*	1-S2n	0.458	0.764	0.458	0.817	8.555	1.612
4.94	4.94	329.91	1.078	0.0*	1-S2n	0.465	0.777	0.465	0.830	8.580	1.626
5.09	5.09	329.93	1.099	0.0*	1-S2n	0.472	0.791	0.480	0.842	8.465	1.639
5.24	5.24	329.95	1.120	0.0*	1-S2n	0.479	0.804	0.488	0.855	8.522	1.652
5.33	5.33	329.96	1.132	0.0*	1-S2n	0.483	0.811	0.493	0.862	8.563	1.659
5.54	5.54	329.99	1.161	0.0*	1-S2n	0.493	0.829	0.502	0.879	8.675	1.677
5.70	5.70	330.01	1.182	0.0*	1-S2n	0.500	0.841	0.509	0.891	8.767	1.689
5.85	5.85	330.03	1.201	0.0*	1-S2n	0.507	0.853	0.507	0.903	9.050	1.701
6.00	6.00	330.05	1.221	0.0*	1-S2n	0.514	0.865	0.514	0.915	9.072	1.713

* Full Flow Headwater elevation is below inlet invert.

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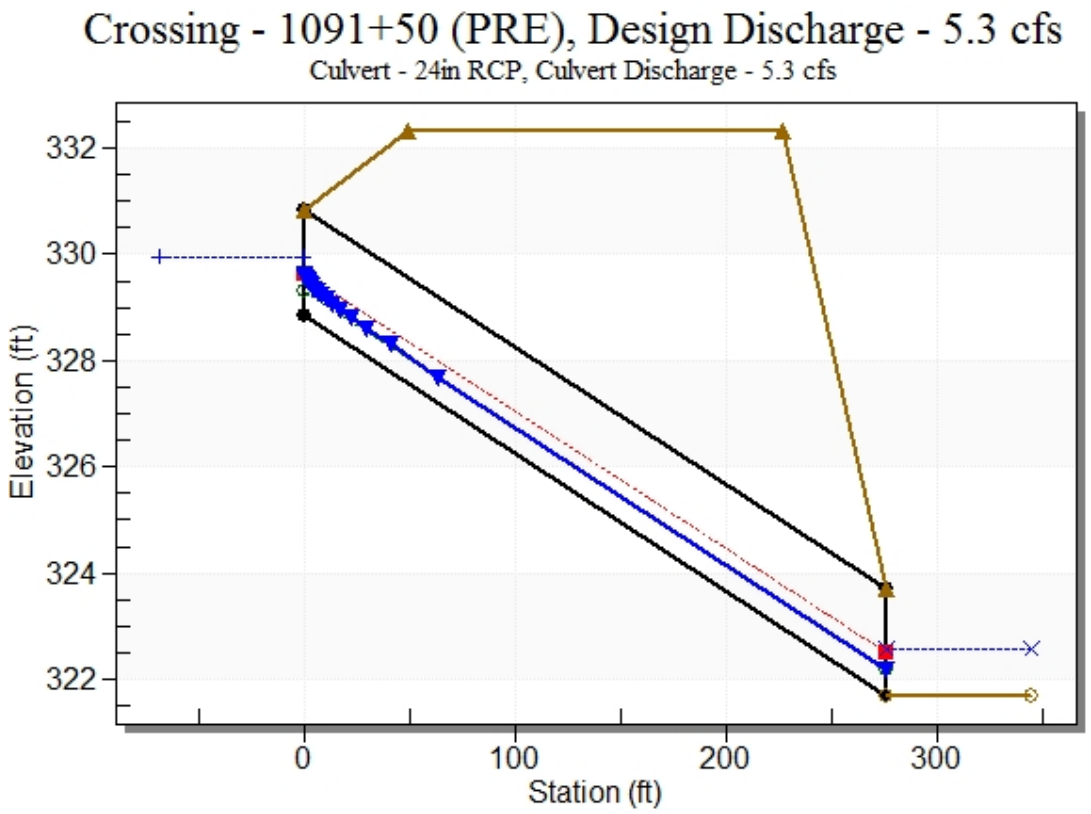
Straight Culvert

Inlet Elevation (invert): 328.83 ft, Outlet Elevation (invert): 321.70 ft

Culvert Length: 276.09 ft, Culvert Slope: 0.0258

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 328.83 ft

Outlet Station: 276.00 ft

Outlet Elevation: 321.70 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1091+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.48	322.49	0.79	1.58	0.49	0.38
4.63	322.50	0.80	1.60	0.50	0.38
4.78	322.52	0.82	1.61	0.51	0.38
4.94	322.53	0.83	1.63	0.52	0.38
5.09	322.54	0.84	1.64	0.53	0.38
5.24	322.55	0.85	1.65	0.53	0.38
5.33	322.56	0.86	1.66	0.54	0.38
5.54	322.58	0.88	1.68	0.55	0.38
5.70	322.59	0.89	1.69	0.56	0.38
5.85	322.60	0.90	1.70	0.56	0.38
6.00	322.61	0.91	1.71	0.57	0.38

Tailwater Channel Data - 1091+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 321.70 ft

Roadway Data for Crossing: 1091+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 332.34 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 10.37 cfs

Design Flow: 12.34 cfs

Maximum Flow: 13.9 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1091+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
330.55	10.37	10.37	0.00	1
330.59	10.72	10.72	0.00	1
330.63	11.08	11.08	0.00	1
330.66	11.43	11.43	0.00	1
330.70	11.78	11.78	0.00	1
330.74	12.14	12.14	0.00	1
330.76	12.34	12.34	0.00	1
330.82	12.84	12.84	0.00	1
330.85	13.19	13.19	0.00	1
330.89	13.55	13.55	0.00	1
330.93	13.90	13.90	0.00	1
332.34	23.45	23.45	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.37	10.37	330.55	1.720	0.0*	1-S2n	0.681	1.151	0.681	1.194	10.598	1.978
10.72	10.72	330.59	1.758	0.0*	1-S2n	0.694	1.170	0.694	1.214	10.702	1.996
11.08	11.08	330.63	1.795	0.0*	1-S2n	0.706	1.190	0.706	1.233	10.801	2.013
11.43	11.43	330.66	1.833	0.0*	1-S2n	0.718	1.209	0.718	1.251	10.876	2.029
11.78	11.78	330.70	1.871	0.0*	1-S2n	0.730	1.228	0.774	1.269	10.131	2.045
12.14	12.14	330.74	1.909	0.0*	1-S2n	0.741	1.246	0.763	1.287	10.654	2.061
12.34	12.34	330.76	1.931	0.0*	1-S2n	0.748	1.260	0.748	1.297	11.119	2.070
12.84	12.84	330.82	1.986	0.0*	1-S2n	0.765	1.286	0.765	1.322	11.242	2.092
13.19	13.19	330.85	2.025	0.0*	5-S2n	0.776	1.304	0.776	1.339	11.313	2.106
13.55	13.55	330.89	2.064	0.0*	5-S2n	0.787	1.322	0.787	1.356	11.398	2.120
13.90	13.90	330.93	2.104	0.0*	5-S2n	0.798	1.339	0.798	1.372	11.479	2.135

* Full Flow Headwater elevation is below inlet invert.

****

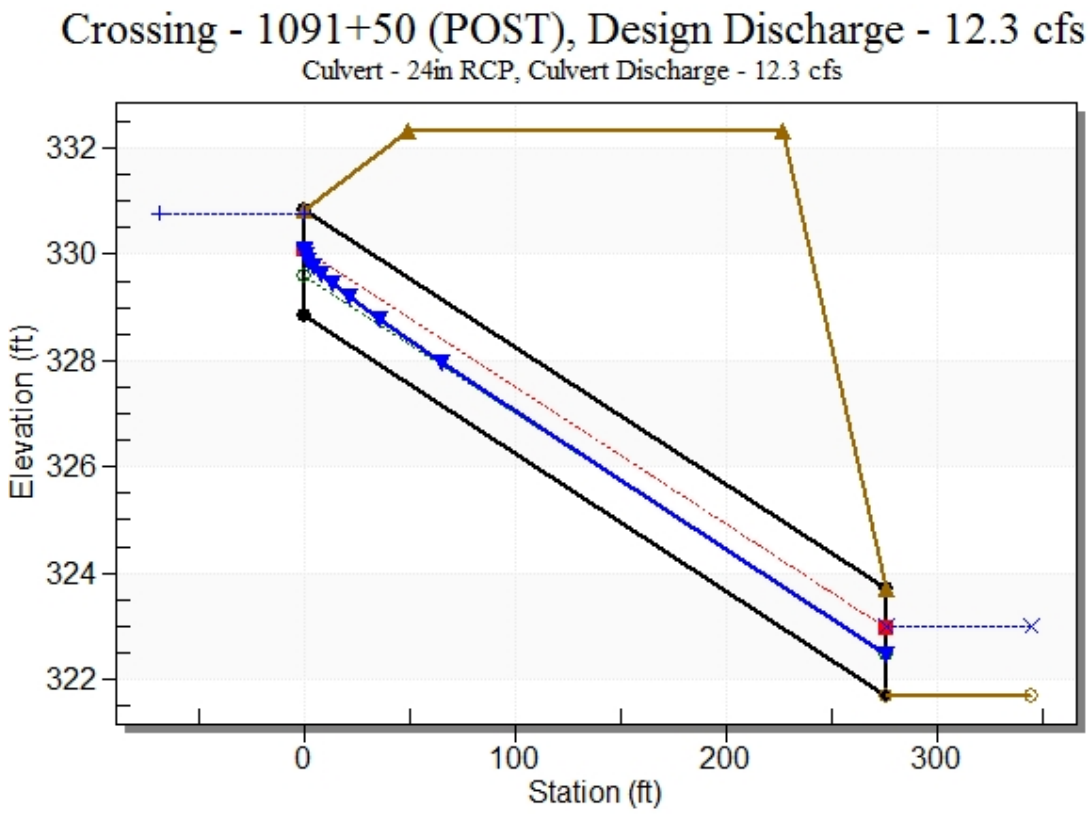
Straight Culvert

Inlet Elevation (invert): 328.83 ft, Outlet Elevation (invert): 321.70 ft

Culvert Length: 276.09 ft, Culvert Slope: 0.0258

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 328.83 ft

Outlet Station: 276.00 ft

Outlet Elevation: 321.70 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1091+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
10.37	322.89	1.19	1.98	0.75	0.40
10.72	322.91	1.21	2.00	0.76	0.40
11.08	322.93	1.23	2.01	0.77	0.40
11.43	322.95	1.25	2.03	0.78	0.40
11.78	322.97	1.27	2.05	0.79	0.40
12.14	322.99	1.29	2.06	0.80	0.40
12.34	323.00	1.30	2.07	0.81	0.40
12.84	323.02	1.32	2.09	0.82	0.40
13.19	323.04	1.34	2.11	0.84	0.40
13.55	323.06	1.36	2.12	0.85	0.40
13.90	323.07	1.37	2.13	0.86	0.40

Tailwater Channel Data - 1091+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 321.70 ft

Roadway Data for Crossing: 1091+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 332.34 ft

Roadway Surface: Paved

Roadway Top Width: 177.00 ft

CULVERT 76

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 76**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.29	2.9610
Grass	0.25	14.91	3.7286
Woods	0.15	14.00	2.0994
	Σ	**32.20**	8.7890

$C_{ave} = \frac{8.7890}{32.20} = 0.27$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.57	5.0112
Grass	0.25	12.64	3.1591
Woods	0.15	14.00	2.0994
	Σ	**32.20**	10.2697

$C_{ave} = \frac{10.2697}{32.20} = 0.32$

T_c =	35.95	min.								
I_{05} =	3.44	in / hr								
I_{10} =	3.79	in / hr								
I_{25} =	4.29	in / hr								
I_{50} =	4.68	in / hr								
I_{100} =	5.06	in / hr								

Pre Construction Runoff:

Q_{05} =	0.27	**x**	3.44	**x**	32.20	**x**	1	=	**30.27**	cfs
Q_{10} =	0.27	**x**	3.79	**x**	32.20	**x**	1	=	**33.29**	cfs
Q_{25} =	0.27	**x**	4.29	**x**	32.20	**x**	1.1	=	**41.46**	cfs
Q_{50} =	0.27	**x**	4.68	**x**	32.20	**x**	1.2	=	**49.34**	cfs
Q_{100} =	0.27	**x**	5.06	**x**	32.20	**x**	1.25	=	**55.56**	cfs

Post Construction Runoff:

Q_{05} =	0.32	**x**	3.44	**x**	32.20	**x**	1	=	**35.38**	cfs
Q_{10} =	0.32	**x**	3.79	**x**	32.20	**x**	1	=	**38.90**	cfs
Q_{25} =	0.32	**x**	4.29	**x**	32.20	**x**	1.1	=	**48.44**	cfs
Q_{50} =	0.32	**x**	4.68	**x**	32.20	**x**	1.2	=	**57.65**	cfs
Q_{100} =	0.32	**x**	5.06	**x**	32.20	**x**	1.25	=	**64.92**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 76	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.400**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**600**				
9	Watercourse slope, s		ft/ft	**0.0500**				
10	Average velocity, V (figure 3-1)		ft/s	**3.61**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.046**	+		=	**0.046**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**4**				
	Back Slope, (_ : 1)			**4**				
	Bottom Width		ft	**4**				
	Flow Depth		ft	**1**				
12	Cross sectional flow area, a		ft^2	**8.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**12.25**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.65**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0280**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**3.13**	**#DIV/0!**			
18	Flow length, L		ft	**1200**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.107**	+		=	**0.107**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.599**
							min	**35.95**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 41.46 cfs

Design Flow: 49.34 cfs

Maximum Flow: 55.56 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1094+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	42in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
335.40	41.46	41.46	0.00	1
335.46	42.87	42.87	0.00	1
335.51	44.28	44.28	0.00	1
335.57	45.69	45.69	0.00	1
335.62	47.10	47.10	0.00	1
335.68	48.51	48.51	0.00	1
335.71	49.34	49.34	0.00	1
335.79	51.33	51.33	0.00	1
335.85	52.74	52.74	0.00	1
335.91	54.15	54.15	0.00	1
335.96	55.56	55.56	0.00	1
344.00	161.77	161.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 42in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
41.46	41.46	335.40	2.870	0.0*	1-S2n	1.226	2.000	1.283	1.908	12.525	2.781
42.87	42.87	335.46	2.926	0.0*	1-S2n	1.248	2.035	1.299	1.939	12.739	2.806
44.28	44.28	335.51	2.983	0.0*	1-S2n	1.270	2.072	1.270	1.971	13.569	2.830
45.69	45.69	335.57	3.039	0.0*	1-S2n	1.291	2.106	1.354	2.001	12.840	2.853
47.10	47.10	335.62	3.095	0.0*	1-S2n	1.313	2.139	1.377	2.031	12.949	2.876
48.51	48.51	335.68	3.151	0.0*	1-S2n	1.334	2.172	1.395	2.061	13.101	2.899
49.34	49.34	335.71	3.184	0.0*	1-S2n	1.347	2.191	1.405	2.078	13.195	2.912
51.33	51.33	335.79	3.264	0.0*	1-S2n	1.376	2.236	1.376	2.118	14.127	2.942
52.74	52.74	335.85	3.320	0.0*	1-S2n	1.396	2.267	1.464	2.146	13.360	2.963
54.15	54.15	335.91	3.377	0.0*	1-S2n	1.417	2.298	1.488	2.174	13.431	2.984
55.56	55.56	335.96	3.435	0.0*	1-S2n	1.437	2.331	1.507	2.201	13.548	3.004

* Full Flow Headwater elevation is below inlet invert.

****

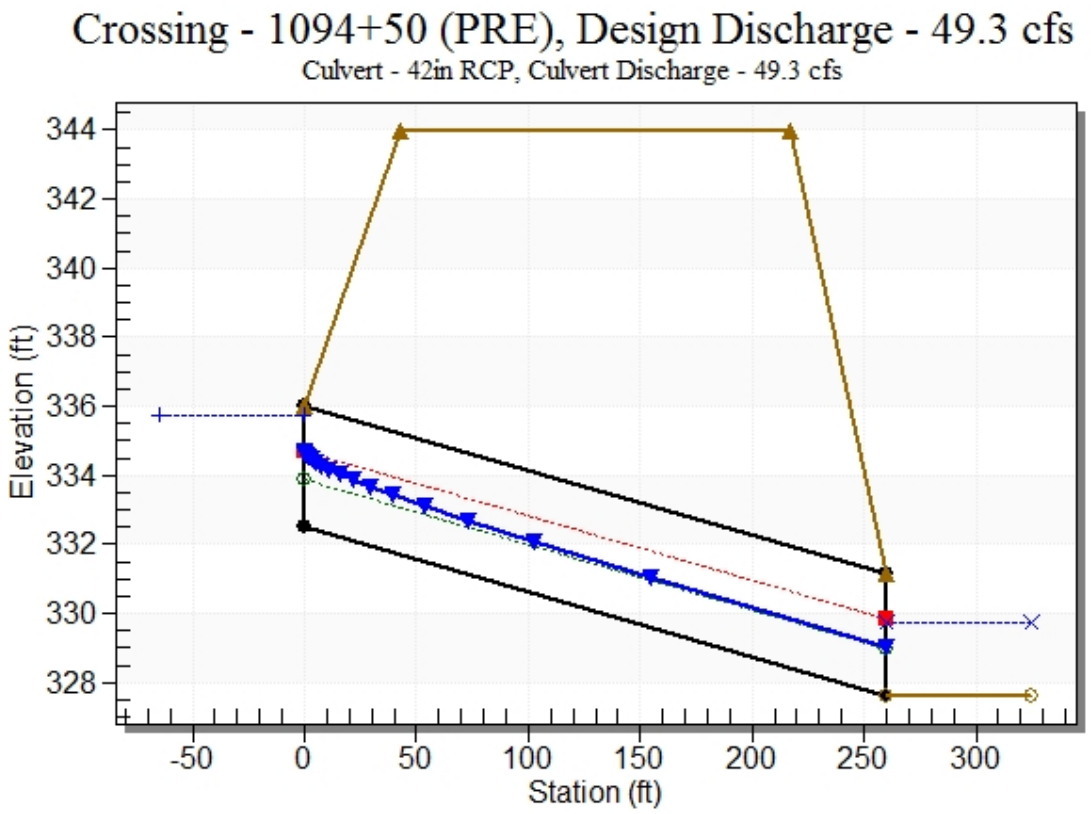
Straight Culvert

Inlet Elevation (invert): 332.53 ft, Outlet Elevation (invert): 327.63 ft

Culvert Length: 260.05 ft, Culvert Slope: 0.0188

****

Water Surface Profile Plot for Culvert: 42in RCP



Site Data - 42in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 332.53 ft

Outlet Station: 260.00 ft

Outlet Elevation: 327.63 ft

Number of Barrels: 1

Culvert Data Summary - 42in RCP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1094+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
41.46	329.54	1.91	2.78	1.19	0.43
42.87	329.57	1.94	2.81	1.21	0.43
44.28	329.60	1.97	2.83	1.23	0.43
45.69	329.63	2.00	2.85	1.25	0.44
47.10	329.66	2.03	2.88	1.27	0.44
48.51	329.69	2.06	2.90	1.29	0.44
49.34	329.71	2.08	2.91	1.30	0.44
51.33	329.75	2.12	2.94	1.32	0.44
52.74	329.78	2.15	2.96	1.34	0.44
54.15	329.80	2.17	2.98	1.36	0.44
55.56	329.83	2.20	3.00	1.37	0.44

Tailwater Channel Data - 1094+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 327.63 ft

Roadway Data for Crossing: 1094+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 344.00 ft

Roadway Surface: Paved

Roadway Top Width: 174.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 48.44 cfs

Design Flow: 57.65 cfs

Maximum Flow: 64.92 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1094+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	42in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
335.68	48.44	48.44	0.00	1
335.74	50.09	50.09	0.00	1
335.81	51.74	51.74	0.00	1
335.88	53.38	53.38	0.00	1
335.94	55.03	55.03	0.00	1
336.01	56.68	56.68	0.00	1
336.05	57.65	57.65	0.00	1
336.15	59.98	59.98	0.00	1
336.22	61.62	61.62	0.00	1
336.29	63.27	63.27	0.00	1
336.36	64.92	64.92	0.00	1
344.00	161.77	161.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 42in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
48.44	48.44	335.68	3.148	0.0*	1-S2n	1.333	2.170	1.395	2.059	13.093	2.898
50.09	50.09	335.74	3.214	0.0*	1-S2n	1.357	2.208	1.413	2.093	13.292	2.923
51.74	51.74	335.81	3.280	0.0*	1-S2n	1.382	2.245	1.382	2.126	14.158	2.948
53.38	53.38	335.88	3.346	0.0*	1-S2n	1.406	2.281	1.475	2.159	13.391	2.973
55.03	55.03	335.94	3.413	0.0*	1-S2n	1.430	2.317	1.501	2.191	13.493	2.997
56.68	56.68	336.01	3.481	0.0*	1-S2n	1.453	2.355	1.521	2.223	13.651	3.020
57.65	57.65	336.05	3.521	0.0*	5-S2n	1.467	2.376	1.533	2.241	13.746	3.033
59.98	59.98	336.15	3.619	0.0*	5-S2n	1.500	2.424	1.572	2.284	13.840	3.065
61.62	61.62	336.22	3.689	0.0*	5-S2n	1.523	2.457	1.601	2.314	13.894	3.087
63.27	63.27	336.29	3.761	0.0*	5-S2n	1.546	2.490	1.626	2.343	13.980	3.108
64.92	64.92	336.36	3.833	0.0*	5-S2n	1.569	2.523	1.649	2.373	14.082	3.129

* Full Flow Headwater elevation is below inlet invert.

****

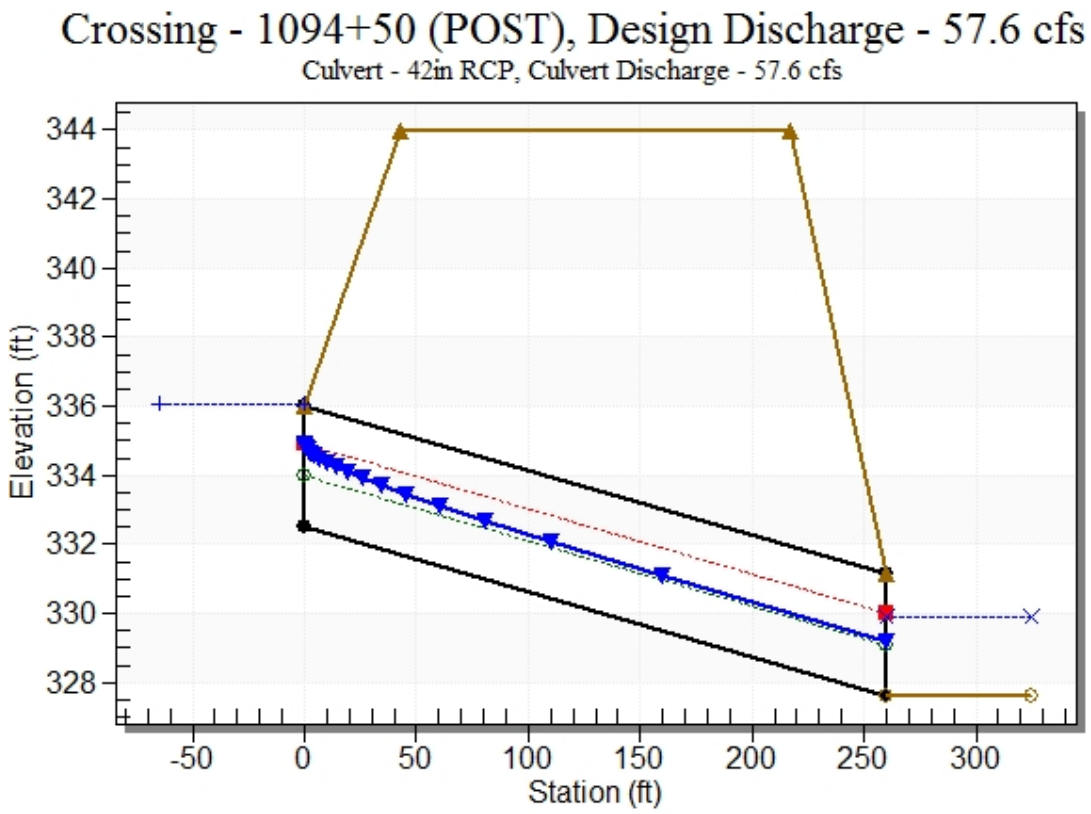
Straight Culvert

Inlet Elevation (invert): 332.53 ft, Outlet Elevation (invert): 327.63 ft

Culvert Length: 260.05 ft, Culvert Slope: 0.0188

****

Water Surface Profile Plot for Culvert: 42in RCP



Site Data - 42in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 332.53 ft

Outlet Station: 260.00 ft

Outlet Elevation: 327.63 ft

Number of Barrels: 1

Culvert Data Summary - 42in RCP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1094+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
48.44	329.69	2.06	2.90	1.28	0.44
50.09	329.72	2.09	2.92	1.31	0.44
51.74	329.76	2.13	2.95	1.33	0.44
53.38	329.79	2.16	2.97	1.35	0.44
55.03	329.82	2.19	3.00	1.37	0.44
56.68	329.85	2.22	3.02	1.39	0.44
57.65	329.87	2.24	3.03	1.40	0.44
59.98	329.91	2.28	3.06	1.43	0.44
61.62	329.94	2.31	3.09	1.44	0.44
63.27	329.97	2.34	3.11	1.46	0.44
64.92	330.00	2.37	3.13	1.48	0.44

Tailwater Channel Data - 1094+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 327.63 ft

Roadway Data for Crossing: 1094+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 344.00 ft

Roadway Surface: Paved

Roadway Top Width: 174.00 ft

CULVERT 77

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 77**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.34	0.3026
Grass	0.25	0.73	0.1824
Woods	0.15	0.00	0.0000
	Σ	**1.07**	0.4849

$C_{ave} = \frac{0.4849}{1.07} = 0.46$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.73	0.6554
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.6554

$C_{ave} = \frac{0.6554}{0.73} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.46	x	6.32	x	1.07	x	1	=	**3.07**	cfs
Q_{10} =	0.46	x	7.04	x	1.07	x	1	=	**3.41**	cfs
Q_{25} =	0.46	x	8.10	x	1.07	x	1.1	=	**4.32**	cfs
Q_{50} =	0.46	x	8.95	x	1.07	x	1.2	=	**5.21**	cfs
Q_{100} =	0.46	x	9.80	x	1.07	x	1.25	=	**5.94**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.73	x	1	=	**4.15**	cfs
Q_{10} =	0.90	x	7.04	x	0.73	x	1	=	**4.61**	cfs
Q_{25} =	0.90	x	8.10	x	0.73	x	1.1	=	**5.84**	cfs
Q_{50} =	0.90	x	8.95	x	0.73	x	1.2	=	**7.04**	cfs
Q_{100} =	0.90	x	9.80	x	0.73	x	1.25	=	**8.03**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.32 cfs

Design Flow: 5.21 cfs

Maximum Flow: 5.94 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1099+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
353.98	4.32	4.32	0.00	1
354.02	4.48	4.48	0.00	1
354.06	4.64	4.64	0.00	1
354.10	4.81	4.81	0.00	1
354.14	4.97	4.97	0.00	1
354.18	5.13	5.13	0.00	1
354.21	5.21	5.21	0.00	1
354.27	5.45	5.45	0.00	1
354.32	5.62	5.62	0.00	1
354.36	5.78	5.78	0.00	1
354.41	5.94	5.94	0.00	1
354.50	6.22	6.22	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.32	4.32	353.98	1.284	0.0*	5-S2n	0.380	0.840	0.380	0.776	13.267	1.568
4.48	4.48	354.02	1.322	0.0*	5-S2n	0.387	0.856	0.387	0.790	13.414	1.584
4.64	4.64	354.06	1.361	0.0*	5-S2n	0.394	0.871	0.394	0.805	13.568	1.599
4.81	4.81	354.10	1.401	0.0*	5-S2n	0.401	0.886	0.401	0.819	13.714	1.614
4.97	4.97	354.14	1.442	0.0*	5-S2n	0.408	0.901	0.441	0.832	12.410	1.628
5.13	5.13	354.18	1.484	0.0*	5-S2n	0.415	0.915	0.424	0.846	13.553	1.642
5.21	5.21	354.21	1.505	0.0*	5-S2n	0.419	0.922	0.419	0.853	13.978	1.649
5.45	5.45	354.27	1.572	0.0*	5-S2n	0.429	0.943	0.429	0.872	14.178	1.670
5.62	5.62	354.32	1.617	0.0*	5-S2n	0.436	0.956	0.436	0.885	14.254	1.683
5.78	5.78	354.36	1.665	0.0*	5-S2n	0.442	0.969	0.442	0.898	14.369	1.696
5.94	5.94	354.41	1.713	0.0*	5-S2n	0.449	0.982	0.449	0.910	14.481	1.708

* Full Flow Headwater elevation is below inlet invert.

****

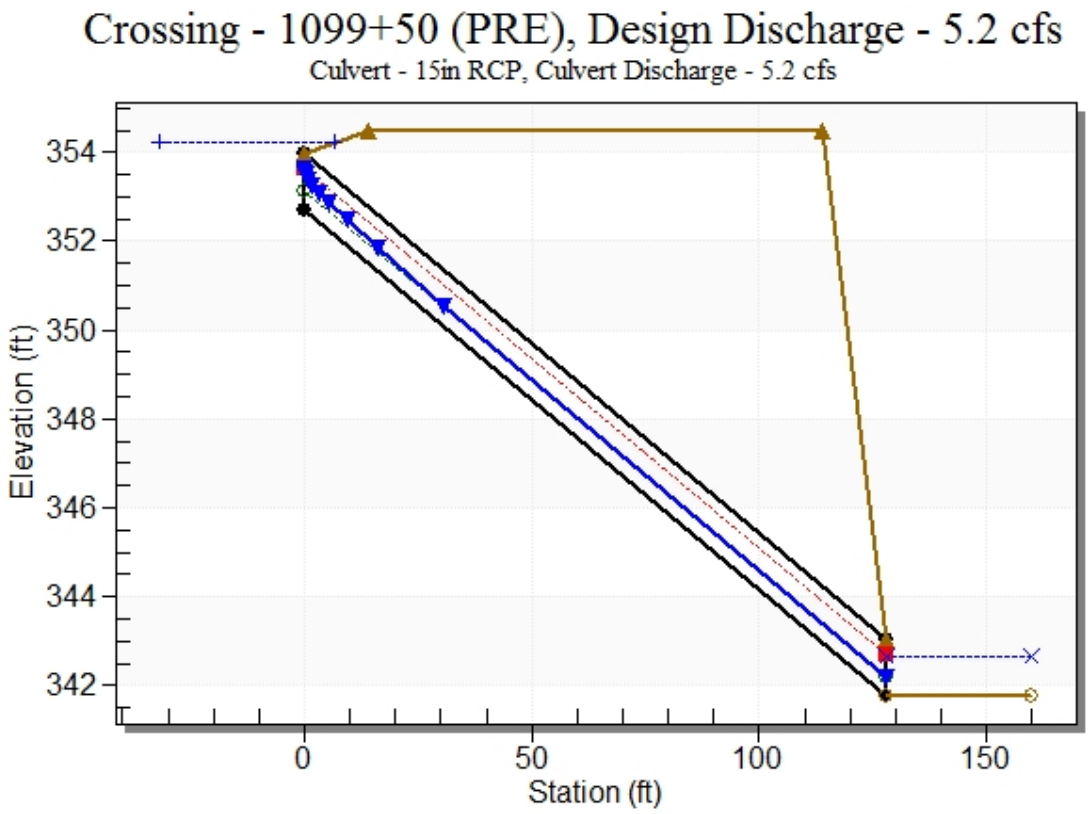
Straight Culvert

Inlet Elevation (invert): 352.70 ft, Outlet Elevation (invert): 341.78 ft

Culvert Length: 128.46 ft, Culvert Slope: 0.0853

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 352.70 ft

Outlet Station: 128.00 ft

Outlet Elevation: 341.78 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1099+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.32	342.56	0.78	1.57	0.48	0.38
4.48	342.57	0.79	1.58	0.49	0.38
4.64	342.58	0.80	1.60	0.50	0.38
4.81	342.60	0.82	1.61	0.51	0.38
4.97	342.61	0.83	1.63	0.52	0.38
5.13	342.63	0.85	1.64	0.53	0.38
5.21	342.63	0.85	1.65	0.53	0.38
5.45	342.65	0.87	1.67	0.54	0.38
5.62	342.67	0.89	1.68	0.55	0.38
5.78	342.68	0.90	1.70	0.56	0.38
5.94	342.69	0.91	1.71	0.57	0.38

Tailwater Channel Data - 1099+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 341.78 ft

Roadway Data for Crossing: 1099+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 354.50 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.84 cfs

Design Flow: 7.04 cfs

Maximum Flow: 8.03 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1099+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
354.38	5.84	5.84	0.00	1
354.45	6.06	6.06	0.00	1
354.50	6.28	6.22	0.00	22
354.51	6.50	6.26	0.19	5
354.52	6.72	6.28	0.39	4
354.53	6.93	6.30	0.58	3
354.53	7.04	6.31	0.69	3
354.54	7.37	6.33	0.98	3
354.54	7.59	6.35	1.20	3
354.55	7.81	6.36	1.42	3
354.55	8.03	6.37	1.63	3
354.50	6.22	6.22	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.84	5.84	354.38	1.683	0.0*	5-S2n	0.445	0.974	0.445	0.902	14.412	1.701
6.06	6.06	354.45	1.750	0.0*	5-S2n	0.454	0.991	0.454	0.919	14.569	1.717
6.28	6.22	354.50	1.800	0.0*	5-S2n	0.460	1.003	0.497	0.935	13.254	1.734
6.50	6.26	354.51	1.812	0.0*	5-S2n	0.462	1.006	0.495	0.951	13.379	1.749
6.72	6.28	354.52	1.820	0.0*	5-S2n	0.463	1.008	0.494	0.967	13.463	1.765
6.93	6.30	354.53	1.825	0.0*	5-S2n	0.463	1.009	0.494	0.983	13.523	1.780
7.04	6.31	354.53	1.828	0.0*	5-S2n	0.464	1.010	0.493	0.990	13.557	1.787
7.37	6.33	354.54	1.836	0.0*	5-S2n	0.465	1.011	0.492	1.013	13.638	1.809
7.59	6.35	354.54	1.841	0.0*	5-S2n	0.465	1.013	0.492	1.027	13.694	1.823
7.81	6.36	354.55	1.845	0.0*	5-S2n	0.466	1.014	0.491	1.041	13.746	1.837
8.03	6.37	354.55	1.850	0.0*	5-S2n	0.466	1.015	0.491	1.056	13.794	1.850

* Full Flow Headwater elevation is below inlet invert.

****

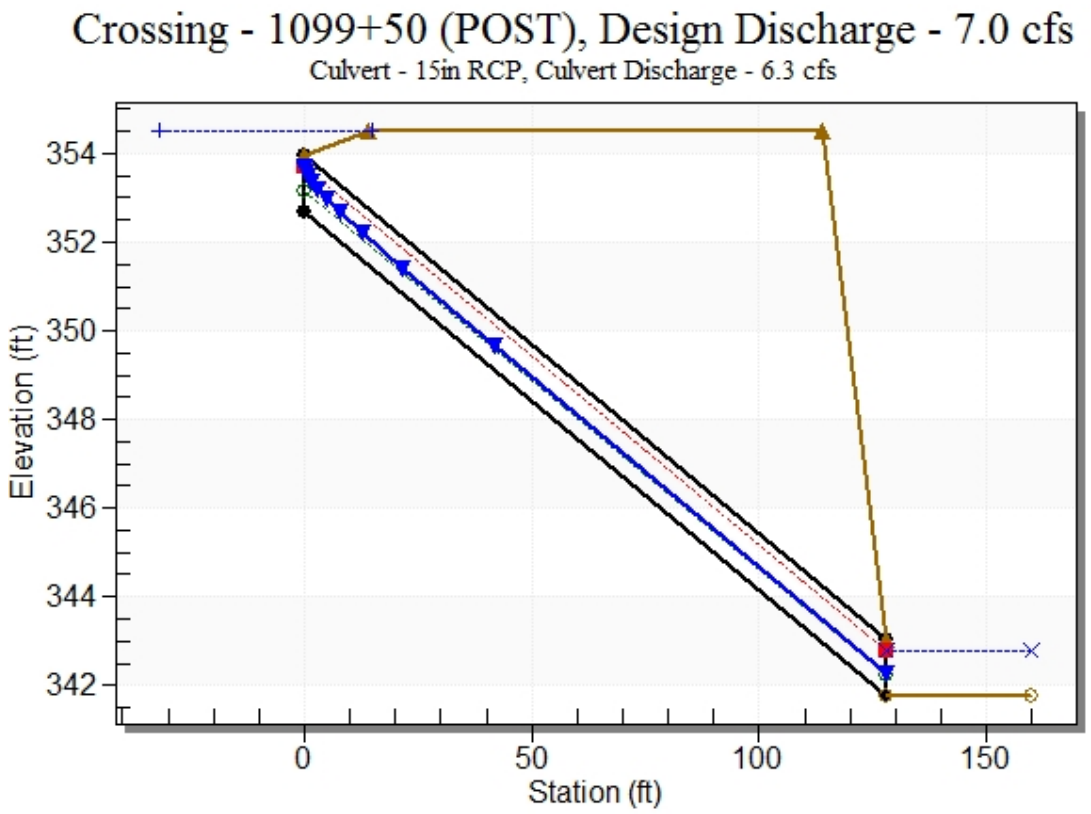
Straight Culvert

Inlet Elevation (invert): 352.70 ft, Outlet Elevation (invert): 341.78 ft

Culvert Length: 128.46 ft, Culvert Slope: 0.0853

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 352.70 ft

Outlet Station: 128.00 ft

Outlet Elevation: 341.78 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1099+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.84	342.68	0.90	1.70	0.56	0.38
6.06	342.70	0.92	1.72	0.57	0.38
6.28	342.72	0.94	1.73	0.58	0.38
6.50	342.73	0.95	1.75	0.59	0.39
6.72	342.75	0.97	1.77	0.60	0.39
6.93	342.76	0.98	1.78	0.61	0.39
7.04	342.77	0.99	1.79	0.62	0.39
7.37	342.79	1.01	1.81	0.63	0.39
7.59	342.81	1.03	1.82	0.64	0.39
7.81	342.82	1.04	1.84	0.65	0.39
8.03	342.84	1.06	1.85	0.66	0.39

Tailwater Channel Data - 1099+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 341.78 ft

Roadway Data for Crossing: 1099+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 354.50 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 78/80

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 78/80a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.61	0.5531
Grass	0.25	0.79	0.1967
Woods	0.15	0.00	0.0000
	Σ	**1.40**	0.7498

$C_{ave} = \frac{0.7498}{1.40} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.73	0.6611
Grass	0.25	0.79	0.1967
Woods	0.15	0.00	0.0000
	Σ	**1.52**	0.8578

$C_{ave} = \frac{0.8578}{1.52} = 0.56$

T_c =	13.82	min.
I_{05} =	5.11	in / hr
I_{10} =	5.66	in / hr
I_{25} =	6.46	in / hr
I_{50} =	7.10	in / hr
I_{100} =	7.73	in / hr

Pre Construction Runoff:

Q_{05} =	0.54	x	5.11	x	1.40	x	1	=	**3.83**	cfs
Q_{10} =	0.54	x	5.66	x	1.40	x	1	=	**4.24**	cfs
Q_{25} =	0.54	x	6.46	x	1.40	x	1.1	=	**5.33**	cfs
Q_{50} =	0.54	x	7.10	x	1.40	x	1.2	=	**6.39**	cfs
Q_{100} =	0.54	x	7.73	x	1.40	x	1.25	=	**7.24**	cfs

Post Construction Runoff:

Q_{05} =	0.56	x	5.11	x	1.52	x	1	=	**4.38**	cfs
Q_{10} =	0.56	x	5.66	x	1.52	x	1	=	**4.85**	cfs
Q_{25} =	0.56	x	6.46	x	1.52	x	1.1	=	**6.10**	cfs
Q_{50} =	0.56	x	7.10	x	1.52	x	1.2	=	**7.31**	cfs
Q_{100} =	0.56	x	7.73	x	1.52	x	1.25	=	**8.29**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 78/80b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.12	0.1096
Grass	0.25	0.16	0.0390
Woods	0.15	0.28	0.0425
	Σ	**0.56**	0.1911

$C_{ave} = \frac{0.1911}{0.56} = 0.34$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.12	0.1096
Grass	0.25	0.16	0.0390
Woods	0.15	0.28	0.0425
	Σ	**0.56**	0.1911

$C_{ave} = \frac{0.1911}{0.56} = 0.34$

T_c =	31.51	min.
I_{05} =	3.69	in / hr
I_{10} =	4.06	in / hr
I_{25} =	4.60	in / hr
I_{50} =	5.02	in / hr
I_{100} =	5.43	in / hr

Pre Construction Runoff:

Q_{05} =	0.34	x	3.69	x	0.56	x	1	=	**0.70**	cfs
Q_{10} =	0.34	x	4.06	x	0.56	x	1	=	**0.78**	cfs
Q_{25} =	0.34	x	4.60	x	0.56	x	1.1	=	**0.97**	cfs
Q_{50} =	0.34	x	5.02	x	0.56	x	1.2	=	**1.15**	cfs
Q_{100} =	0.34	x	5.43	x	0.56	x	1.25	=	**1.30**	cfs

Post Construction Runoff:

Q_{05} =	0.34	x	3.69	x	0.56	x	1	=	**0.70**	cfs
Q_{10} =	0.34	x	4.06	x	0.56	x	1	=	**0.78**	cfs
Q_{25} =	0.34	x	4.60	x	0.56	x	1.1	=	**0.97**	cfs
Q_{50} =	0.34	x	5.02	x	0.56	x	1.2	=	**1.15**	cfs
Q_{100} =	0.34	x	5.43	x	0.56	x	1.25	=	**1.30**	cfs

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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 78/80c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.15	0.1374
Grass	0.25	0.08	0.0212
Woods	0.15	0.21	0.0311
	Σ	**0.44**	0.1897

$C_{ave} = \frac{0.1897}{0.44} = 0.43$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.19	0.1734
Grass	0.25	0.08	0.0212
Woods	0.15	0.21	0.0311
	Σ	**0.48**	0.2257

$C_{ave} = \frac{0.2257}{0.48} = 0.47$

T_c =	26.79	min.
I_{05} =	3.98	in / hr
I_{10} =	4.39	in / hr
I_{25} =	4.98	in / hr
I_{50} =	5.45	in / hr
I_{100} =	5.90	in / hr

Pre Construction Runoff:

Q_{05} =	0.43	x	3.98	x	0.44	x	1	=	**0.76**	cfs
Q_{10} =	0.43	x	4.39	x	0.44	x	1	=	**0.83**	cfs
Q_{25} =	0.43	x	4.98	x	0.44	x	1.1	=	**1.04**	cfs
Q_{50} =	0.43	x	5.45	x	0.44	x	1.2	=	**1.24**	cfs
Q_{100} =	0.43	x	5.90	x	0.44	x	1.25	=	**1.40**	cfs

Post Construction Runoff:

Q_{05} =	0.47	x	3.98	x	0.48	x	1	=	**0.90**	cfs
Q_{10} =	0.47	x	4.39	x	0.48	x	1	=	**0.99**	cfs
Q_{25} =	0.47	x	4.98	x	0.48	x	1.1	=	**1.24**	cfs
Q_{50} =	0.47	x	5.45	x	0.48	x	1.2	=	**1.47**	cfs
Q_{100} =	0.47	x	5.90	x	0.48	x	1.25	=	**1.66**	cfs

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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 78/80d**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.51	0.4595
Grass	0.25	0.73	0.1815
Woods	0.15	0.00	0.0000
	Σ	**1.24**	0.6411

$C_{ave} = \frac{0.6411}{1.24} = 0.52$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.09	0.9786
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**1.09**	0.9786

$C_{ave} = \frac{0.9786}{1.09} = 0.90$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.52	x	6.32	x	1.24	x	1	=	**4.05**	cfs
Q_{10} =	0.52	x	7.04	x	1.24	x	1	=	**4.51**	cfs
Q_{25} =	0.52	x	8.10	x	1.24	x	1.1	=	**5.71**	cfs
Q_{50} =	0.52	x	8.95	x	1.24	x	1.2	=	**6.89**	cfs
Q_{100} =	0.52	x	9.80	x	1.24	x	1.25	=	**7.86**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	1.09	x	1	=	**6.19**	cfs
Q_{10} =	0.90	x	7.04	x	1.09	x	1	=	**6.89**	cfs
Q_{25} =	0.90	x	8.10	x	1.09	x	1.1	=	**8.72**	cfs
Q_{50} =	0.90	x	8.95	x	1.09	x	1.2	=	**10.51**	cfs
Q_{100} =	0.90	x	9.80	x	1.09	x	1.25	=	**11.99**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 78/80a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.240**				
3	Flow length, L (total L < or = 100)		ft	**75**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.135**	+		=	**0.135**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)							
8	Flow length, L		ft					
9	Watercourse slope, s		ft/ft					
10	Average velocity, V (figure 3-1)		ft/s	**0.00**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**2**				
	Back Slope, (_ : 1)			**2**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.50**		**0.00**		
13	Wetted perimeter, p_w		ft	**4.24**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.35**		**#DIV/0!**		
15	Channel Slope, s		ft/ft	**0.0100**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**1.24**		**#DIV/0!**		
18	Flow length, L		ft	**425**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.095**	+		=	**0.095**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.230**
							min	**13.82**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 78/80b Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Woods				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft	**75**					
4 Two-yr 24-hr rainfall, P_2		in	**3.58**					
5 Land slope, s		ft/ft	**0.0150**					
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.525**	+		=	**0.525**	
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)								
8 Flow length, L		ft						
9 Watercourse slope, s		ft/ft						
10 Average velocity, V (figure 3-1)		ft/s	**0.00**	**0.00**				
11 $T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=		
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2	**0.00**	**0.00**				
13 Wetted perimeter, p_w		ft	**0.00**	**0.00**				
14 Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**				
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**				
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=		
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.525**
							min	**31.51**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 78/80c Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)	----------			Woods				
2 Manning's roughness coeff., n (table 3-1)	----------			**0.800**				
3 Flow length, L (total L < or = 100)	----------		ft	**50**				
4 Two-yr 24-hr rainfall, P_2	----------		in	**3.58**				
5 Land slope, s	----------		ft/ft	**0.0100**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)	----------							
8 Flow length, L	----------		ft					
9 Watercourse slope, s	----------		ft/ft					
10 Average velocity, V (figure 3-1)	----------		ft/s	**0.00**		**0.00**		
11 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
Channel Flow			Segment ID					
Front Slope, (_ : 1)	----------							
Back Slope, (_ : 1)	----------							
Bottom Width	----------		ft					
Flow Depth	----------		ft					
12 Cross sectional flow area, a	----------		ft^2	**0.00**		**0.00**		
13 Wetted perimeter, p_w	----------		ft	**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	----------	ft	**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s	----------		ft/ft					
16 Manning's roughness coeff., n	----------							
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18 Flow length, L	----------		ft					
19 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------				hr	**0.446**
							min	**26.79**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-78/80		Outlet	OP	370.41	370.41	0.00	0.00	0.00	32.20	0.00	3.64	0.48	0.00
CB-78/80d		Other	D.I. 24"X36"	377.17	377.17	1.83	0.28	32.05	32.05	10.61	3.64	0.48	5.01
CB-78/80c		Other	D.I. 24"X36"	378.87	378.87	2.47	0.25	13.82	31.72	9.64	2.40	0.47	7.15
CB-78/80b		Other	D.I. 24"X36"	384.43	384.43	2.41	0.27	13.82	31.51	8.04	1.96	0.48	7.15
CB-78/80a		Other	D.I. 24"X36"	386.31	386.31	1.66	0.00	13.82	13.82	6.41	1.40	0.53	7.15

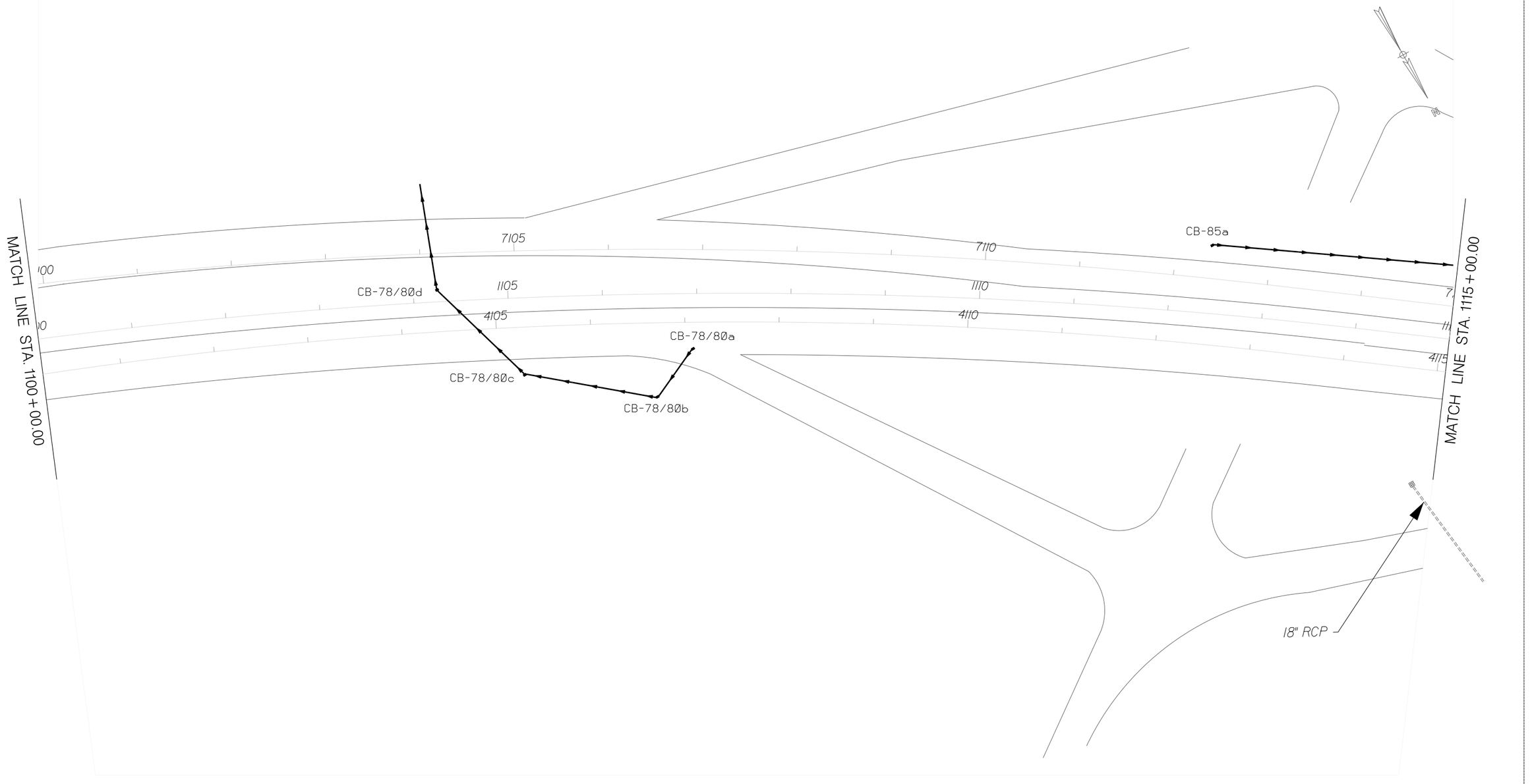
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-4	CB-78/80d	OF-78/80	Circular	Concrete	1	1.50	113	4.37	10.61	25.59	0.70	13.08	376.84	376.92	371.91	371.12	375.34	370.41	6.00	12.81	1.50	0.71
NP-3	CB-78/80c	CB-78/80d	Circular	Concrete	1	1.50	128	0.77	9.64	10.73	1.19	6.42	377.90	377.87	376.92	376.61	376.40	375.42	5.49	6.42	1.47	1.19
NP-2	CB-78/80b	CB-78/80c	Circular	Concrete	1	1.50	140	3.77	8.04	23.78	0.63	11.52	383.52	383.50	378.23	377.36	382.02	376.73	4.56	11.45	1.48	0.63
NP-1	CB-78/80a	CB-78/80b	Circular	Concrete	1	1.50	61	3.34	6.41	22.39	0.57	10.37	386.15	386.18	384.12	383.21	384.65	382.62	3.63	9.93	1.50	0.59

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-78/80d	5.00	6.95	9.03	0.52	1.24	0.52	1.24	0.00	0.00
CB-78/80c	26.79	1.23	5.49	0.42	0.44	0.42	0.44	0.00	0.00
CB-78/80b	31.51	1.15	5.06	0.34	0.56	0.34	0.56	0.00	0.00
CB-78/80a	13.82	6.41	7.15	0.53	1.40	0.53	1.40	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	41



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

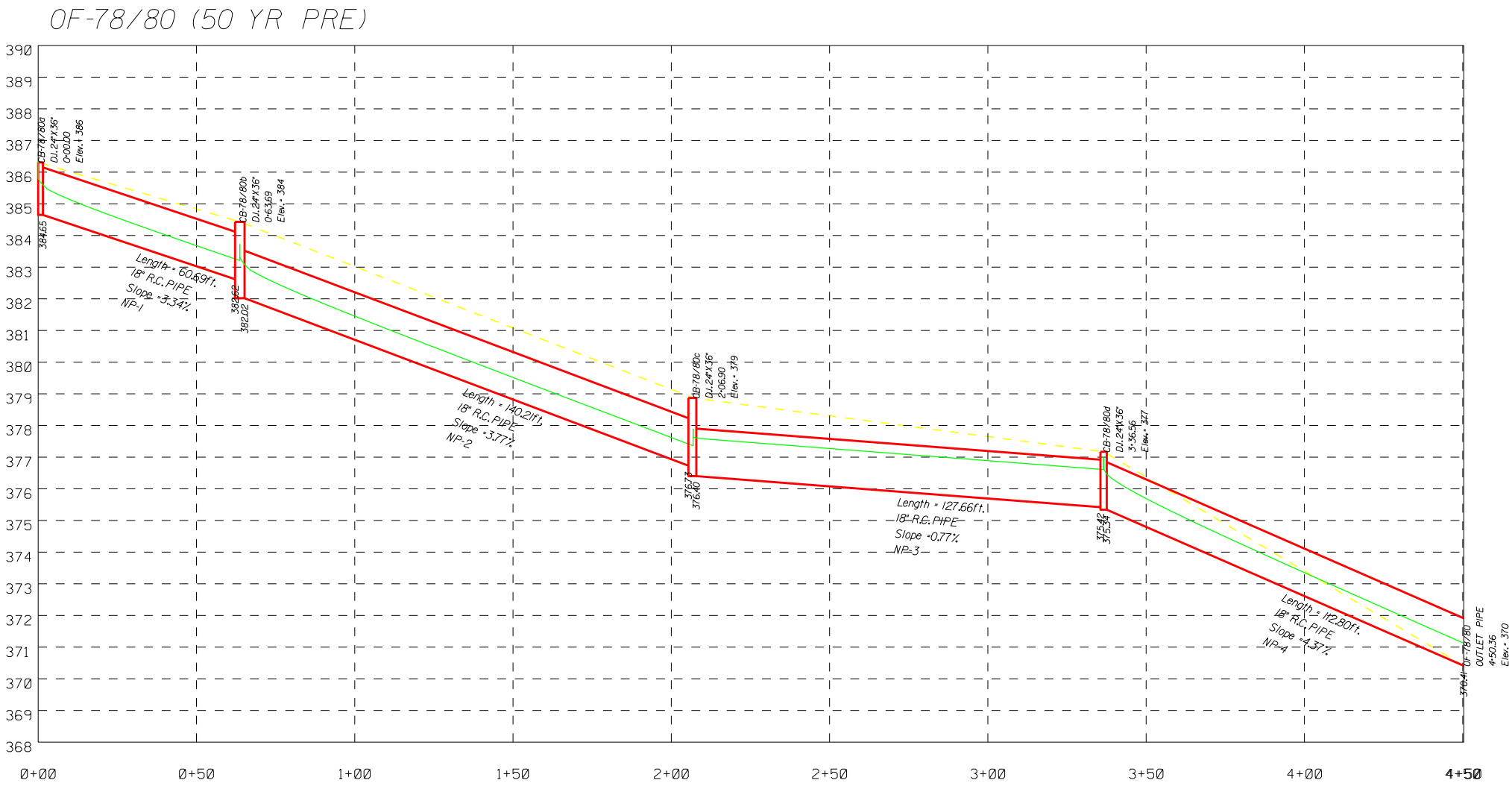
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1100+00.00 TO STA. 1115+00.00

$$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$$date$$$$


OF-78/80 (50 YR PRE)
390
389
388
387
386
385
384
383
382
381
380
379
378
377
376
375
374
373
372
371
370
369
368
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
CB-78/80a
DI.24"X36"
0+00.00
Elev.= 386
384.65
Length = 60.69ft.
18" R.C. PIPE
Slope =-3.34%
NP-1
CB-78/80b
DI.24"X36"
0+63.69
Elev.= 384
382.62
382.02
Length = 140.21ft.
18" R.C. PIPE
Slope =-3.77%
NP-2
CB-78/80c
DI.24"X36"
2+06.90
Elev.= 379
376.74
376.40
Length = 127.66ft.
18" R.C. PIPE
Slope =-0.77%
NP-3
CB-78/80d
DI.24"X36"
3+36.56
Elev.= 377
375.42
375.34
Length = 112.80ft.
18" R.C. PIPE
Slope =-4.37%
NP-4
OF-78/80
OUTLET PIPE
4+50.36
Elev.= 370
370.41

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

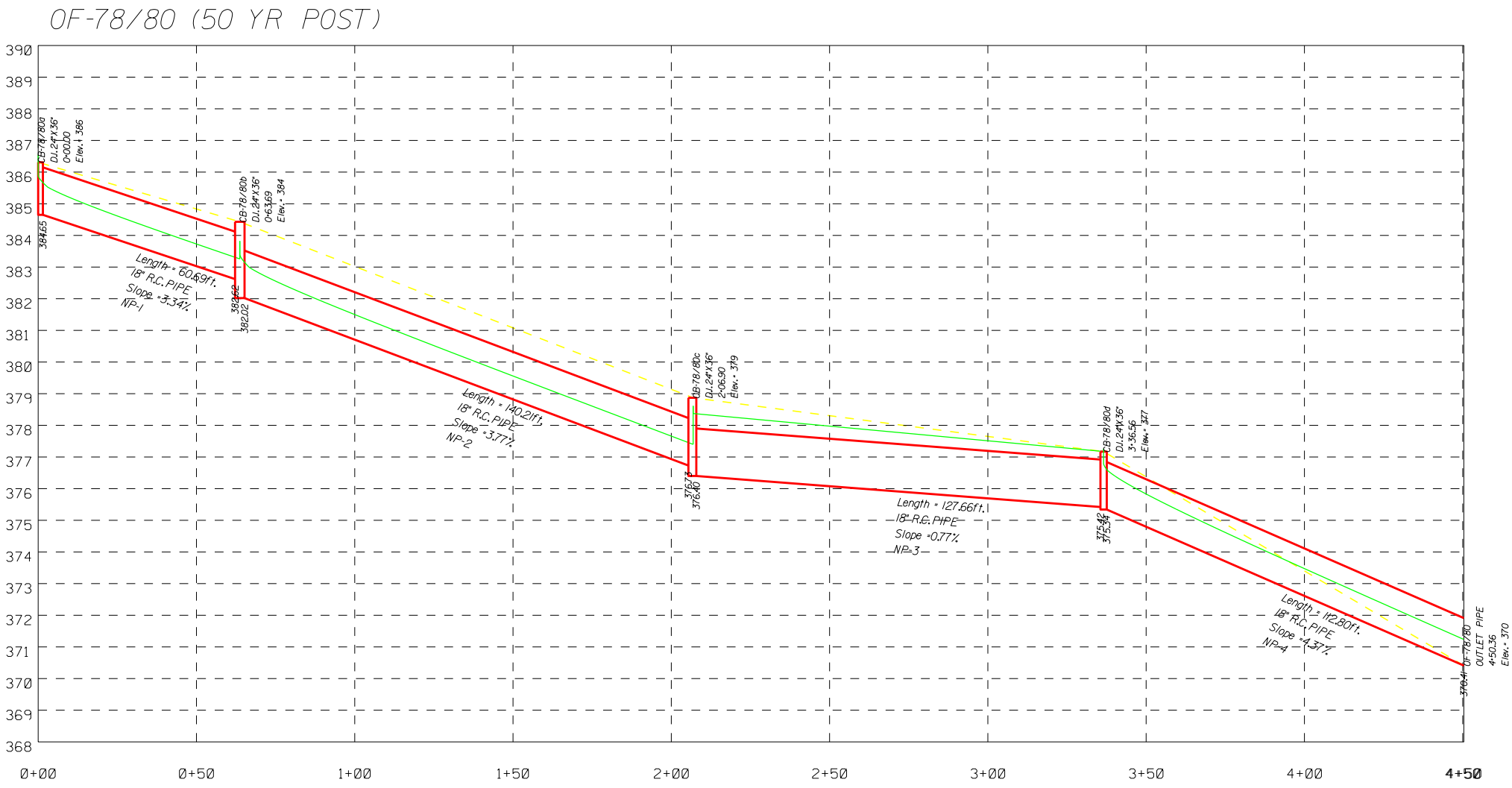
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-78/80	Outlet	OP	370.41	370.41	0.00	0.00	0.00	32.19	0.00	3.65	0.62	0.00
CB-78/80d	Other	D.I. 24"X36"	377.17	377.17	1.83	0.42	32.05	32.05	13.52	3.65	0.62	5.01
CB-78/80c	Other	D.I. 24"X36"	378.87	378.87	2.47	0.22	13.82	31.71	10.88	2.56	0.49	7.15
CB-78/80b	Other	D.I. 24"X36"	384.43	384.43	2.41	0.30	13.82	31.51	8.97	2.08	0.50	7.15
CB-78/80a	Other	D.I. 24"X36"	386.31	386.31	1.66	0.00	13.82	13.82	7.34	1.52	0.56	7.15

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-4	CB-78/80d	OF-78/80	Circular	Concrete	1	1.50	113	4.37	13.52	25.59	0.81	13.89	376.84	377.17	371.91	371.24	375.34	370.41	7.65	13.54	1.50	0.83
NP-3	CB-78/80c	CB-78/80d	Circular	Concrete	1	1.50	128	0.77	10.88	10.73	1.50	6.32	377.90	378.58	376.92	377.17	376.40	375.42	6.16	6.16	1.50	1.50
NP-2	CB-78/80b	CB-78/80c	Circular	Concrete	1	1.50	140	3.77	8.97	23.78	0.66	11.86	383.52	383.60	378.23	377.40	382.02	376.73	5.07	11.77	1.50	0.67
NP-1	CB-78/80a	CB-78/80b	Circular	Concrete	1	1.50	61	3.34	7.34	22.39	0.61	10.76	386.15	386.35	384.12	383.26	384.65	382.62	4.15	10.24	1.50	0.64

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-78/80d	5.00	10.63	9.03	0.90	1.09	0.90	1.09	0.00	0.00
CB-78/80c	26.79	1.46	5.49	0.46	0.48	0.46	0.48	0.00	0.00
CB-78/80b	31.51	1.15	5.06	0.34	0.56	0.34	0.56	0.00	0.00
CB-78/80a	13.82	7.34	7.15	0.56	1.52	0.56	1.52	0.00	0.00


OF-78/80 (50 YR POST)
390
389
388
387
386
385
384
383
382
381
380
379
378
377
376
375
374
373
372
371
370
369
368
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
CB-78/80a
DI.24"X36"
0+00.00
Elev.= 386
384.65
Length = 60.69ft.
18" R.C. PIPE
Slope =-3.34%
NP-1
CB-78/80b
DI.24"X36"
0+63.69
Elev.= 384
382.62
382.02
Length = 140.21ft.
18" R.C. PIPE
Slope =-3.77%
NP-2
CB-78/80c
DI.24"X36"
2+06.90
Elev.= 379
376.77
376.40
Length = 127.66ft.
18" R.C. PIPE
Slope =-0.77%
NP-3
CB-78/80d
DI.24"X36"
3+36.56
Elev.= 377
375.42
375.34
Length = 112.80ft.
18" R.C. PIPE
Slope =-4.37%
NP-4
OF-78/80
OUTLET PIPE
4+50.36
Elev.= 370
370.41

CULVERT 79

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 79**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.51	0.4621
Grass	0.25	0.77	0.1916
Woods	0.15	0.61	0.0922
	Σ	**1.89**	0.7458

$C_{ave} = \frac{0.7458}{1.89} = 0.39$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.51	0.4621
Grass	0.25	0.77	0.1916
Woods	0.15	0.61	0.0922
	Σ	**1.89**	0.7458

$C_{ave} = \frac{0.7458}{1.89} = 0.39$

T_c =	11.66	min.
I_{05} =	5.36	in / hr
I_{10} =	5.94	in / hr
I_{25} =	6.80	in / hr
I_{50} =	7.48	in / hr
I_{100} =	8.15	in / hr

Pre Construction Runoff:

Q_{05} =	0.39	x	5.36	x	1.89	x	1	=	**4.00**	cfs
Q_{10} =	0.39	x	5.94	x	1.89	x	1	=	**4.43**	cfs
Q_{25} =	0.39	x	6.80	x	1.89	x	1.1	=	**5.58**	cfs
Q_{50} =	0.39	x	7.48	x	1.89	x	1.2	=	**6.69**	cfs
Q_{100} =	0.39	x	8.15	x	1.89	x	1.25	=	**7.60**	cfs

Post Construction Runoff:

Q_{05} =	0.39	x	5.36	x	1.89	x	1	=	**4.00**	cfs
Q_{10} =	0.39	x	5.94	x	1.89	x	1	=	**4.43**	cfs
Q_{25} =	0.39	x	6.80	x	1.89	x	1.1	=	**5.58**	cfs
Q_{50} =	0.39	x	7.48	x	1.89	x	1.2	=	**6.69**	cfs
Q_{100} =	0.39	x	8.15	x	1.89	x	1.25	=	**7.60**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 79 Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Woods				
2 Manning's roughness coeff., n (table 3-1)				**0.400**				
3 Flow length, L (total L < or = 100)		ft		**50**				
4 Two-yr 24-hr rainfall, P_2		in		**3.58**				
5 Land slope, s		ft/ft		**0.0200**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr		**0.194**	+		=	**0.194**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)								
8 Flow length, L		ft						
9 Watercourse slope, s		ft/ft						
10 Average velocity, V (figure 3-1)		ft/s		**0.00**		**0.00**		
11 $T_t = L / (3600\ V)$	Compute T_t	hr		**#DIV/0!**	+	**#DIV/0!**	=	
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2		**0.00**		**0.00**		
13 Wetted perimeter, p_w		ft		**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	ft		**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s		**#DIV/0!**		**#DIV/0!**		
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr		**#DIV/0!**	+	**#DIV/0!**	=	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.194**
							min	**11.66**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.58 cfs

Design Flow: 6.69 cfs

Maximum Flow: 7.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1106+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
388.74	5.58	5.58	0.00	1
388.77	5.78	5.78	0.00	1
388.81	5.98	5.98	0.00	1
388.84	6.19	6.19	0.00	1
388.88	6.39	6.39	0.00	1
388.91	6.59	6.59	0.00	1
388.93	6.69	6.69	0.00	1
388.98	6.99	6.99	0.00	1
389.02	7.20	7.20	0.00	1
389.06	7.40	7.40	0.00	1
389.09	7.60	7.60	0.00	1
389.76	10.56	10.56	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.58	5.58	388.74	1.361	0.0*	1-S2n	0.474	0.908	0.474	0.584	11.252	3.014
5.78	5.78	388.77	1.395	0.0*	1-S2n	0.483	0.924	0.483	0.595	11.371	3.044
5.98	5.98	388.81	1.428	0.0*	1-S2n	0.491	0.940	0.491	0.606	11.485	3.073
6.19	6.19	388.84	1.462	0.0*	1-S2n	0.500	0.956	0.500	0.617	11.594	3.102
6.39	6.39	388.88	1.497	0.0*	1-S2n	0.509	0.972	0.509	0.627	11.711	3.130
6.59	6.59	388.91	1.531	0.0*	5-S2n	0.517	0.991	0.517	0.637	11.786	3.156
6.69	6.69	388.93	1.549	0.0*	5-S2n	0.521	0.998	0.521	0.643	11.837	3.170
6.99	6.99	388.98	1.603	0.0*	5-S2n	0.534	1.021	0.534	0.657	11.986	3.209
7.20	7.20	389.02	1.639	0.0*	5-S2n	0.542	1.036	0.579	0.667	11.060	3.235
7.40	7.40	389.06	1.676	0.0*	5-S2n	0.550	1.050	0.550	0.677	12.160	3.259
7.60	7.60	389.09	1.714	0.0*	5-S2n	0.558	1.064	0.558	0.686	12.254	3.284

* Full Flow Headwater elevation is below inlet invert.

****

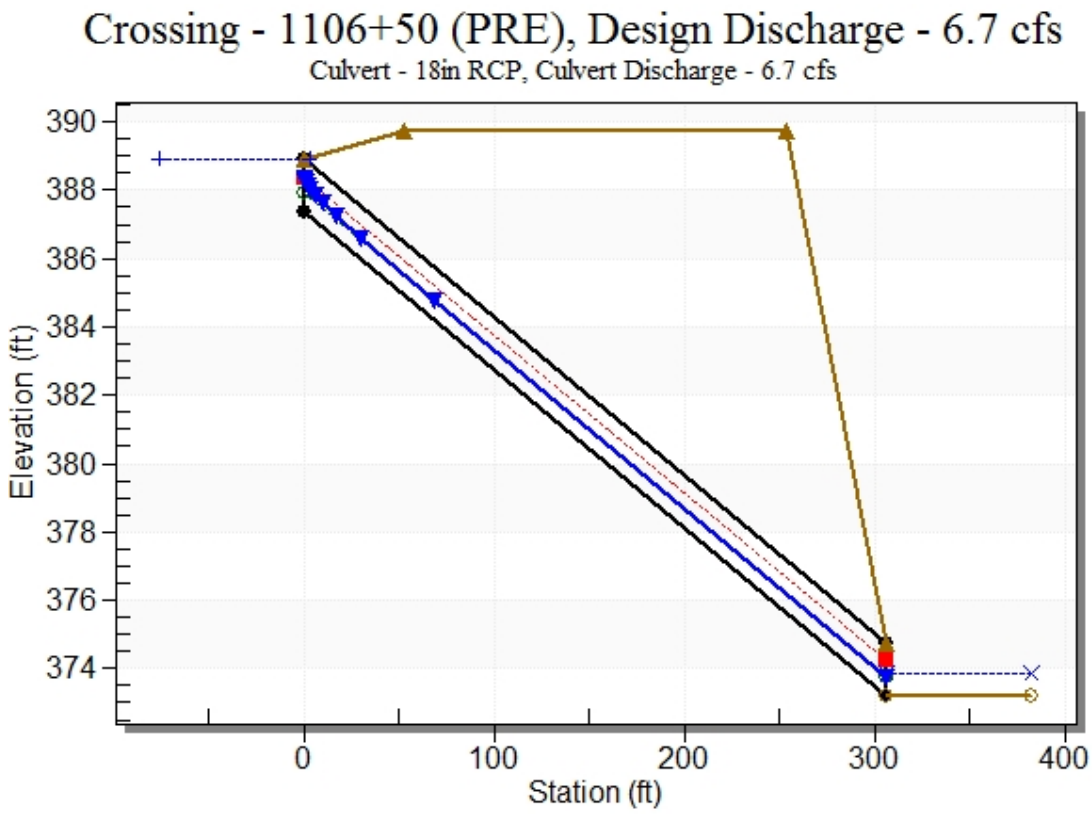
Straight Culvert

Inlet Elevation (invert): 387.38 ft, Outlet Elevation (invert): 373.22 ft

Culvert Length: 306.33 ft, Culvert Slope: 0.0463

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 387.38 ft

Outlet Station: 306.00 ft

Outlet Elevation: 373.22 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1106+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.58	373.80	0.58	3.01	1.82	0.81
5.78	373.82	0.60	3.04	1.86	0.81
5.98	373.83	0.61	3.07	1.89	0.82
6.19	373.84	0.62	3.10	1.92	0.82
6.39	373.85	0.63	3.13	1.96	0.82
6.59	373.86	0.64	3.16	1.99	0.82
6.69	373.86	0.64	3.17	2.00	0.82
6.99	373.88	0.66	3.21	2.05	0.82
7.20	373.89	0.67	3.23	2.08	0.83
7.40	373.90	0.68	3.26	2.11	0.83
7.60	373.91	0.69	3.28	2.14	0.83

Tailwater Channel Data - 1106+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 373.22 ft

Roadway Data for Crossing: 1106+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 389.76 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.58 cfs

Design Flow: 6.69 cfs

Maximum Flow: 7.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1106+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
388.74	5.58	5.58	0.00	1
388.77	5.78	5.78	0.00	1
388.81	5.98	5.98	0.00	1
388.84	6.19	6.19	0.00	1
388.88	6.39	6.39	0.00	1
388.91	6.59	6.59	0.00	1
388.93	6.69	6.69	0.00	1
388.98	6.99	6.99	0.00	1
389.02	7.20	7.20	0.00	1
389.06	7.40	7.40	0.00	1
389.09	7.60	7.60	0.00	1
389.76	10.56	10.56	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.58	5.58	388.74	1.361	0.0*	1-S2n	0.474	0.908	0.474	0.584	11.252	3.014
5.78	5.78	388.77	1.395	0.0*	1-S2n	0.483	0.924	0.483	0.595	11.371	3.044
5.98	5.98	388.81	1.428	0.0*	1-S2n	0.491	0.940	0.491	0.606	11.485	3.073
6.19	6.19	388.84	1.462	0.0*	1-S2n	0.500	0.956	0.500	0.617	11.594	3.102
6.39	6.39	388.88	1.497	0.0*	1-S2n	0.509	0.972	0.509	0.627	11.711	3.130
6.59	6.59	388.91	1.531	0.0*	5-S2n	0.517	0.991	0.517	0.637	11.786	3.156
6.69	6.69	388.93	1.549	0.0*	5-S2n	0.521	0.998	0.521	0.643	11.837	3.170
6.99	6.99	388.98	1.603	0.0*	5-S2n	0.534	1.021	0.534	0.657	11.986	3.209
7.20	7.20	389.02	1.639	0.0*	5-S2n	0.542	1.036	0.579	0.667	11.060	3.235
7.40	7.40	389.06	1.676	0.0*	5-S2n	0.550	1.050	0.550	0.677	12.160	3.259
7.60	7.60	389.09	1.714	0.0*	5-S2n	0.558	1.064	0.558	0.686	12.254	3.284

* Full Flow Headwater elevation is below inlet invert.

****

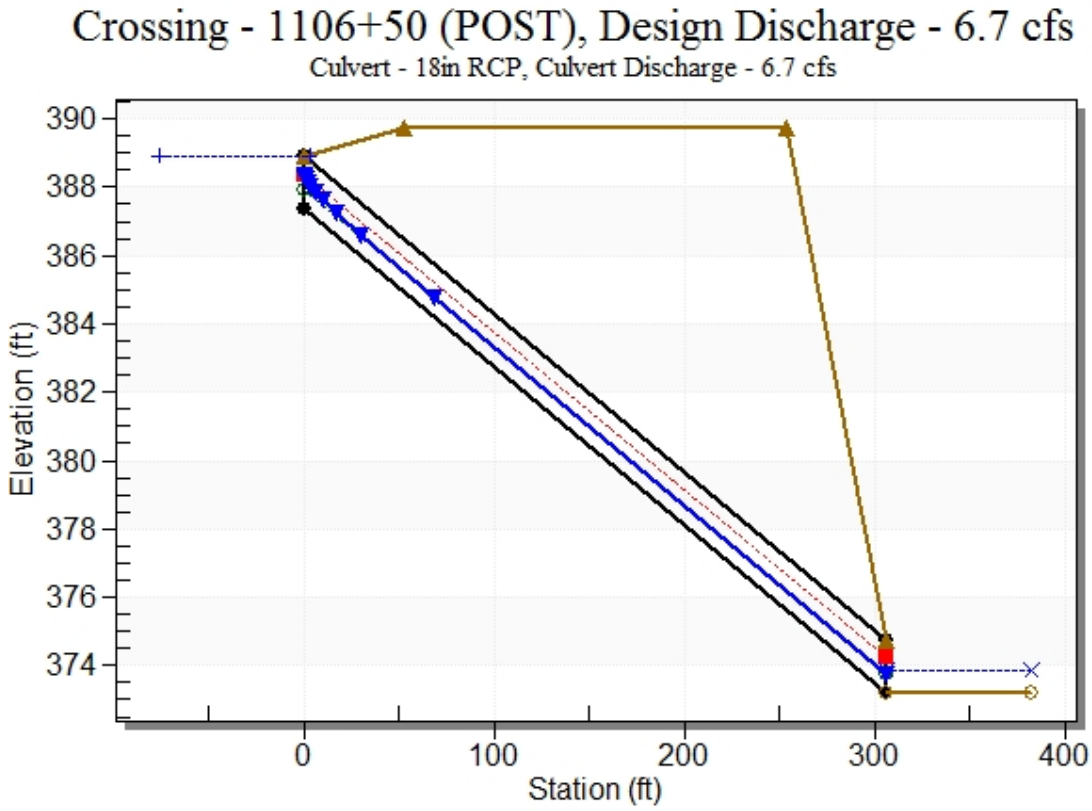
Straight Culvert

Inlet Elevation (invert): 387.38 ft, Outlet Elevation (invert): 373.22 ft

Culvert Length: 306.33 ft, Culvert Slope: 0.0463

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 387.38 ft

Outlet Station: 306.00 ft

Outlet Elevation: 373.22 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1106+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.58	373.80	0.58	3.01	1.82	0.81
5.78	373.82	0.60	3.04	1.86	0.81
5.98	373.83	0.61	3.07	1.89	0.82
6.19	373.84	0.62	3.10	1.92	0.82
6.39	373.85	0.63	3.13	1.96	0.82
6.59	373.86	0.64	3.16	1.99	0.82
6.69	373.86	0.64	3.17	2.00	0.82
6.99	373.88	0.66	3.21	2.05	0.82
7.20	373.89	0.67	3.23	2.08	0.83
7.40	373.90	0.68	3.26	2.11	0.83
7.60	373.91	0.69	3.28	2.14	0.83

Tailwater Channel Data - 1106+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 373.22 ft

Roadway Data for Crossing: 1106+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 389.76 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

CULVERT 81

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 81**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.07	0.0674
Grass	0.25	0.28	0.0688
Woods	0.15	0.00	0.0000
	Σ	**0.35**	0.1362

$C_{ave} = \frac{0.1362}{0.35} = 0.39$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.07	0.0674
Grass	0.25	0.28	0.0688
Woods	0.15	0.00	0.0000
	Σ	**0.35**	0.1362

$C_{ave} = \frac{0.1362}{0.35} = 0.39$

T_c =	5.00 min.
I_{05} =	6.32 in / hr
I_{10} =	7.04 in / hr
I_{25} =	8.10 in / hr
I_{50} =	8.95 in / hr
I_{100} =	9.80 in / hr

Pre Construction Runoff:

Q_{05} =	0.39	x	6.32	x	0.35	x	1	=	**0.86**	cfs
Q_{10} =	0.39	x	7.04	x	0.35	x	1	=	**0.96**	cfs
Q_{25} =	0.39	x	8.10	x	0.35	x	1.1	=	**1.21**	cfs
Q_{50} =	0.39	x	8.95	x	0.35	x	1.2	=	**1.46**	cfs
Q_{100} =	0.39	x	9.80	x	0.35	x	1.25	=	**1.67**	cfs

Post Construction Runoff:

Q_{05} =	0.39	x	6.32	x	0.35	x	1	=	**0.86**	cfs
Q_{10} =	0.39	x	7.04	x	0.35	x	1	=	**0.96**	cfs
Q_{25} =	0.39	x	8.10	x	0.35	x	1.1	=	**1.21**	cfs
Q_{50} =	0.39	x	8.95	x	0.35	x	1.2	=	**1.46**	cfs
Q_{100} =	0.39	x	9.80	x	0.35	x	1.25	=	**1.67**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.21 cfs

Design Flow: 1.46 cfs

Maximum Flow: 1.67 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1111+45 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
394.18	1.21	1.21	0.00	1
394.20	1.26	1.26	0.00	1
394.21	1.30	1.30	0.00	1
394.22	1.35	1.35	0.00	1
394.23	1.39	1.39	0.00	1
394.24	1.44	1.44	0.00	1
394.24	1.46	1.46	0.00	1
394.26	1.53	1.53	0.00	1
394.27	1.58	1.58	0.00	1
394.28	1.62	1.62	0.00	1
394.29	1.67	1.67	0.00	1
395.33	7.44	7.44	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.21	1.21	394.18	0.554	0.0*	1-S2n	0.256	0.408	0.256	0.327	5.856	1.393
1.26	1.26	394.20	0.565	0.0*	1-S2n	0.261	0.416	0.261	0.334	5.927	1.409
1.30	1.30	394.21	0.576	0.0*	1-S2n	0.266	0.424	0.276	0.341	5.702	1.424
1.35	1.35	394.22	0.587	0.0*	1-S2n	0.271	0.432	0.279	0.347	5.816	1.440
1.39	1.39	394.23	0.596	0.0*	1-S2n	0.275	0.440	0.286	0.354	5.724	1.454
1.44	1.44	394.24	0.607	0.0*	1-S2n	0.279	0.448	0.279	0.360	6.219	1.469
1.46	1.46	394.24	0.612	0.0*	1-S2n	0.281	0.451	0.281	0.363	6.150	1.475
1.53	1.53	394.26	0.628	0.0*	1-S2n	0.288	0.459	0.288	0.373	6.249	1.496
1.58	1.58	394.27	0.638	0.0*	1-S2n	0.292	0.466	0.292	0.379	6.309	1.509
1.62	1.62	394.28	0.647	0.0*	1-S2n	0.296	0.474	0.296	0.385	6.367	1.522
1.67	1.67	394.29	0.657	0.0*	1-S2n	0.301	0.481	0.313	0.391	6.084	1.535

* Full Flow Headwater elevation is below inlet invert.

****

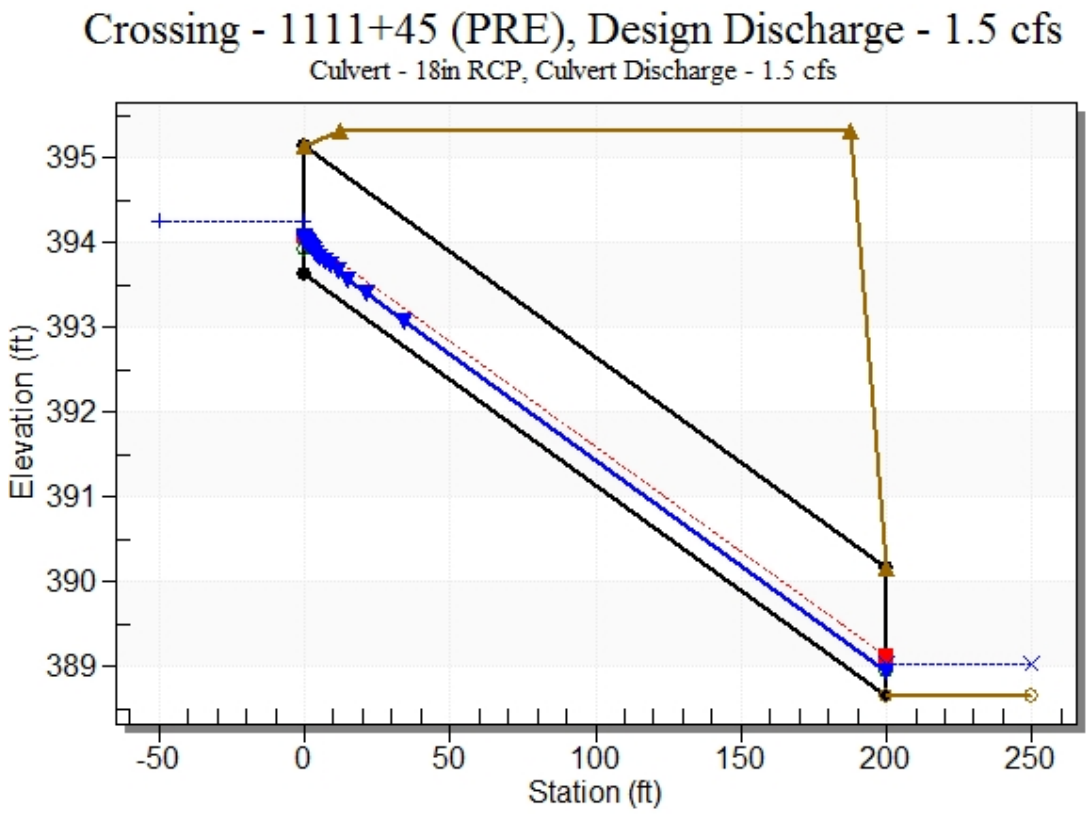
Straight Culvert

Inlet Elevation (invert): 393.63 ft, Outlet Elevation (invert): 388.66 ft

Culvert Length: 200.06 ft, Culvert Slope: 0.0248

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 393.63 ft

Outlet Station: 200.00 ft

Outlet Elevation: 388.66 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1111+45 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.21	388.99	0.33	1.39	0.41	0.48
1.26	388.99	0.33	1.41	0.42	0.48
1.30	389.00	0.34	1.42	0.43	0.48
1.35	389.01	0.35	1.44	0.43	0.48
1.39	389.01	0.35	1.45	0.44	0.48
1.44	389.02	0.36	1.47	0.45	0.48
1.46	389.02	0.36	1.47	0.45	0.49
1.53	389.03	0.37	1.50	0.47	0.49
1.58	389.04	0.38	1.51	0.47	0.49
1.62	389.05	0.39	1.52	0.48	0.49
1.67	389.05	0.39	1.54	0.49	0.49

Tailwater Channel Data - 1111+45 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 388.66 ft

Roadway Data for Crossing: 1111+45 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 395.33 ft

Roadway Surface: Paved

Roadway Top Width: 175.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.21 cfs

Design Flow: 1.46 cfs

Maximum Flow: 1.67 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1111+45 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
394.18	1.21	1.21	0.00	1
394.20	1.26	1.26	0.00	1
394.21	1.30	1.30	0.00	1
394.22	1.35	1.35	0.00	1
394.23	1.39	1.39	0.00	1
394.24	1.44	1.44	0.00	1
394.24	1.46	1.46	0.00	1
394.26	1.53	1.53	0.00	1
394.27	1.58	1.58	0.00	1
394.28	1.62	1.62	0.00	1
394.29	1.67	1.67	0.00	1
395.33	7.44	7.44	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.21	1.21	394.18	0.554	0.0*	1-S2n	0.256	0.408	0.256	0.327	5.856	1.393
1.26	1.26	394.20	0.565	0.0*	1-S2n	0.261	0.416	0.261	0.334	5.927	1.409
1.30	1.30	394.21	0.576	0.0*	1-S2n	0.266	0.424	0.276	0.341	5.702	1.424
1.35	1.35	394.22	0.587	0.0*	1-S2n	0.271	0.432	0.279	0.347	5.816	1.440
1.39	1.39	394.23	0.596	0.0*	1-S2n	0.275	0.440	0.286	0.354	5.724	1.454
1.44	1.44	394.24	0.607	0.0*	1-S2n	0.279	0.448	0.279	0.360	6.219	1.469
1.46	1.46	394.24	0.612	0.0*	1-S2n	0.281	0.451	0.281	0.363	6.150	1.475
1.53	1.53	394.26	0.628	0.0*	1-S2n	0.288	0.459	0.288	0.373	6.249	1.496
1.58	1.58	394.27	0.638	0.0*	1-S2n	0.292	0.466	0.292	0.379	6.309	1.509
1.62	1.62	394.28	0.647	0.0*	1-S2n	0.296	0.474	0.296	0.385	6.367	1.522
1.67	1.67	394.29	0.657	0.0*	1-S2n	0.301	0.481	0.313	0.391	6.084	1.535

* Full Flow Headwater elevation is below inlet invert.

****

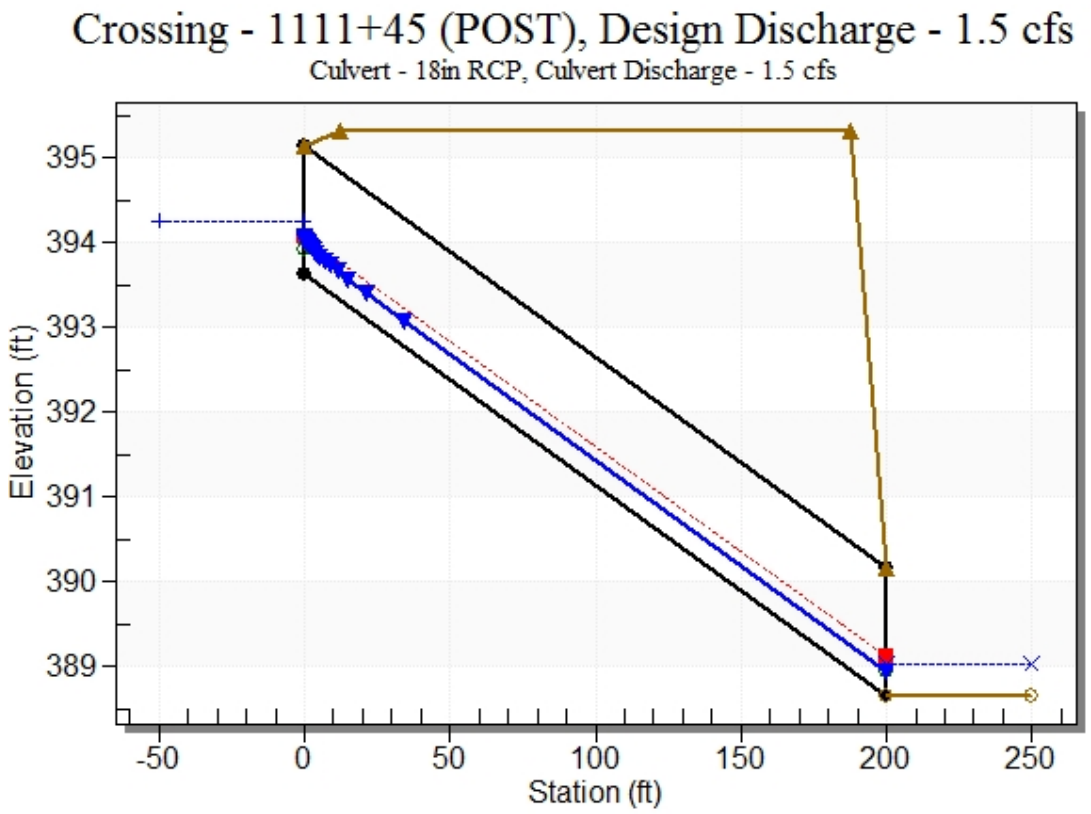
Straight Culvert

Inlet Elevation (invert): 393.63 ft, Outlet Elevation (invert): 388.66 ft

Culvert Length: 200.06 ft, Culvert Slope: 0.0248

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 393.63 ft

Outlet Station: 200.00 ft

Outlet Elevation: 388.66 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1111+45 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.21	388.99	0.33	1.39	0.41	0.48
1.26	388.99	0.33	1.41	0.42	0.48
1.30	389.00	0.34	1.42	0.43	0.48
1.35	389.01	0.35	1.44	0.43	0.48
1.39	389.01	0.35	1.45	0.44	0.48
1.44	389.02	0.36	1.47	0.45	0.48
1.46	389.02	0.36	1.47	0.45	0.49
1.53	389.03	0.37	1.50	0.47	0.49
1.58	389.04	0.38	1.51	0.47	0.49
1.62	389.05	0.39	1.52	0.48	0.49
1.67	389.05	0.39	1.54	0.49	0.49

Tailwater Channel Data - 1111+45 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 388.66 ft

Roadway Data for Crossing: 1111+45 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 395.33 ft

Roadway Surface: Paved

Roadway Top Width: 175.00 ft

CULVERT 82

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 82**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.14	0.1227
Grass	0.25	0.13	0.0319
Woods	0.15	0.00	0.0000
	Σ	**0.26**	0.1546

$C_{ave} = \frac{0.1546}{0.26} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.26	0.2340
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.26**	0.2340

$C_{ave} = \frac{0.2340}{0.26} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.59	x	6.32	x	0.26	x	1	=	**0.98**	cfs
Q_{10} =	0.59	x	7.04	x	0.26	x	1	=	**1.09**	cfs
Q_{25} =	0.59	x	8.10	x	0.26	x	1.1	=	**1.38**	cfs
Q_{50} =	0.59	x	8.95	x	0.26	x	1.2	=	**1.66**	cfs
Q_{100} =	0.59	x	9.80	x	0.26	x	1.25	=	**1.89**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.26	x	1	=	**1.48**	cfs
Q_{10} =	0.90	x	7.04	x	0.26	x	1	=	**1.65**	cfs
Q_{25} =	0.90	x	8.10	x	0.26	x	1.1	=	**2.09**	cfs
Q_{50} =	0.90	x	8.95	x	0.26	x	1.2	=	**2.51**	cfs
Q_{100} =	0.90	x	9.80	x	0.26	x	1.25	=	**2.87**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.38 cfs

Design Flow: 1.66 cfs

Maximum Flow: 1.89 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1112+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
388.83	1.38	1.38	0.00	1
388.85	1.43	1.43	0.00	1
388.86	1.48	1.48	0.00	1
388.88	1.53	1.53	0.00	1
388.89	1.58	1.58	0.00	1
388.91	1.63	1.63	0.00	1
388.91	1.66	1.66	0.00	1
388.93	1.74	1.74	0.00	1
388.95	1.79	1.79	0.00	1
388.96	1.84	1.84	0.00	1
388.97	1.89	1.89	0.00	1
390.28	6.93	6.93	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.38	1.38	388.83	0.632	0.0*	1-S2n	0.292	0.460	0.292	0.172	6.155	3.426
1.43	1.43	388.85	0.647	0.0*	1-S2n	0.297	0.469	0.297	0.176	6.234	3.467
1.48	1.48	388.86	0.662	0.0*	1-S2n	0.302	0.478	0.302	0.179	6.310	3.509
1.53	1.53	388.88	0.677	0.0*	1-S2n	0.308	0.487	0.308	0.183	6.317	3.549
1.58	1.58	388.89	0.691	0.0*	1-S2n	0.313	0.496	0.313	0.186	6.381	3.587
1.63	1.63	388.91	0.706	0.0*	1-S2n	0.318	0.505	0.331	0.190	6.101	3.625
1.66	1.66	388.91	0.713	0.0*	1-S2n	0.321	0.509	0.321	0.191	6.470	3.644
1.74	1.74	388.93	0.733	0.0*	1-S2n	0.328	0.522	0.341	0.196	6.186	3.699
1.79	1.79	388.95	0.747	0.0*	1-S2n	0.333	0.530	0.333	0.200	6.636	3.733
1.84	1.84	388.96	0.761	0.0*	1-S2n	0.337	0.538	0.352	0.203	6.282	3.768
1.89	1.89	388.97	0.774	0.0*	1-S2n	0.342	0.546	0.357	0.206	6.339	3.802

* Full Flow Headwater elevation is below inlet invert.

****

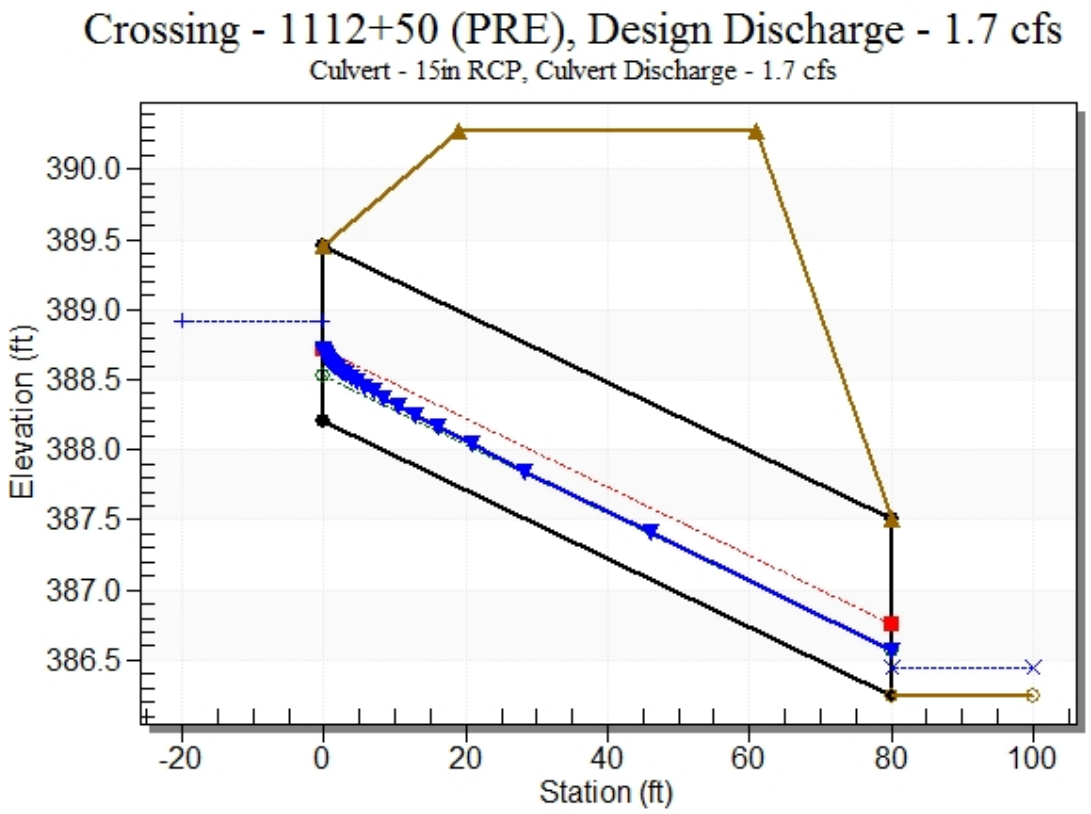
Straight Culvert

Inlet Elevation (invert): 388.20 ft, Outlet Elevation (invert): 386.25 ft

Culvert Length: 80.02 ft, Culvert Slope: 0.0244

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 388.20 ft

Outlet Station: 80.00 ft

Outlet Elevation: 386.25 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1112+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.38	386.42	0.17	3.43	0.11	1.56
1.43	386.43	0.18	3.47	0.11	1.56
1.48	386.43	0.18	3.51	0.11	1.57
1.53	386.43	0.18	3.55	0.11	1.57
1.58	386.44	0.19	3.59	0.12	1.58
1.63	386.44	0.19	3.62	0.12	1.58
1.66	386.44	0.19	3.64	0.12	1.58
1.74	386.45	0.20	3.70	0.12	1.59
1.79	386.45	0.20	3.73	0.12	1.59
1.84	386.45	0.20	3.77	0.13	1.59
1.89	386.46	0.21	3.80	0.13	1.60

Tailwater Channel Data - 1112+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0120

Channel Invert Elevation: 386.25 ft

Roadway Data for Crossing: 1112+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 390.28 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.09 cfs

Design Flow: 2.51 cfs

Maximum Flow: 2.87 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1112+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
389.02	2.09	2.09	0.00	1
389.04	2.17	2.17	0.00	1
389.06	2.25	2.25	0.00	1
389.08	2.32	2.32	0.00	1
389.10	2.40	2.40	0.00	1
389.12	2.48	2.48	0.00	1
389.12	2.51	2.51	0.00	1
389.15	2.64	2.64	0.00	1
389.17	2.71	2.71	0.00	1
389.19	2.79	2.79	0.00	1
389.20	2.87	2.87	0.00	1
390.28	6.93	6.93	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.09	2.09	389.02	0.824	0.0*	1-S2n	0.360	0.577	0.376	0.218	6.509	3.930
2.17	2.17	389.04	0.843	0.0*	1-S2n	0.367	0.588	0.383	0.223	6.581	3.976
2.25	2.25	389.06	0.862	0.0*	1-S2n	0.374	0.599	0.390	0.227	6.654	4.022
2.32	2.32	389.08	0.880	0.0*	1-S2n	0.381	0.610	0.397	0.232	6.728	4.066
2.40	2.40	389.10	0.899	0.0*	1-S2n	0.388	0.620	0.404	0.236	6.768	4.109
2.48	2.48	389.12	0.917	0.0*	1-S2n	0.394	0.630	0.411	0.241	6.830	4.152
2.51	2.51	389.12	0.923	0.0*	1-S2n	0.396	0.634	0.413	0.242	6.855	4.168
2.64	2.64	389.15	0.952	0.0*	1-S2n	0.407	0.650	0.423	0.249	6.975	4.233
2.71	2.71	389.17	0.969	0.0*	1-S2n	0.413	0.660	0.428	0.253	7.073	4.274
2.79	2.79	389.19	0.987	0.0*	1-S2n	0.419	0.669	0.419	0.257	7.478	4.312
2.87	2.87	389.20	1.004	0.0*	1-S2n	0.425	0.679	0.425	0.262	7.542	4.349

* Full Flow Headwater elevation is below inlet invert.

****

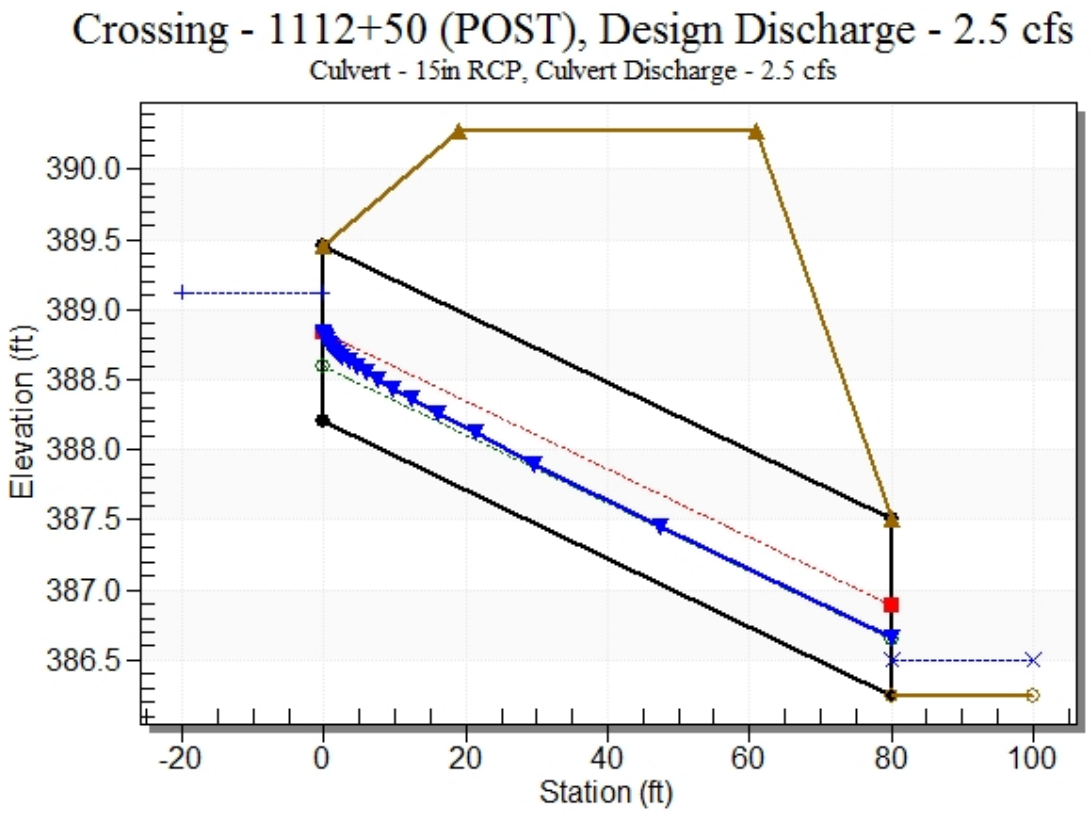
Straight Culvert

Inlet Elevation (invert): 388.20 ft, Outlet Elevation (invert): 386.25 ft

Culvert Length: 80.02 ft, Culvert Slope: 0.0244

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 388.20 ft

Outlet Station: 80.00 ft

Outlet Elevation: 386.25 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1112+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.09	386.47	0.22	3.93	0.14	1.61
2.17	386.47	0.22	3.98	0.14	1.61
2.25	386.48	0.23	4.02	0.14	1.62
2.32	386.48	0.23	4.07	0.14	1.62
2.40	386.49	0.24	4.11	0.15	1.63
2.48	386.49	0.24	4.15	0.15	1.63
2.51	386.49	0.24	4.17	0.15	1.63
2.64	386.50	0.25	4.23	0.16	1.64
2.71	386.50	0.25	4.27	0.16	1.64
2.79	386.51	0.26	4.31	0.16	1.64
2.87	386.51	0.26	4.35	0.16	1.65

Tailwater Channel Data - 1112+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0120

Channel Invert Elevation: 386.25 ft

Roadway Data for Crossing: 1112+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 390.28 ft

Roadway Surface: Paved

Roadway Top Width: 42.00 ft

CULVERT 83/84/85/86

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 83**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.93	0.8397
Grass	0.25	0.70	0.1749
Woods	0.15	0.00	0.0000
	Σ	**1.63**	1.0146

$C_{ave} = \frac{1.0146}{1.63} = 0.62$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.93	0.8397
Grass	0.25	0.70	0.1749
Woods	0.15	0.00	0.0000
	Σ	**1.63**	1.0146

$C_{ave} = \frac{1.0146}{1.63} = 0.62$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.62	**x**	6.32	**x**	1.63	**x**	1	=	**6.42**	cfs
Q_{10} =	0.62	**x**	7.04	**x**	1.63	**x**	1	=	**7.14**	cfs
Q_{25} =	0.62	**x**	8.10	**x**	1.63	**x**	1.1	=	**9.04**	cfs
Q_{50} =	0.62	**x**	8.95	**x**	1.63	**x**	1.2	=	**10.90**	cfs
Q_{100} =	0.62	**x**	9.80	**x**	1.63	**x**	1.25	=	**12.43**	cfs

Post Construction Runoff:

Q_{05} =	0.62	**x**	6.32	**x**	1.63	**x**	1	=	**6.42**	cfs
Q_{10} =	0.62	**x**	7.04	**x**	1.63	**x**	1	=	**7.14**	cfs
Q_{25} =	0.62	**x**	8.10	**x**	1.63	**x**	1.1	=	**9.04**	cfs
Q_{50} =	0.62	**x**	8.95	**x**	1.63	**x**	1.2	=	**10.90**	cfs
Q_{100} =	0.62	**x**	9.80	**x**	1.63	**x**	1.25	=	**12.43**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 84**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.30	0.2685
Grass	0.25	0.36	0.0905
Woods	0.15	0.00	0.0000
	Σ	**0.66**	0.3590

$C_{ave} = \frac{0.3590}{0.66} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.36	0.3258
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.36**	0.3258

$C_{ave} = \frac{0.3258}{0.36} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.54	**x**	6.32	**x**	0.66	**x**	1	=	**2.27**	cfs
Q_{10} =	0.54	**x**	7.04	**x**	0.66	**x**	1	=	**2.53**	cfs
Q_{25} =	0.54	**x**	8.10	**x**	0.66	**x**	1.1	=	**3.20**	cfs
Q_{50} =	0.54	**x**	8.95	**x**	0.66	**x**	1.2	=	**3.86**	cfs
Q_{100} =	0.54	**x**	9.80	**x**	0.66	**x**	1.25	=	**4.40**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.32	**x**	0.36	**x**	1	=	**2.06**	cfs
Q_{10} =	0.90	**x**	7.04	**x**	0.36	**x**	1	=	**2.29**	cfs
Q_{25} =	0.90	**x**	8.10	**x**	0.36	**x**	1.1	=	**2.90**	cfs
Q_{50} =	0.90	**x**	8.95	**x**	0.36	**x**	1.2	=	**3.50**	cfs
Q_{100} =	0.90	**x**	9.80	**x**	0.36	**x**	1.25	=	**3.99**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 85a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.27	0.2388
Grass	0.25	1.07	0.2672
Woods	0.15	0.00	0.0000
	Σ	**1.33**	0.5059

$C_{ave} = \frac{0.5059}{1.33} = 0.38$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.27	0.2388
Grass	0.25	1.07	0.2672
Woods	0.15	0.00	0.0000
	Σ	**1.33**	0.5059

$C_{ave} = \frac{0.5059}{1.33} = 0.38$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.38	x	6.32	x	1.33	x	1	=	**3.20**	cfs
Q_{10} =	0.38	x	7.04	x	1.33	x	1	=	**3.56**	cfs
Q_{25} =	0.38	x	8.10	x	1.33	x	1.1	=	**4.51**	cfs
Q_{50} =	0.38	x	8.95	x	1.33	x	1.2	=	**5.44**	cfs
Q_{100} =	0.38	x	9.80	x	1.33	x	1.25	=	**6.20**	cfs

Post Construction Runoff:

Q_{05} =	0.38	x	6.32	x	1.33	x	1	=	**3.20**	cfs
Q_{10} =	0.38	x	7.04	x	1.33	x	1	=	**3.56**	cfs
Q_{25} =	0.38	x	8.10	x	1.33	x	1.1	=	**4.51**	cfs
Q_{50} =	0.38	x	8.95	x	1.33	x	1.2	=	**5.44**	cfs
Q_{100} =	0.38	x	9.80	x	1.33	x	1.25	=	**6.20**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 85b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.76	1.5863
Grass	0.25	2.50	0.6253
Woods	0.15	0.00	0.0000
	Σ	**4.26**	2.2116

$C_{ave} = \frac{2.2116}{4.26} = 0.52$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.98	1.7788
Grass	0.25	2.50	0.6253
Woods	0.15	0.00	0.0000
	Σ	**4.48**	2.4040

$C_{ave} = \frac{2.4040}{4.48} = 0.54$

T_c =	11.47	min.								
I_{05} =	5.39	in / hr								
I_{10} =	5.97	in / hr								
I_{25} =	6.83	in / hr								
I_{50} =	7.51	in / hr								
I_{100} =	8.19	in / hr								

Pre Construction Runoff:

Q_{05} =	0.52	**x**	5.39	**x**	4.26	**x**	1	=	**11.91**	cfs
Q_{10} =	0.52	**x**	5.97	**x**	4.26	**x**	1	=	**13.20**	cfs
Q_{25} =	0.52	**x**	6.83	**x**	4.26	**x**	1.1	=	**16.62**	cfs
Q_{50} =	0.52	**x**	7.51	**x**	4.26	**x**	1.2	=	**19.94**	cfs
Q_{100} =	0.52	**x**	8.19	**x**	4.26	**x**	1.25	=	**22.64**	cfs

Post Construction Runoff:

Q_{05} =	0.54	**x**	5.39	**x**	4.48	**x**	1	=	**12.95**	cfs
Q_{10} =	0.54	**x**	5.97	**x**	4.48	**x**	1	=	**14.35**	cfs
Q_{25} =	0.54	**x**	6.83	**x**	4.48	**x**	1.1	=	**18.07**	cfs
Q_{50} =	0.54	**x**	7.51	**x**	4.48	**x**	1.2	=	**21.68**	cfs
Q_{100} =	0.54	**x**	8.19	**x**	4.48	**x**	1.25	=	**24.61**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
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Location: **Site 86a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.67	2.3988
Grass	0.25	1.34	0.3338
Woods	0.15	5.90	0.8849
	Σ	**9.90**	3.6174

$C_{ave} = \frac{3.6174}{9.90} = 0.37$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.67	2.3988
Grass	0.25	1.34	0.3338
Woods	0.15	5.90	0.8849
	Σ	**9.90**	3.6174

$C_{ave} = \frac{3.6174}{9.90} = 0.37$

T_c =	32.64	min.
I_{05} =	3.62	in / hr
I_{10} =	3.99	in / hr
I_{25} =	4.52	in / hr
I_{50} =	4.93	in / hr
I_{100} =	5.33	in / hr

Pre Construction Runoff:

Q_{05} =	0.37	x	3.62	x	9.90	x	1	=	**13.10**	cfs
Q_{10} =	0.37	x	3.99	x	9.90	x	1	=	**14.42**	cfs
Q_{25} =	0.37	x	4.52	x	9.90	x	1.1	=	**17.97**	cfs
Q_{50} =	0.37	x	4.93	x	9.90	x	1.2	=	**21.40**	cfs
Q_{100} =	0.37	x	5.33	x	9.90	x	1.25	=	**24.11**	cfs

Post Construction Runoff:

Q_{05} =	0.37	x	3.62	x	9.90	x	1	=	**13.10**	cfs
Q_{10} =	0.37	x	3.99	x	9.90	x	1	=	**14.42**	cfs
Q_{25} =	0.37	x	4.52	x	9.90	x	1.1	=	**17.97**	cfs
Q_{50} =	0.37	x	4.93	x	9.90	x	1.2	=	**21.40**	cfs
Q_{100} =	0.37	x	5.33	x	9.90	x	1.25	=	**24.11**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 86b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3344
Grass	0.25	0.11	0.0286
Woods	0.15	0.27	0.0407
	Σ	**0.76**	0.4036

$C_{ave} = \frac{0.4036}{0.76} = 0.53$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3344
Grass	0.25	0.11	0.0286
Woods	0.15	0.27	0.0407
	Σ	**0.76**	0.4036

$C_{ave} = \frac{0.4036}{0.76} = 0.53$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.53	x	6.32	x	0.76	x	1	=	**2.55**	cfs
Q_{10} =	0.53	x	7.04	x	0.76	x	1	=	**2.84**	cfs
Q_{25} =	0.53	x	8.10	x	0.76	x	1.1	=	**3.60**	cfs
Q_{50} =	0.53	x	8.95	x	0.76	x	1.2	=	**4.34**	cfs
Q_{100} =	0.53	x	9.80	x	0.76	x	1.25	=	**4.95**	cfs

Post Construction Runoff:

Q_{05} =	0.53	x	6.32	x	0.76	x	1	=	**2.55**	cfs
Q_{10} =	0.53	x	7.04	x	0.76	x	1	=	**2.84**	cfs
Q_{25} =	0.53	x	8.10	x	0.76	x	1.1	=	**3.60**	cfs
Q_{50} =	0.53	x	8.95	x	0.76	x	1.2	=	**4.34**	cfs
Q_{100} =	0.53	x	9.80	x	0.76	x	1.25	=	**4.95**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 83b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.240**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.191**	+		=	**0.191**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft					
9	Watercourse slope, s	----------	ft/ft					
10	Average velocity, V (figure 3-1)	----------	ft/s	**0.00**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+		=	
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.191**
							min	**11.47**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 86a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**650**				
9	Watercourse slope, s		ft/ft	**0.0677**				
10	Average velocity, V (figure 3-1)		ft/s	**4.20**	**0.00**			
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.043**	+		=	**0.043**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)					hr		**0.544**
						min		**32.64**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-86		Outlet	OP	353.72	353.72	0.00	0.48	0.00	33.18	0.00	16.91	0.42	0.00
JB-1		Junction	JUNCT BOX	380.00	380.00	12.00	0.32	32.80	32.80	42.13	16.91	0.42	4.95
CB-85b		Other	C.B. TYPE 112	378.50	378.50	7.58	1.22	11.47	11.47	27.90	6.25	0.49	7.57
CB-86b		Other	C.B. TYPE 112	383.19	383.19	9.36	0.03	32.70	32.70	23.93	10.66	0.38	4.96
CB-85a		Other	C.B. TYPE 112	391.49	391.49	4.42	0.00	5.00	5.00	5.43	1.33	0.38	9.03
CB-84		Other	C.B. TYPE 112	381.03	381.03	3.75	0.00	5.00	5.00	3.90	0.66	0.55	9.03
DN-86a		Other	DUMMY JOINT	377.96	377.96	0.00	0.00	32.64	32.64	21.57	9.90	0.37	4.96

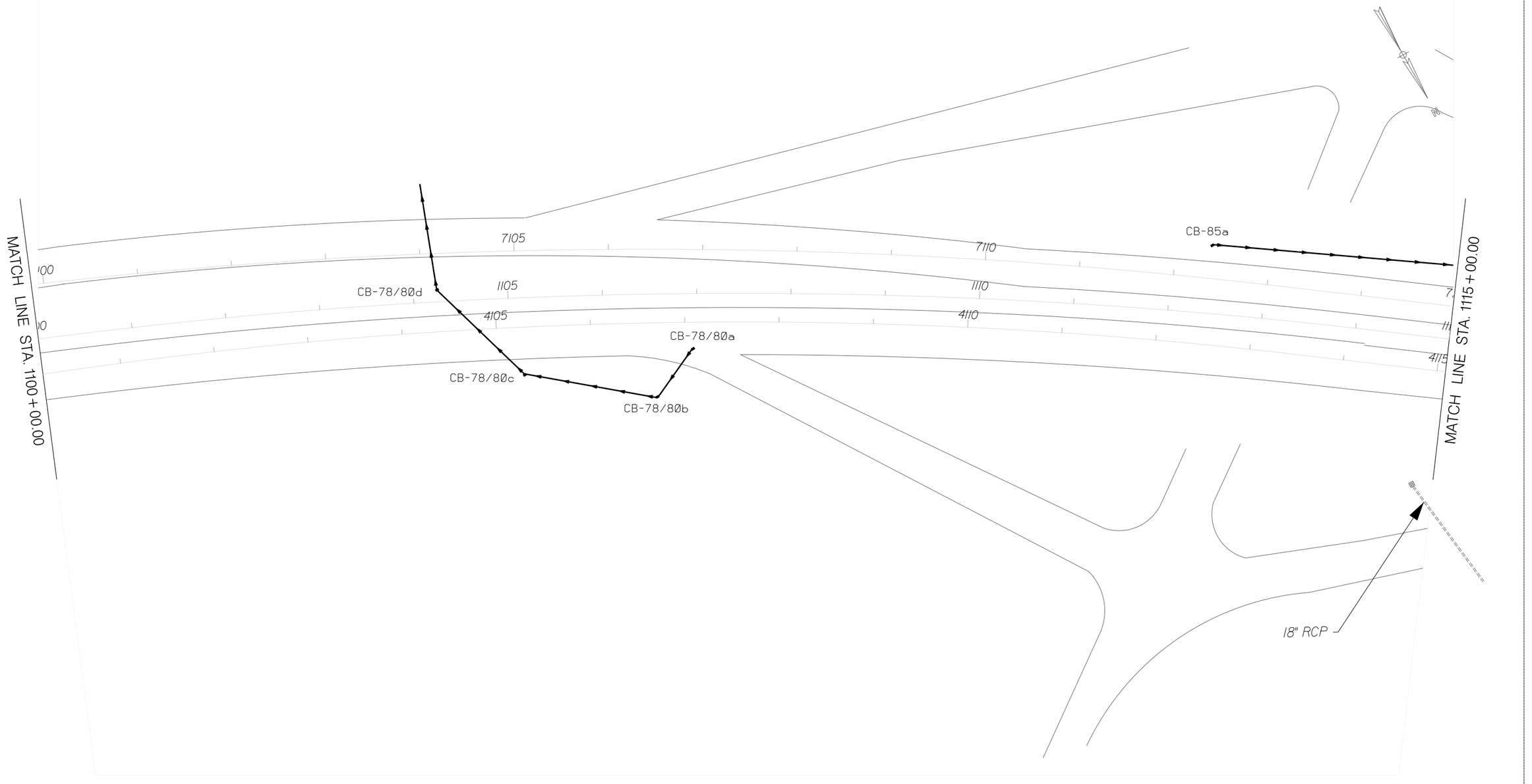
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-10	JB-1	OF-86	Circular	Concrete	1	3.00	390	3.66	42.13	148.70	1.14	17.18	371.00	370.43	356.72	354.86	368.00	353.72	6.86	17.10	2.43	1.14
NP-7	CB-85b	JB-1	Circular	Concrete	1	2.00	44	6.61	27.90	67.79	0.93	19.45	372.92	374.07	370.00	369.10	370.92	368.00	8.88	15.79	2.00	1.10
NP-9	CB-86b	JB-1	Circular	Concrete	1	2.50	104	5.58	23.93	112.95	0.81	17.33	376.33	375.61	370.50	368.85	373.83	368.00	6.39	16.26	1.78	0.85
NP-5	CB-85a	CB-85b	Circular	Concrete	1	1.50	555	1.94	5.43	17.04	0.61	8.14	388.57	388.44	377.82	376.93	387.07	376.32	3.21	8.14	1.37	0.61
NP-6	CB-84	CB-85b	Circular	Concrete	1	1.25	86	7.24	3.90	20.26	0.39	12.10	378.53	378.52	372.27	371.41	377.28	371.02	3.18	11.99	1.24	0.39
NP-8	DN-86a	CB-86b	Circular	Concrete	1	2.50	64	6.25	21.57	119.54	0.75	17.52	380.46	380.41	376.48	374.80	377.96	373.98	4.42	15.40	2.45	0.82

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-85b	11.47	20.07	7.57	0.52	4.26	0.52	4.26	0.00	0.00
CB-86b	5.00	4.34	9.03	0.53	0.76	0.53	0.75	0.00	0.01
CB-85a	5.00	5.43	9.03	0.38	1.33	0.38	1.33	0.00	0.00
CB-84	5.00	3.90	9.03	0.55	0.66	0.55	0.66	0.00	0.00
DN-86a	32.64	21.57	4.96	0.37	9.90	0.37	9.90	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	41



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

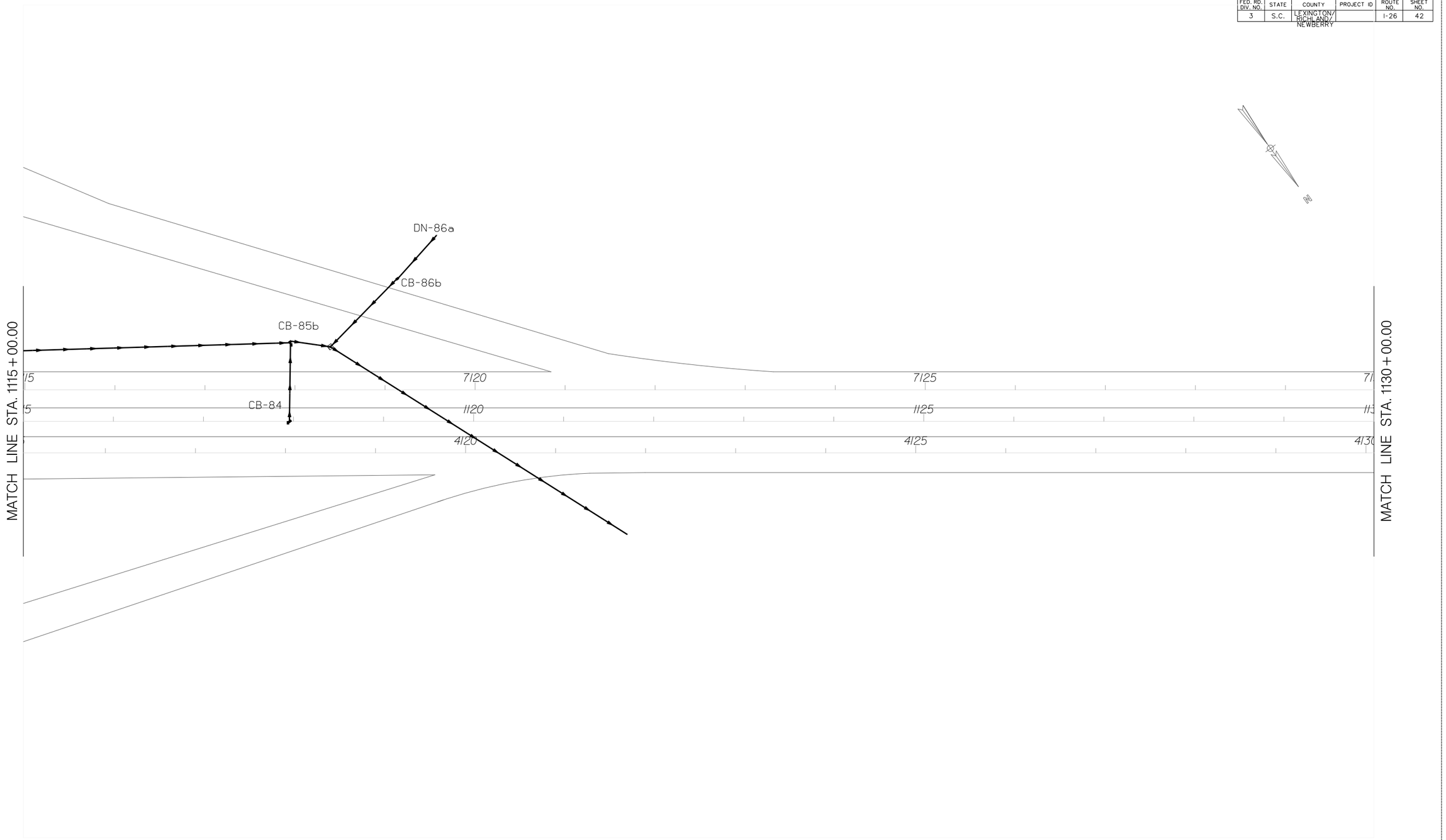
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1100+00.00 TO STA. 1115+00.00

$$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$$date$$$$

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	42



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1115+00.00 TO STA. 1130+00.00

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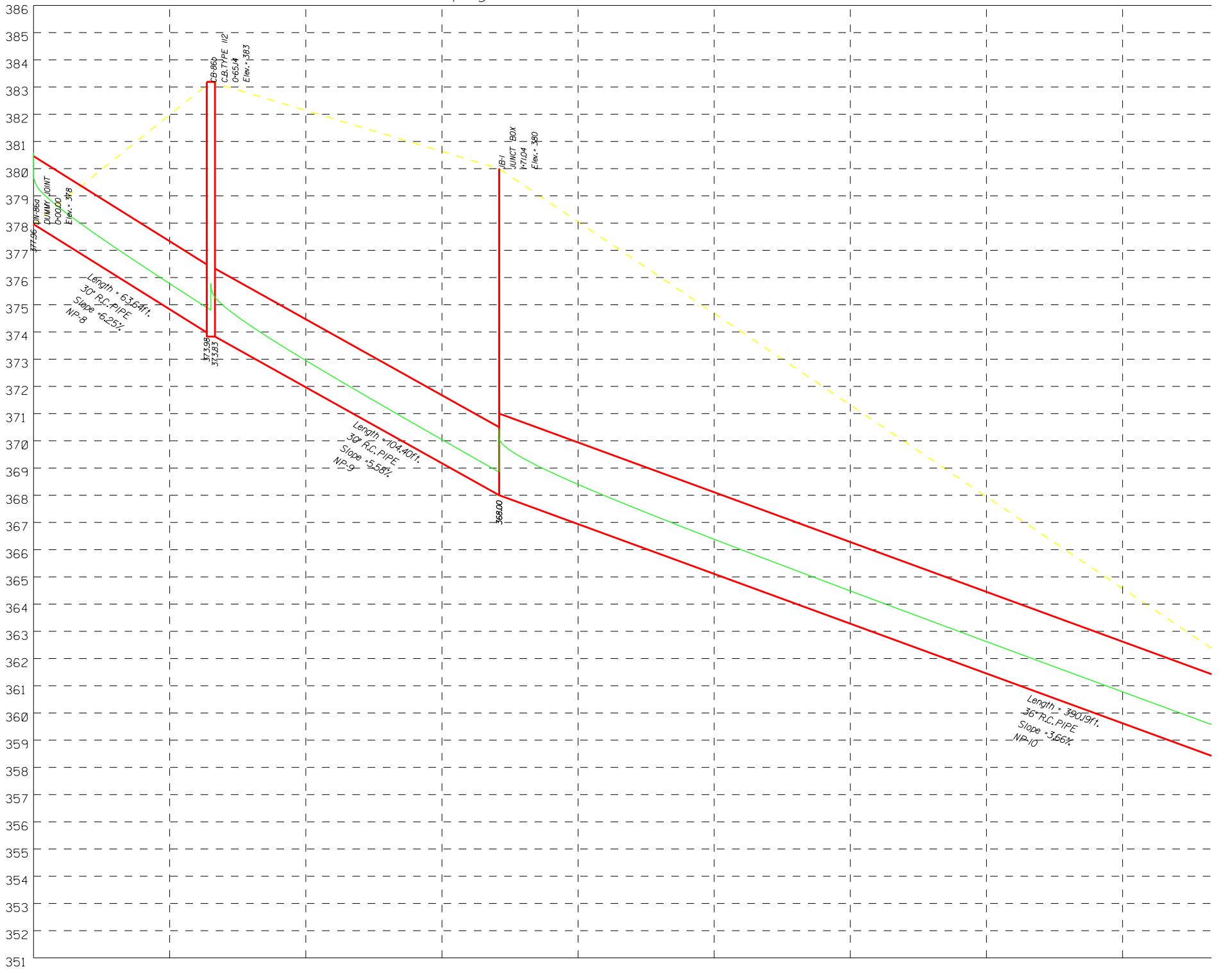
$$$date$$$$


OF-83/84/85/86 (50 YR PRE)(A)(page 1 of 2)
386
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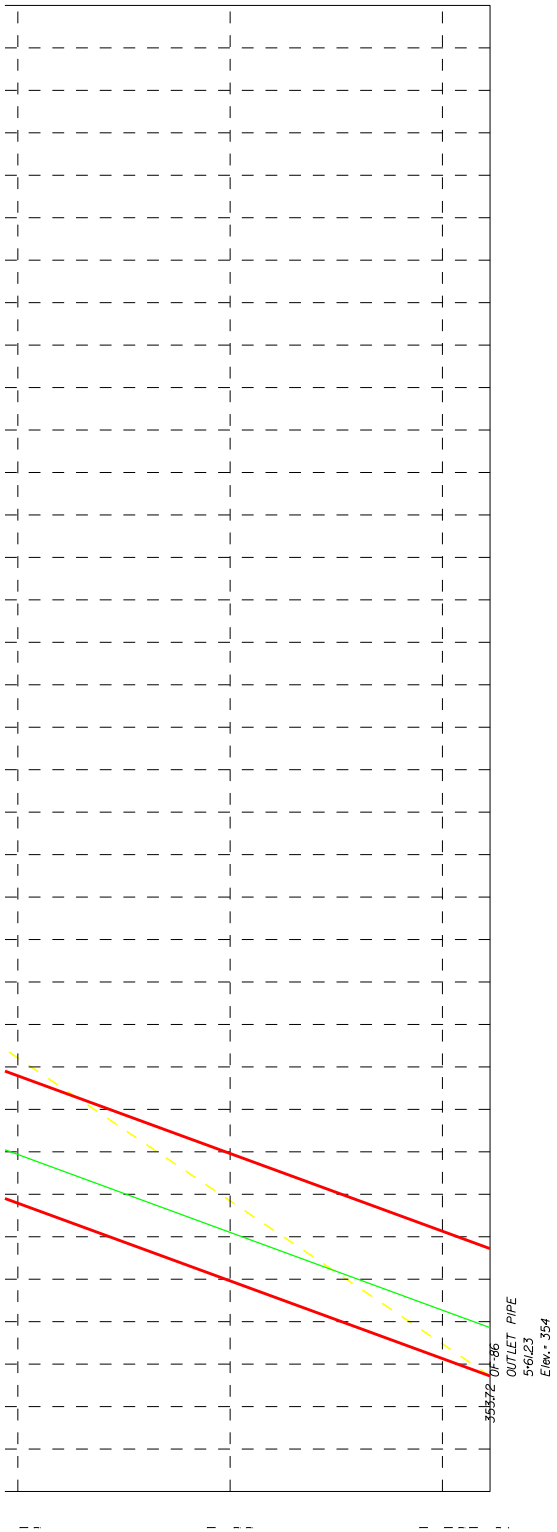
358
357
356
355
354
353
352
351
CB 86b
C.B. TYPE II
O 65.14
Elev. = 383
JB-1
JUNCT BOX
N 71,04 1
Elev. = 380
DW 86a
DUMMY JOINT
O 0.00
Elev. = 378
377.96
Length = 636.64ft.
30" R.C. PIPE
Slope = 6.25%
NP-8
377.98
373.83
Length = 104.40ft.
30" R.C. PIPE
Slope = 5.58%
NP-9
368.00
Length = 390.19ft.
36" R.C. PIPE
Slope = 3.66%
NP-10

OF-83/84/85/86 (50 YR PRE)(A)(page 2 of 2)



OF-83/84/85/86 (50 YR PRE)(B)

OF-83/84/85/86 (50 YR PRE)(C)(page 1 of 2)


OF+83/84/85/86 (50 YR PRE)(C)(page 2 of 2)
CB/TYPE #2
5+57.89
Elev.= 379
JUNCT BOX
6+03.56
Elev.= 380
376.36
370.92
368.00
Length = 441.16ft.
24" R.C. PIPE
Slope =6.61%
NP-7
Length = 390.19ft.
36" R.C. PIPE
Slope =3.66%
NP-10
OUTLET PIPE
9+93.74
Elev.= 354
353.72
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
9+94

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-86	Outlet	OP	353.72	353.72	0.00	0.48	0.00	33.18	0.00	16.83	0.43	0.00
JB-1	Junction	JUNCT BOX	380.00	380.00	12.00	0.26	32.80	32.80	43.10	16.83	0.43	4.95
CB-85b	Other	C.B. TYPE 112	378.50	378.50	7.58	1.35	11.47	11.47	29.37	6.17	0.52	7.57
CB-86b	Other	C.B. TYPE 112	383.19	383.19	9.36	0.03	32.70	32.70	23.93	10.66	0.38	4.96
CB-85a	Other	C.B. TYPE 112	391.49	391.49	4.42	0.00	5.00	5.00	5.43	1.33	0.38	9.03
CB-84	Other	C.B. TYPE 112	381.03	381.03	3.75	0.00	5.00	5.00	3.51	0.36	0.90	9.03
DN-86a	Other	DUMMY JOINT	377.96	377.96	0.00	0.00	32.64	32.64	21.57	9.90	0.37	4.96

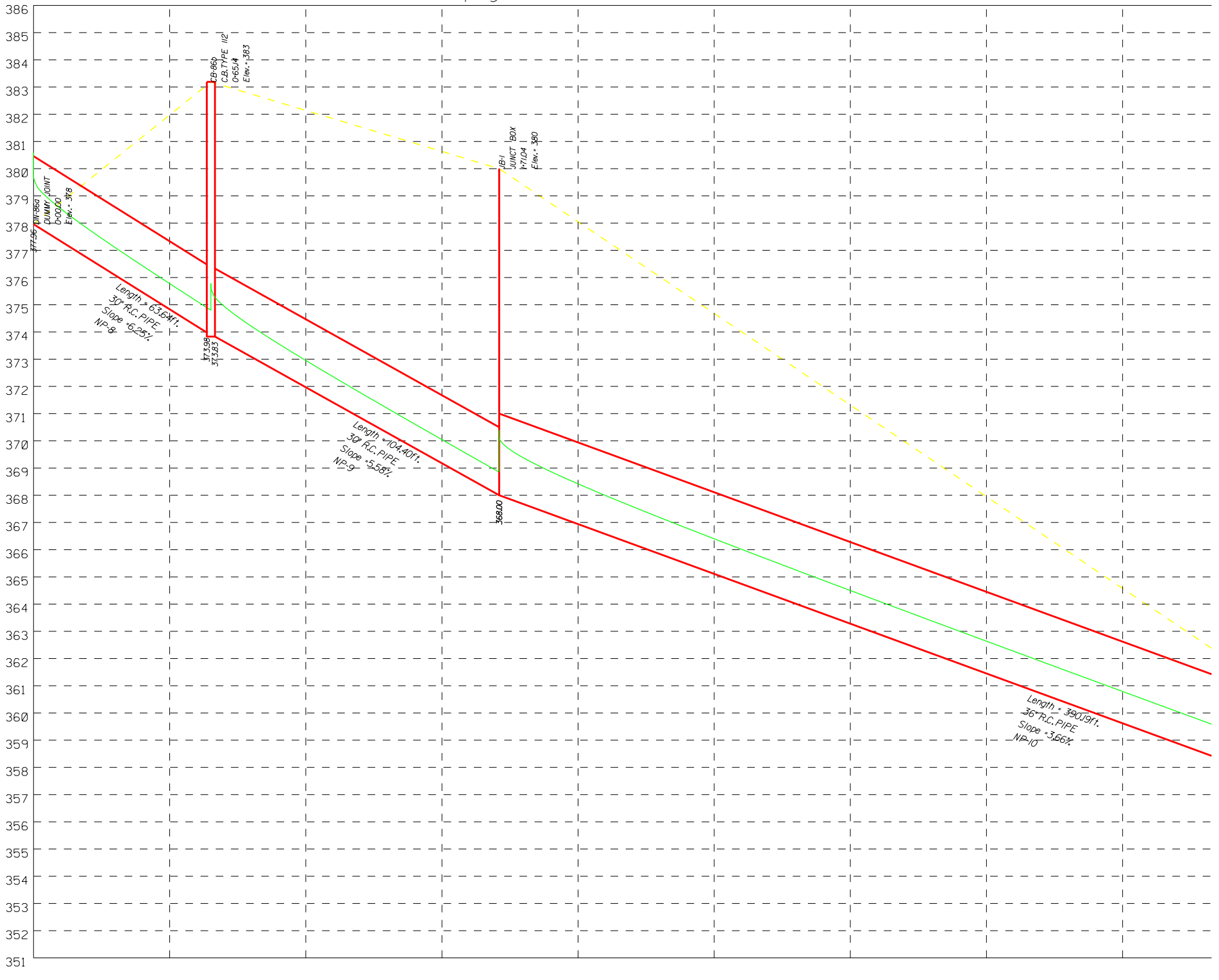
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-10	JB-1	OF-86	Circular	Concrete	1	3.00	390	3.66	43.10	148.70	1.15	17.29	371.00	370.40	356.72	354.87	368.00	353.72	7.11	17.20	2.40	1.15
NP-7	CB-85b	JB-1	Circular	Concrete	1	2.00	44	6.61	29.37	67.79	0.96	19.71	372.92	374.22	370.00	369.13	370.92	368.00	9.35	15.97	2.00	1.13
NP-9	CB-86b	JB-1	Circular	Concrete	1	2.50	104	5.58	23.93	112.95	0.81	17.33	376.33	375.61	370.50	368.85	373.83	368.00	6.39	16.26	1.78	0.85
NP-5	CB-85a	CB-85b	Circular	Concrete	1	1.50	555	1.94	5.43	17.04	0.61	8.14	388.57	388.44	377.82	376.93	387.07	376.32	3.21	8.14	1.37	0.61
NP-6	CB-84	CB-85b	Circular	Concrete	1	1.25	86	7.24	3.51	20.26	0.37	11.75	378.53	378.44	372.27	371.39	377.28	371.02	2.96	11.67	1.16	0.37
NP-8	DN-86a	CB-86b	Circular	Concrete	1	2.50	64	6.25	21.57	119.54	0.75	17.52	380.46	380.41	376.48	374.80	377.96	373.98	4.42	15.40	2.45	0.82

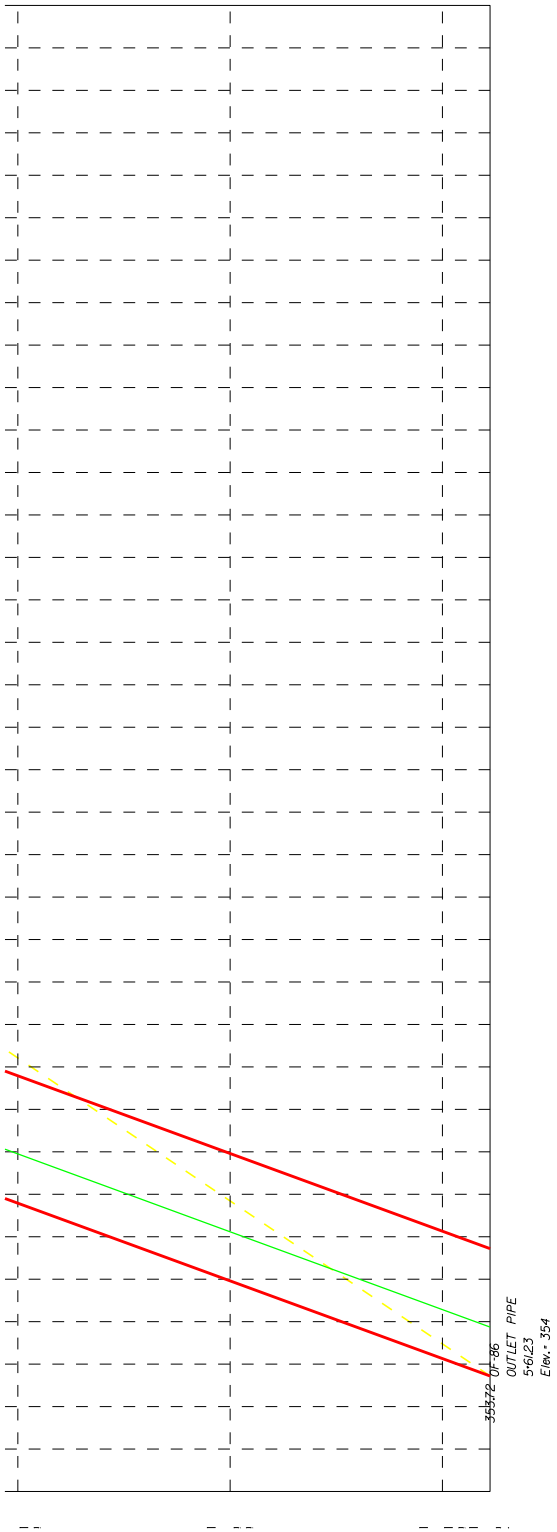
SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-85b	11.47	21.87	7.57	0.54	4.48	0.54	4.48	0.00	0.00
CB-86b	5.00	4.34	9.03	0.53	0.76	0.53	0.75	0.00	0.01
CB-85a	5.00	5.43	9.03	0.38	1.33	0.38	1.33	0.00	0.00
CB-84	5.00	3.51	9.03	0.90	0.36	0.90	0.36	0.90	0.00
DN-86a	32.64	21.57	4.96	0.37	9.90	0.37	9.90	0.00	0.00

OF-83/84/85/86 (50 YR POST)(A)(page 1 of 2)



OF-83/84/85/86 (50 YR POST)(A)(page 2 of 2)



OF-83/84/85/86 (50 YR POST)(B)

OF-83/84/85/86 (50 YR POST)(C)(page 1 of 2)


OF+83/84/85/86 (50 YR POST)(C)(page 2 of 2)
CB-85b
CB/TYPE M2
5+57.89
Elev.= 379
376.32
370.92
MH1
JUNCT BOX
6+03.56
Elev.= 380
368.00
Length = 441.16ft.
24" R.C.PIPE
Slope =6.61%
NP-7
Length = 390.19ft.
36" R.C.PIPE
Slope =3.66%
NP-10
353.72
OF-86
OUTLET PIPE
9+93.74
Elev.= 354
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
9+94

CULVERT 87

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 87**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.85	0.7664
Grass	0.25	0.99	0.2484
Woods	0.15	0.25	0.0381
	Σ	**2.10**	1.0528

$C_{ave} = \frac{1.0528}{2.10} = 0.50$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.02	0.9140
Grass	0.25	0.99	0.2484
Woods	0.15	0.25	0.0381
	Σ	**2.26**	1.2005

$C_{ave} = \frac{1.2005}{2.26} = 0.53$

T_c =	20.50	min.								
I_{05} =	4.46	in / hr								
I_{10} =	4.93	in / hr								
I_{25} =	5.60	in / hr								
I_{50} =	6.14	in / hr								
I_{100} =	6.66	in / hr								

Pre Construction Runoff:

Q_{05} =	0.50	**x**	4.46	**x**	2.10	**x**	1	=	**4.70**	cfs
Q_{10} =	0.50	**x**	4.93	**x**	2.10	**x**	1	=	**5.19**	cfs
Q_{25} =	0.50	**x**	5.60	**x**	2.10	**x**	1.1	=	**6.49**	cfs
Q_{50} =	0.50	**x**	6.14	**x**	2.10	**x**	1.2	=	**7.76**	cfs
Q_{100} =	0.50	**x**	6.66	**x**	2.10	**x**	1.25	=	**8.77**	cfs

Post Construction Runoff:

Q_{05} =	0.53	**x**	4.46	**x**	2.26	**x**	1	=	**5.36**	cfs
Q_{10} =	0.53	**x**	4.93	**x**	2.26	**x**	1	=	**5.91**	cfs
Q_{25} =	0.53	**x**	5.60	**x**	2.26	**x**	1.1	=	**7.40**	cfs
Q_{50} =	0.53	**x**	6.14	**x**	2.26	**x**	1.2	=	**8.84**	cfs
Q_{100} =	0.53	**x**	6.66	**x**	2.26	**x**	1.25	=	**10.00**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 87	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**80**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.342**	+		=	**0.342**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------						
8	Flow length, L	----------	ft					
9	Watercourse slope, s	----------	ft/ft					
10	Average velocity, V (figure 3-1)	----------	ft/s	**0.00**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+		=	
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.342**
							min	**20.50**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.49 cfs

Design Flow: 7.76 cfs

Maximum Flow: 8.77 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1119+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
379.44	6.49	6.49	0.00	1
379.48	6.72	6.72	0.00	1
379.52	6.95	6.95	0.00	1
379.56	7.17	7.17	0.00	1
379.60	7.40	7.40	0.00	1
379.64	7.63	7.63	0.00	1
379.67	7.76	7.76	0.00	1
379.73	8.09	8.09	0.00	1
379.78	8.31	8.31	0.00	1
379.82	8.54	8.54	0.00	1
379.87	8.77	8.77	0.00	1
379.99	9.30	9.30	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.49	6.49	379.44	1.525	0.0*	5-S2n	0.571	0.983	0.596	0.632	9.585	3.144
6.72	6.72	379.48	1.565	0.0*	5-S2n	0.582	1.000	0.609	0.644	9.642	3.174
6.95	6.95	379.52	1.605	0.0*	5-S2n	0.592	1.017	0.592	0.655	10.347	3.203
7.17	7.17	379.56	1.646	0.0*	5-S2n	0.603	1.034	0.603	0.666	10.439	3.232
7.40	7.40	379.60	1.688	0.0*	5-S2n	0.613	1.051	0.613	0.677	10.528	3.260
7.63	7.63	379.64	1.731	0.0*	5-S2n	0.624	1.067	0.624	0.688	10.618	3.288
7.76	7.76	379.67	1.756	0.0*	5-S2n	0.630	1.076	0.674	0.694	9.741	3.303
8.09	8.09	379.73	1.820	0.0*	5-S2n	0.644	1.098	0.688	0.708	9.899	3.340
8.31	8.31	379.78	1.866	0.0*	5-S2n	0.655	1.113	0.696	0.719	10.020	3.365
8.54	8.54	379.82	1.914	0.0*	5-S2n	0.665	1.127	0.704	0.729	10.138	3.391
8.77	8.77	379.87	1.962	0.0*	5-S2n	0.675	1.142	0.712	0.739	10.261	3.415

* Full Flow Headwater elevation is below inlet invert.

****

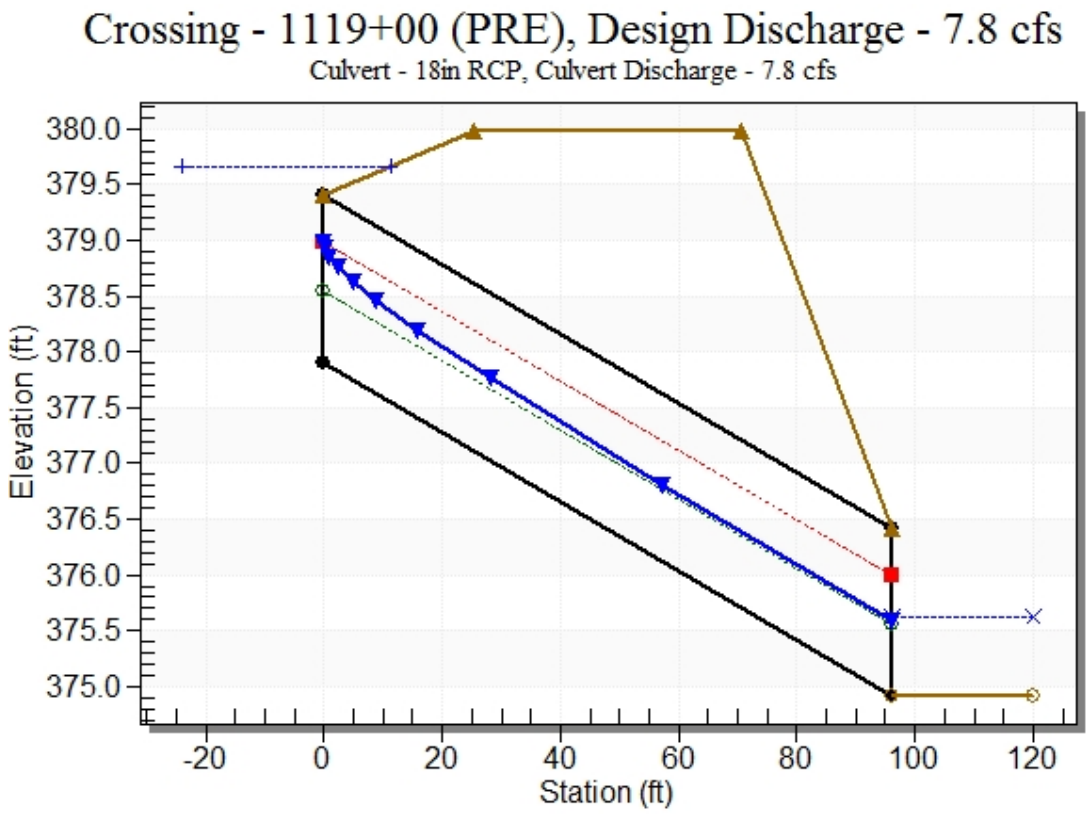
Straight Culvert

Inlet Elevation (invert): 377.91 ft, Outlet Elevation (invert): 374.92 ft

Culvert Length: 96.05 ft, Culvert Slope: 0.0311

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 377.91 ft

Outlet Station: 96.00 ft

Outlet Elevation: 374.92 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1119+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.49	375.55	0.63	3.14	1.97	0.82
6.72	375.56	0.64	3.17	2.01	0.82
6.95	375.58	0.66	3.20	2.04	0.82
7.17	375.59	0.67	3.23	2.08	0.83
7.40	375.60	0.68	3.26	2.11	0.83
7.63	375.61	0.69	3.29	2.15	0.83
7.76	375.61	0.69	3.30	2.16	0.83
8.09	375.63	0.71	3.34	2.21	0.83
8.31	375.64	0.72	3.37	2.24	0.83
8.54	375.65	0.73	3.39	2.27	0.83
8.77	375.66	0.74	3.42	2.30	0.84

Tailwater Channel Data - 1119+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 374.92 ft

Roadway Data for Crossing: 1119+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 379.99 ft

Roadway Surface: Paved

Roadway Top Width: 45.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.4 cfs

Design Flow: 8.84 cfs

Maximum Flow: 10 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1119+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
379.60	7.40	7.40	0.00	1
379.65	7.66	7.66	0.00	1
379.70	7.92	7.92	0.00	1
379.75	8.18	8.18	0.00	1
379.80	8.44	8.44	0.00	1
379.86	8.70	8.70	0.00	1
379.89	8.84	8.84	0.00	1
379.97	9.22	9.22	0.00	1
380.00	9.48	9.33	0.10	10
380.01	9.74	9.37	0.31	4
380.01	10.00	9.40	0.55	4
379.99	9.30	9.30	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.40	7.40	379.60	1.688	0.0*	5-S2n	0.613	1.050	0.613	0.677	10.527	3.260
7.66	7.66	379.65	1.737	0.0*	5-S2n	0.625	1.069	0.625	0.689	10.630	3.291
7.92	7.92	379.70	1.787	0.0*	5-S2n	0.637	1.087	0.681	0.701	9.816	3.321
8.18	8.18	379.75	1.839	0.0*	5-S2n	0.649	1.104	0.691	0.713	9.948	3.351
8.44	8.44	379.80	1.892	0.0*	5-S2n	0.660	1.121	0.701	0.724	10.088	3.380
8.70	8.70	379.86	1.947	0.0*	5-S2n	0.672	1.138	0.710	0.736	10.223	3.408
8.84	8.84	379.89	1.977	0.0*	5-S2n	0.678	1.146	0.714	0.742	10.299	3.422
9.22	9.22	379.97	2.062	0.0*	5-S2n	0.694	1.173	0.724	0.758	10.559	3.462
9.48	9.33	380.00	2.088	0.0*	5-S2n	0.699	1.179	0.699	0.768	11.180	3.488
9.74	9.37	380.01	2.096	0.0*	5-S2n	0.701	1.182	0.701	0.779	11.192	3.514
10.00	9.40	380.01	2.104	0.0*	5-S2n	0.702	1.184	0.702	0.789	11.202	3.539

* Full Flow Headwater elevation is below inlet invert.

****

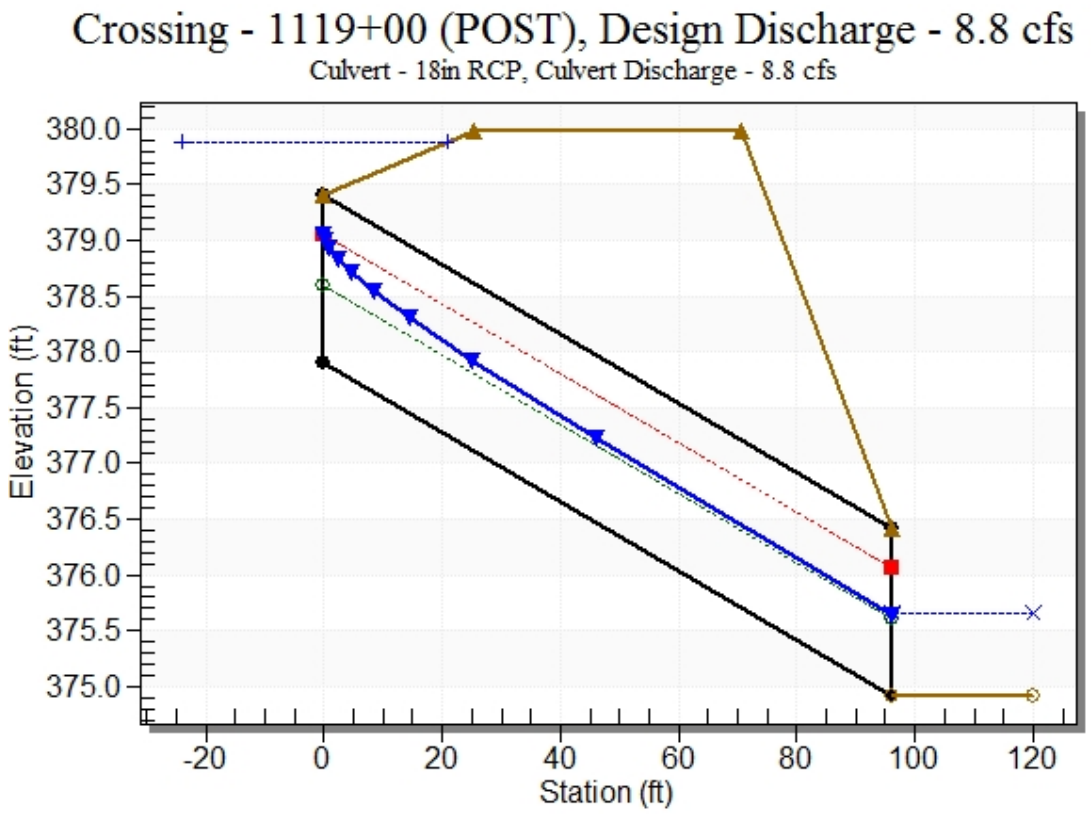
Straight Culvert

Inlet Elevation (invert): 377.91 ft, Outlet Elevation (invert): 374.92 ft

Culvert Length: 96.05 ft, Culvert Slope: 0.0311

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 377.91 ft

Outlet Station: 96.00 ft

Outlet Elevation: 374.92 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1119+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.40	375.60	0.68	3.26	2.11	0.83
7.66	375.61	0.69	3.29	2.15	0.83
7.92	375.62	0.70	3.32	2.19	0.83
8.18	375.63	0.71	3.35	2.22	0.83
8.44	375.64	0.72	3.38	2.26	0.83
8.70	375.66	0.74	3.41	2.29	0.84
8.84	375.66	0.74	3.42	2.31	0.84
9.22	375.68	0.76	3.46	2.36	0.84
9.48	375.69	0.77	3.49	2.40	0.84
9.74	375.70	0.78	3.51	2.43	0.84
10.00	375.71	0.79	3.54	2.46	0.84

Tailwater Channel Data - 1119+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 374.92 ft

Roadway Data for Crossing: 1119+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 379.99 ft

Roadway Surface: Paved

Roadway Top Width: 45.00 ft

CULVERT 89

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 89**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.90	0.8127
Grass	0.25	1.49	0.3737
Woods	0.15	1.49	0.2238
	Σ	**3.89**	1.4101

$C_{ave} = \frac{1.4101}{3.89} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.36	1.2266
Grass	0.25	1.03	0.2587
Woods	0.15	1.49	0.2238
	Σ	**3.89**	1.7091

$C_{ave} = \frac{1.7091}{3.89} = 0.44$

T_c =	23.68	min.								
I_{05} =	4.21	in / hr								
I_{10} =	4.64	in / hr								
I_{25} =	5.27	in / hr								
I_{50} =	5.77	in / hr								
I_{100} =	6.25	in / hr								

Pre Construction Runoff:

Q_{05} =	0.36	**x**	4.21	**x**	3.89	**x**	1	=	**5.93**	cfs
Q_{10} =	0.36	**x**	4.64	**x**	3.89	**x**	1	=	**6.54**	cfs
Q_{25} =	0.36	**x**	5.27	**x**	3.89	**x**	1.1	=	**8.18**	cfs
Q_{50} =	0.36	**x**	5.77	**x**	3.89	**x**	1.2	=	**9.76**	cfs
Q_{100} =	0.36	**x**	6.25	**x**	3.89	**x**	1.25	=	**11.02**	cfs

Post Construction Runoff:

Q_{05} =	0.44	**x**	4.21	**x**	3.89	**x**	1	=	**7.19**	cfs
Q_{10} =	0.44	**x**	4.64	**x**	3.89	**x**	1	=	**7.93**	cfs
Q_{25} =	0.44	**x**	5.27	**x**	3.89	**x**	1.1	=	**9.91**	cfs
Q_{50} =	0.44	**x**	5.77	**x**	3.89	**x**	1.2	=	**11.83**	cfs
Q_{100} =	0.44	**x**	6.25	**x**	3.89	**x**	1.25	=	**13.36**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 89	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0700**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.357**	+		=	**0.357**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**535**				
9	Watercourse slope, s	----------	ft/ft	**0.0598**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.95**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.038**	+		=	**0.038**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.395**
						min		**23.68**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.18 cfs

Design Flow: 9.76 cfs

Maximum Flow: 11.02 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1127+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
364.36	8.18	8.18	0.00	1
364.40	8.46	8.46	0.00	1
364.43	8.75	8.75	0.00	1
364.46	9.03	9.03	0.00	1
364.49	9.32	9.32	0.00	1
364.52	9.60	9.60	0.00	1
364.54	9.76	9.76	0.00	1
364.58	10.17	10.17	0.00	1
364.61	10.45	10.45	0.00	1
364.64	10.74	10.74	0.00	1
364.67	11.02	11.02	0.00	1
366.36	23.27	23.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.18	8.18	364.36	1.494	0.0*	1-S2n	0.709	1.018	0.709	0.713	7.935	3.351
8.46	8.46	364.40	1.526	0.0*	1-S2n	0.722	1.036	0.722	0.725	7.998	3.382
8.75	8.75	364.43	1.557	0.0*	1-S2n	0.735	1.053	0.735	0.738	8.075	3.413
9.03	9.03	364.46	1.588	0.0*	1-S2n	0.747	1.071	0.747	0.750	8.148	3.443
9.32	9.32	364.49	1.619	0.0*	1-S2n	0.760	1.087	0.760	0.762	8.218	3.472
9.60	9.60	364.52	1.650	0.0*	1-S2n	0.773	1.104	0.773	0.773	8.276	3.500
9.76	9.76	364.54	1.667	0.0*	1-S2n	0.780	1.113	0.780	0.780	8.315	3.516
10.17	10.17	364.58	1.710	0.0*	1-S2n	0.797	1.135	0.797	0.796	8.411	3.555
10.45	10.45	364.61	1.741	0.0*	1-S2n	0.810	1.155	0.810	0.807	8.474	3.582
10.74	10.74	364.64	1.771	0.0*	1-S2n	0.822	1.171	0.822	0.818	8.527	3.607
11.02	11.02	364.67	1.801	0.0*	1-S2n	0.834	1.187	0.859	0.829	8.262	3.633

* Full Flow Headwater elevation is below inlet invert.

****

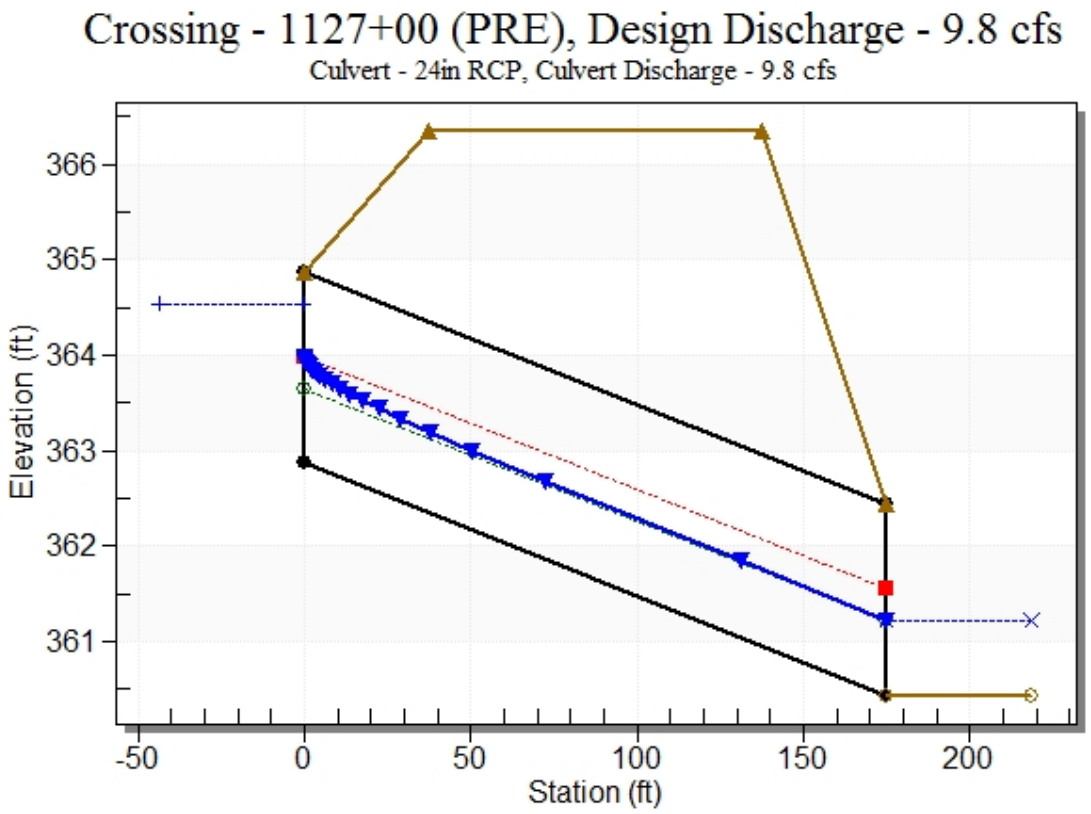
Straight Culvert

Inlet Elevation (invert): 362.87 ft, Outlet Elevation (invert): 360.44 ft

Culvert Length: 175.02 ft, Culvert Slope: 0.0139

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 362.87 ft

Outlet Station: 175.00 ft

Outlet Elevation: 360.44 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1127+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
8.18	361.15	0.71	3.35	2.22	0.83
8.46	361.17	0.73	3.38	2.26	0.83
8.75	361.18	0.74	3.41	2.30	0.84
9.03	361.19	0.75	3.44	2.34	0.84
9.32	361.20	0.76	3.47	2.38	0.84
9.60	361.21	0.77	3.50	2.41	0.84
9.76	361.22	0.78	3.52	2.43	0.84
10.17	361.24	0.80	3.55	2.48	0.84
10.45	361.25	0.81	3.58	2.52	0.84
10.74	361.26	0.82	3.61	2.55	0.85
11.02	361.27	0.83	3.63	2.59	0.85

Tailwater Channel Data - 1127+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 360.44 ft

Roadway Data for Crossing: 1127+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 366.36 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.91 cfs

Design Flow: 11.83 cfs

Maximum Flow: 13.36 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1127+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
364.55	9.91	9.91	0.00	1
364.59	10.26	10.26	0.00	1
364.63	10.60	10.60	0.00	1
364.66	10.95	10.95	0.00	1
364.70	11.29	11.29	0.00	1
364.74	11.64	11.64	0.00	1
364.76	11.83	11.83	0.00	1
364.81	12.32	12.32	0.00	1
364.85	12.67	12.67	0.00	1
364.89	13.01	13.01	0.00	1
364.93	13.36	13.36	0.00	1
366.36	23.27	23.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.91	9.91	364.55	1.683	0.0*	1-S2n	0.786	1.121	0.786	0.786	8.351	3.531
10.26	10.26	364.59	1.720	0.0*	1-S2n	0.801	1.144	0.801	0.800	8.430	3.563
10.60	10.60	364.63	1.756	0.0*	1-S2n	0.816	1.164	0.816	0.813	8.506	3.595
10.95	10.95	364.66	1.793	0.0*	1-S2n	0.831	1.183	0.831	0.826	8.573	3.627
11.29	11.29	364.70	1.830	0.0*	1-S2n	0.845	1.202	0.876	0.839	8.241	3.656
11.64	11.64	364.74	1.867	0.0*	1-S2n	0.859	1.220	0.859	0.852	8.716	3.686
11.83	11.83	364.76	1.888	0.0*	1-S2n	0.868	1.230	0.896	0.859	8.386	3.703
12.32	12.32	364.81	1.941	0.0*	1-S2n	0.888	1.260	0.888	0.877	8.844	3.744
12.67	12.67	364.85	1.979	0.0*	1-S2n	0.902	1.278	0.902	0.889	8.909	3.772
13.01	13.01	364.89	2.017	0.0*	5-S2n	0.916	1.295	0.916	0.901	8.971	3.799
13.36	13.36	364.93	2.055	0.0*	5-S2n	0.930	1.313	0.930	0.913	9.028	3.826

* Full Flow Headwater elevation is below inlet invert.

****

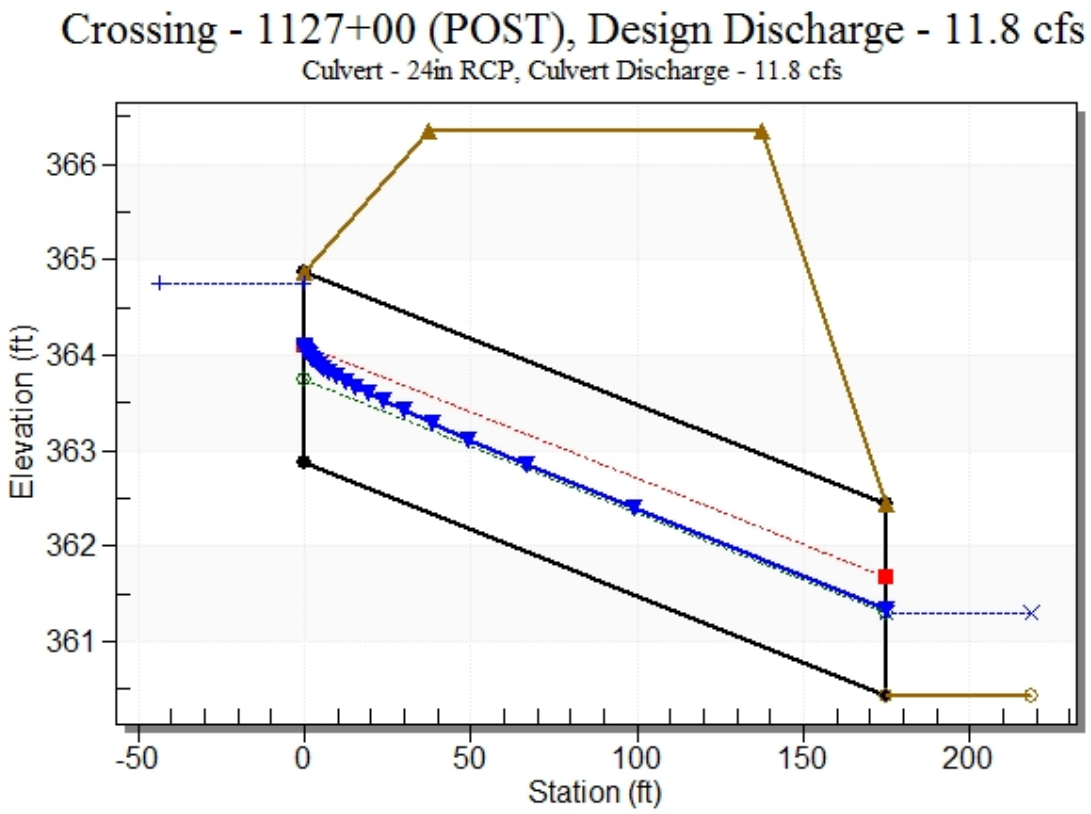
Straight Culvert

Inlet Elevation (invert): 362.87 ft, Outlet Elevation (invert): 360.44 ft

Culvert Length: 175.02 ft, Culvert Slope: 0.0139

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 362.87 ft

Outlet Station: 175.00 ft

Outlet Elevation: 360.44 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1127+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.91	361.23	0.79	3.53	2.45	0.84
10.26	361.24	0.80	3.56	2.49	0.84
10.60	361.25	0.81	3.60	2.54	0.85
10.95	361.27	0.83	3.63	2.58	0.85
11.29	361.28	0.84	3.66	2.62	0.85
11.64	361.29	0.85	3.69	2.66	0.85
11.83	361.30	0.86	3.70	2.68	0.85
12.32	361.32	0.88	3.74	2.74	0.85
12.67	361.33	0.89	3.77	2.77	0.85
13.01	361.34	0.90	3.80	2.81	0.86
13.36	361.35	0.91	3.83	2.85	0.86

Tailwater Channel Data - 1127+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 360.44 ft

Roadway Data for Crossing: 1127+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 366.36 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 15

Hydrograph Report

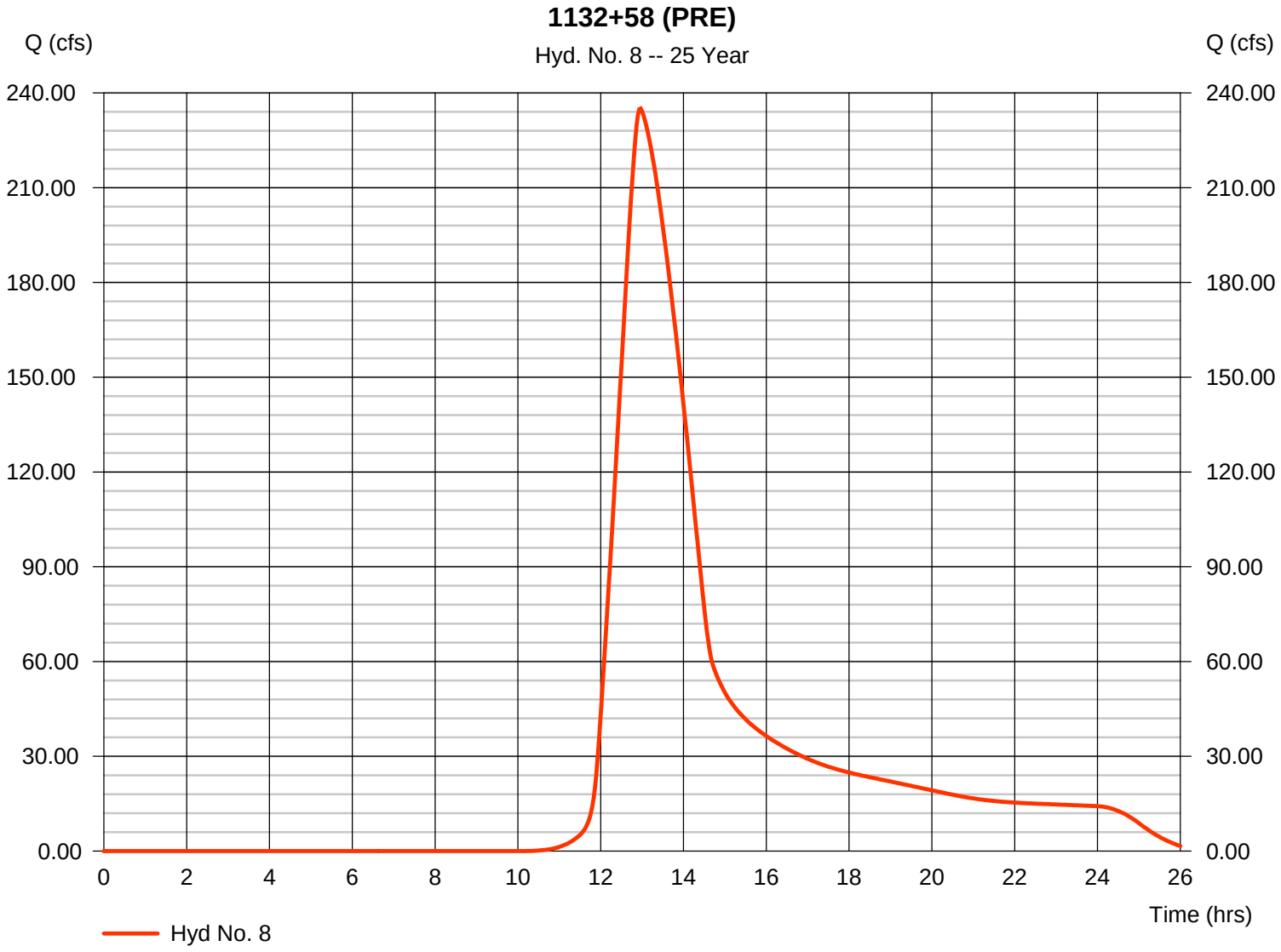
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 8

1132+58 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	235.06 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.97 hrs
Time interval	=	2 min	Hyd. volume	=	2,397,314 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



Hydrograph Report

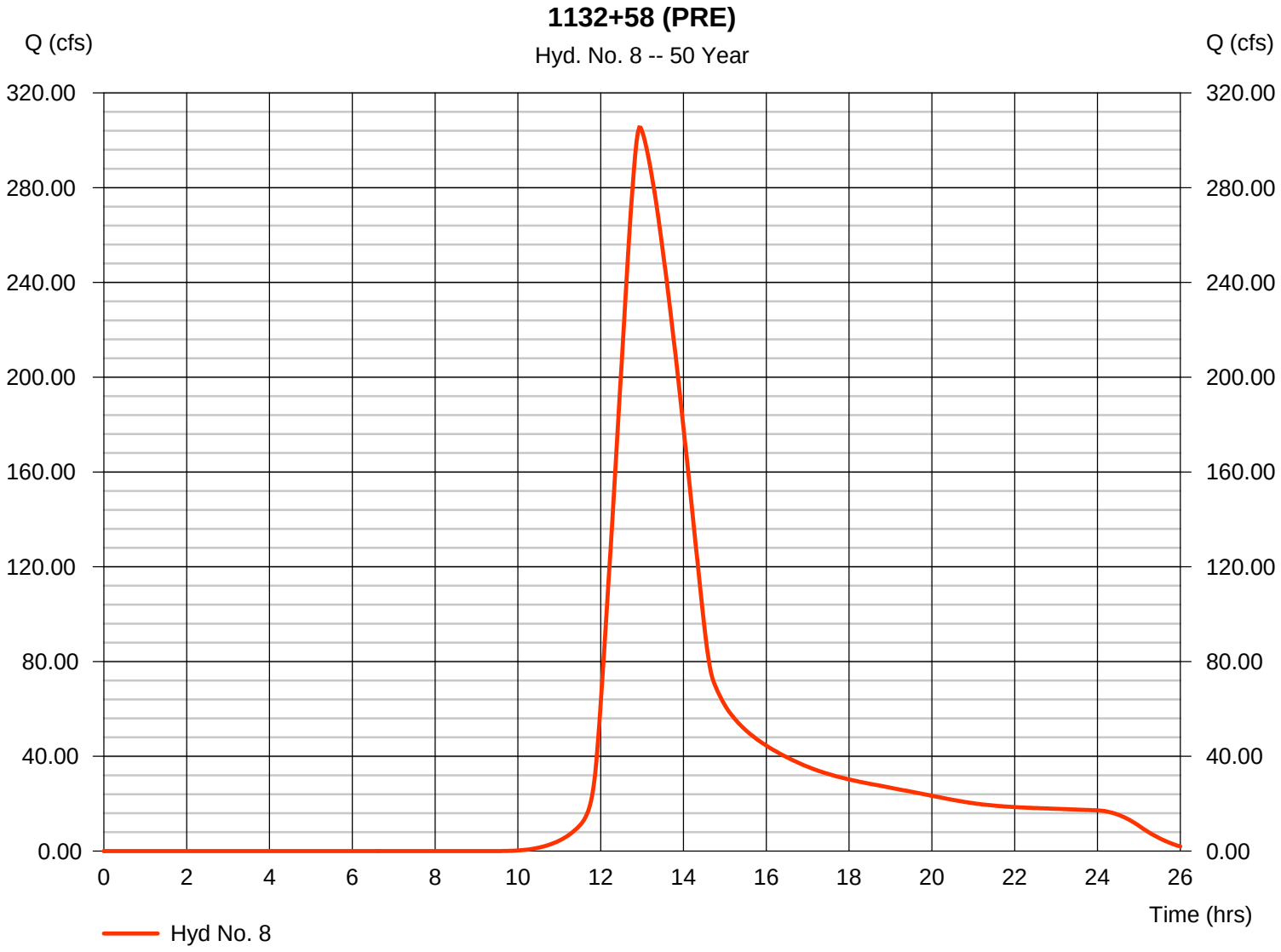
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 8

1132+58 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	305.37 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.93 hrs
Time interval	=	2 min	Hyd. volume	=	3,053,897 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



Hydrograph Report

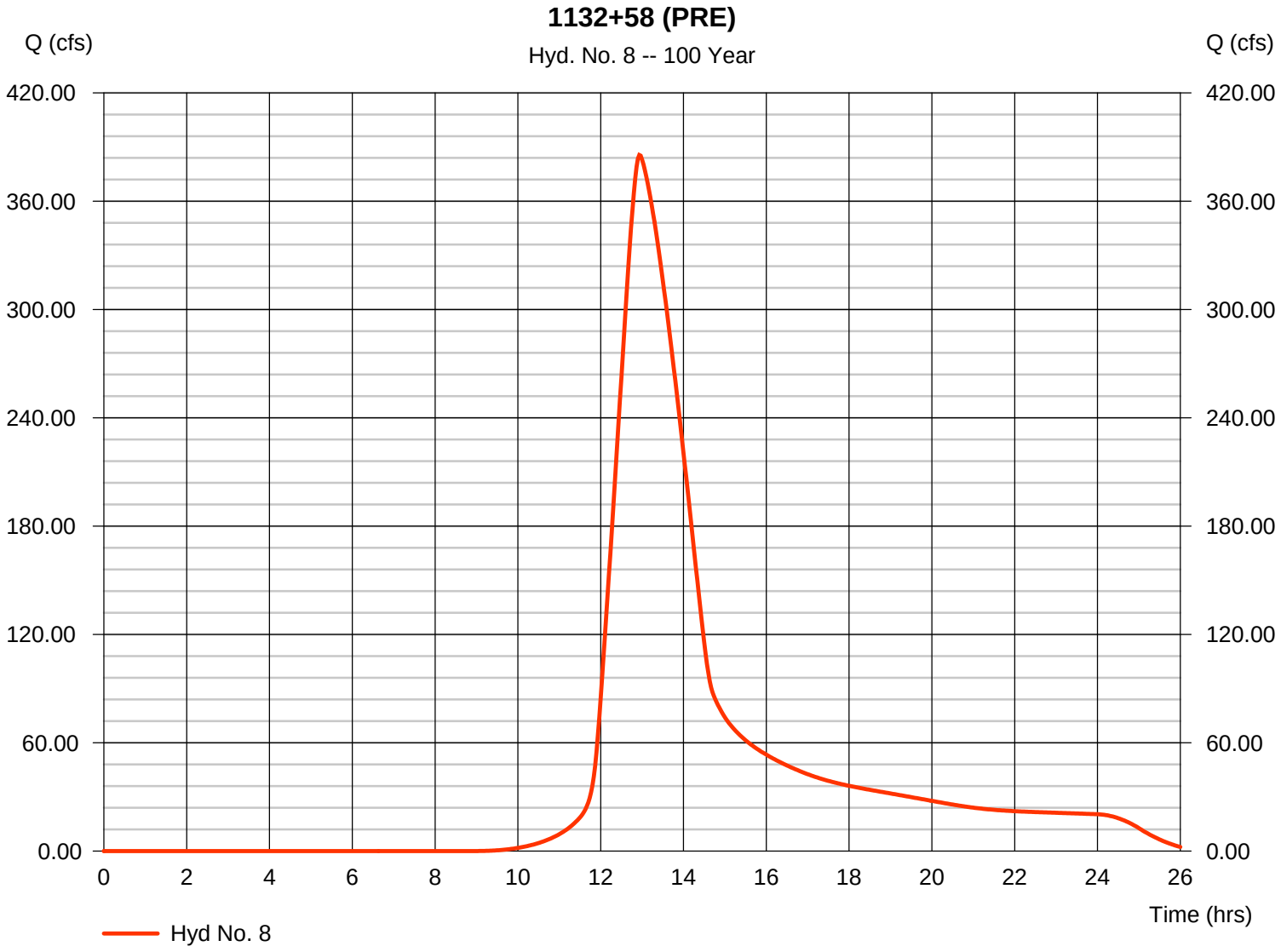
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 8

1132+58 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	385.63 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.93 hrs
Time interval	=	2 min	Hyd. volume	=	3,803,633 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



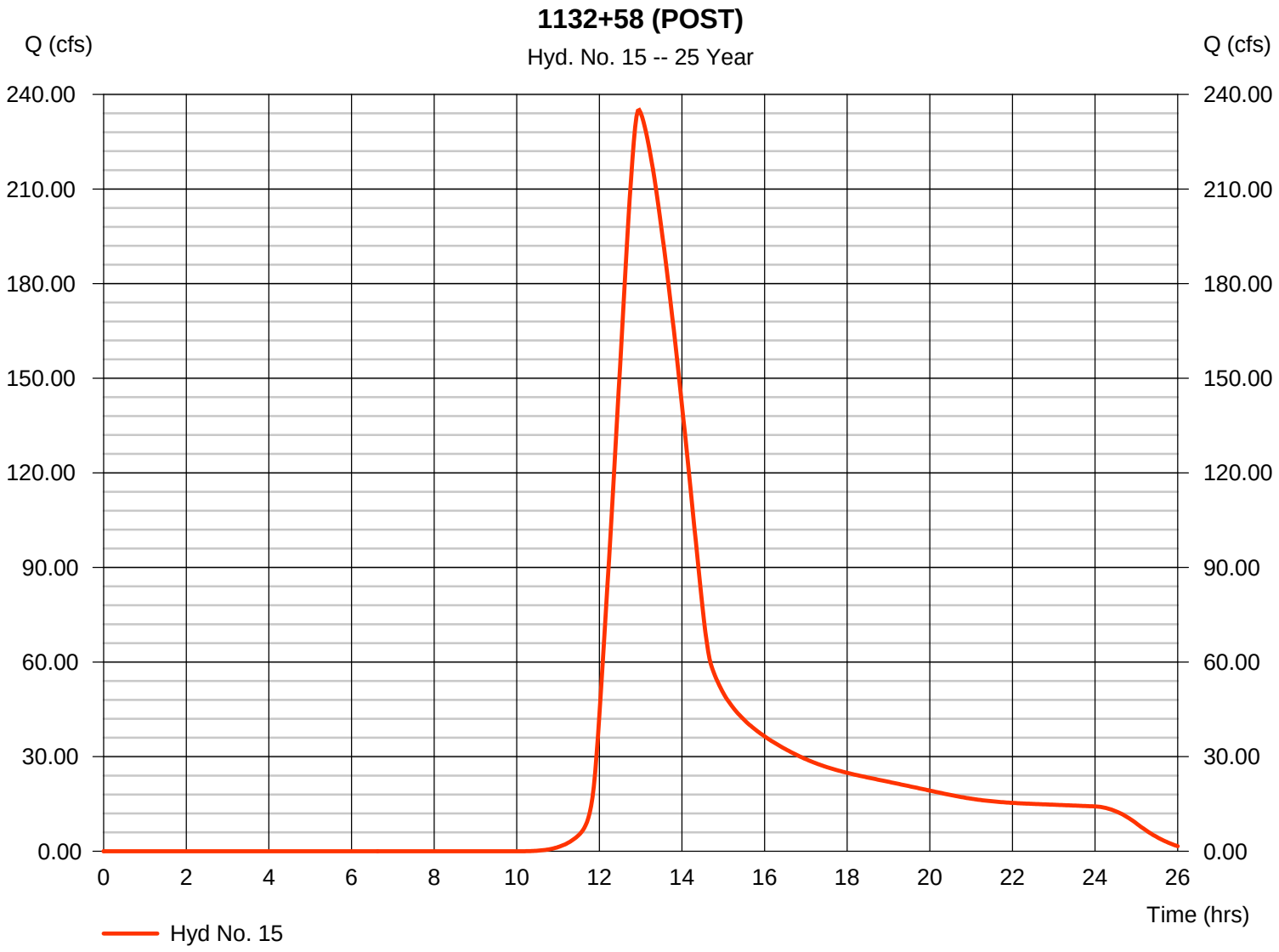
Hydrograph Report

Hyd. No. 15

1132+58 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	235.06 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.97 hrs
Time interval	=	2 min	Hyd. volume	=	2,397,314 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



Hydrograph Report

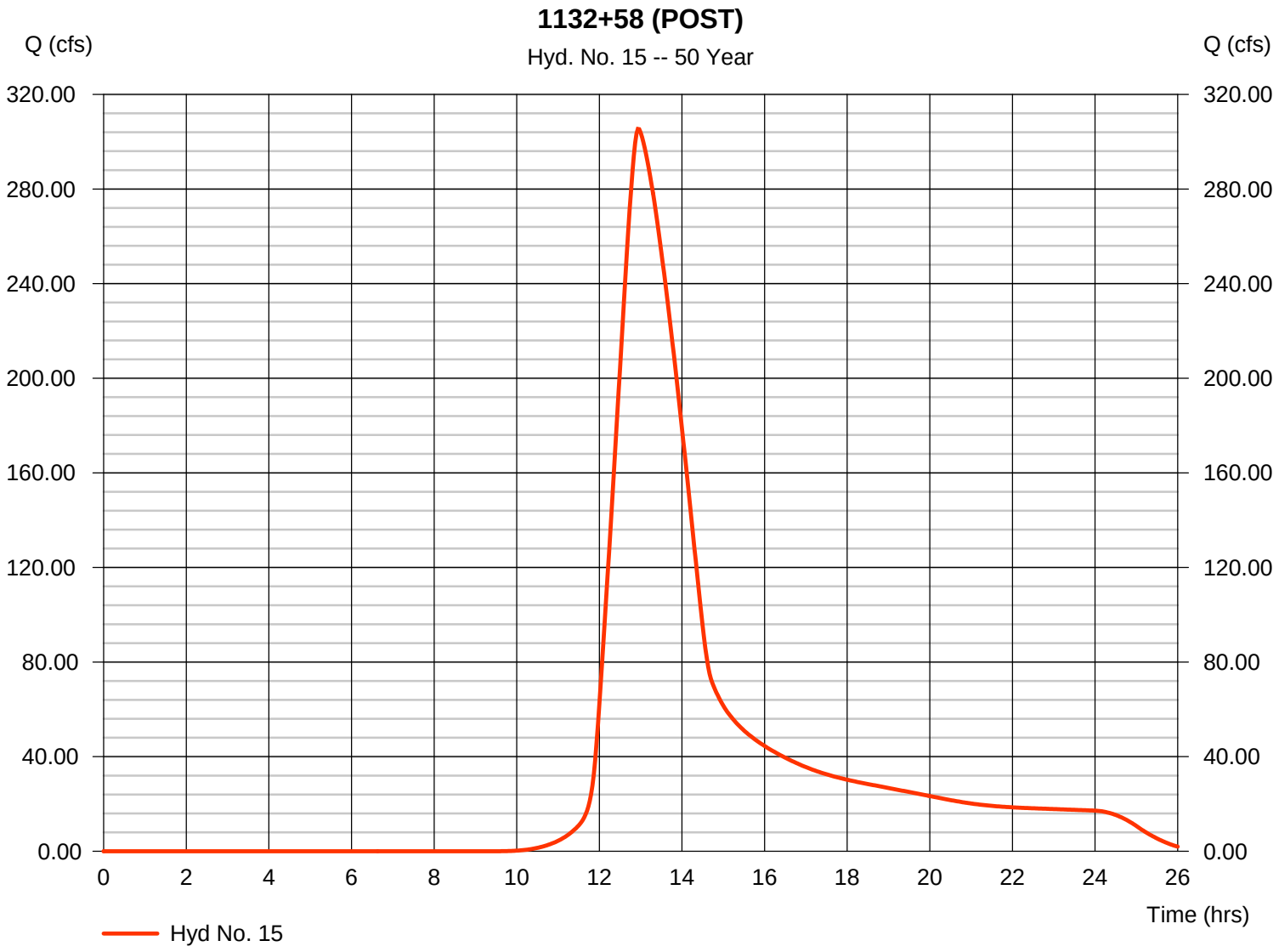
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 15

1132+58 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	305.37 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.93 hrs
Time interval	=	2 min	Hyd. volume	=	3,053,897 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



Hydrograph Report

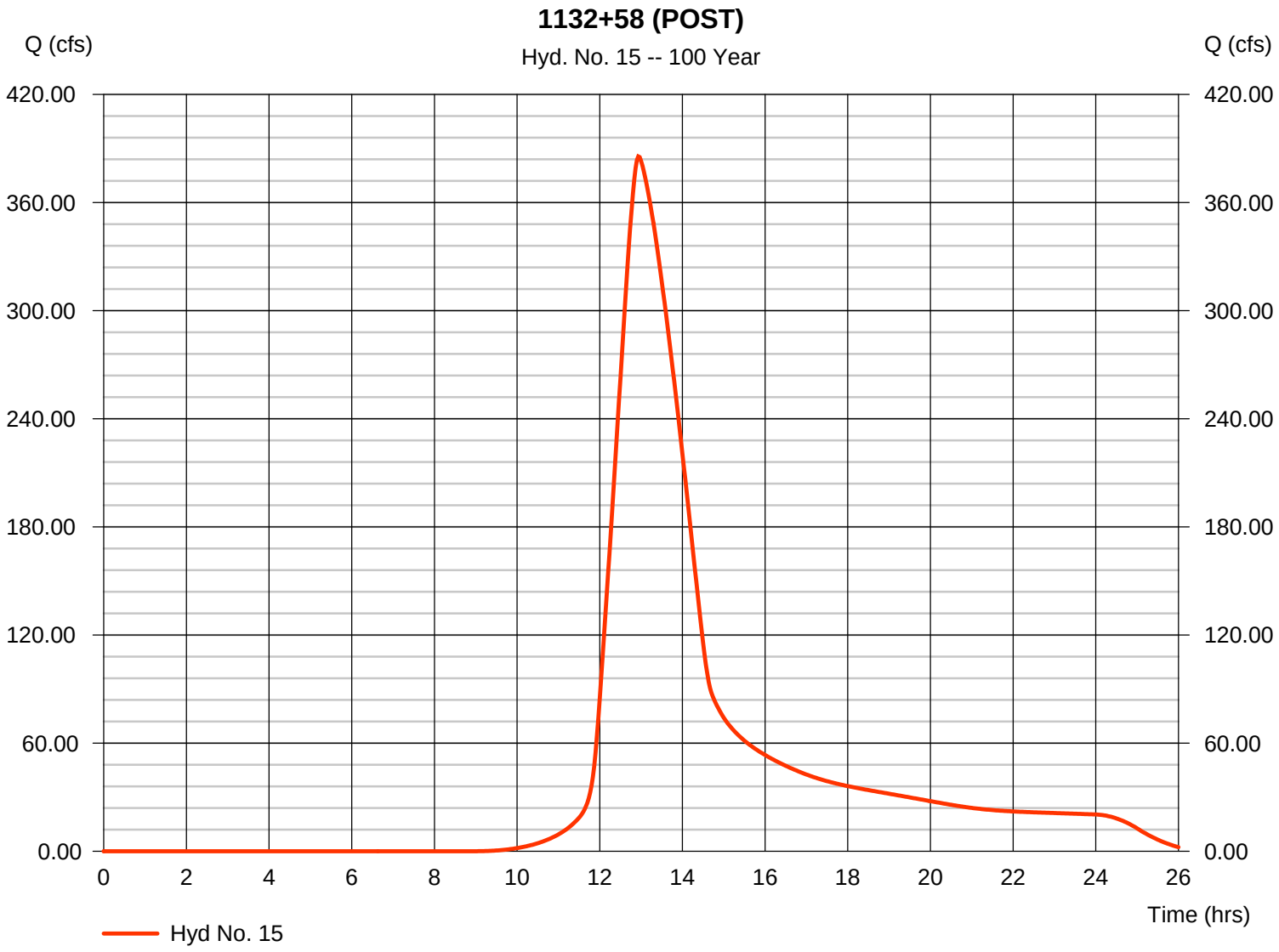
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 15

1132+58 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	385.63 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.93 hrs
Time interval	=	2 min	Hyd. volume	=	3,803,633 cuft
Drainage area	=	263.710 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	102.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(34.900 x 98) + (204.310 x 59) + (11.700 x 61) + (12.800 x 55)] / 263.710



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 235.06 cfs

Design Flow: 305.37 cfs

Maximum Flow: 385.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1132+58 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	7x7 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
344.68	235.06	235.06	0.00	1
344.89	250.12	250.12	0.00	1
345.10	265.17	265.17	0.00	1
345.30	280.23	280.23	0.00	1
345.50	295.29	295.29	0.00	1
345.63	305.37	305.37	0.00	1
345.89	325.40	325.40	0.00	1
346.08	340.46	340.46	0.00	1
346.27	355.52	355.52	0.00	1
346.46	370.57	370.57	0.00	1
346.65	385.63	385.63	0.00	1
360.00	1110.46	1110.46	0.00	Overtopping

Table 2 - Culvert Summary Table: 7x7 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
235.06	235.06	344.68	5.087	3.558	1-JS1t	2.452	3.272	4.441	4.441	7.562	3.333
250.12	250.12	344.89	5.300	3.767	1-JS1t	2.565	3.410	4.573	4.573	7.813	3.387
265.17	265.17	345.10	5.508	3.976	1-JS1t	2.676	3.545	4.701	4.701	8.058	3.439
280.23	280.23	345.30	5.712	4.186	1-JS1t	2.786	3.678	4.825	4.825	8.297	3.488
295.29	295.29	345.50	5.912	4.396	1-JS1t	2.895	3.809	4.945	4.945	8.531	3.536
305.37	305.37	345.63	6.044	4.538	1-JS1t	2.968	3.895	5.023	5.023	8.685	3.566
325.40	325.40	345.89	6.303	4.821	1-JS1t	3.110	4.064	5.174	5.174	8.984	3.625
340.46	340.46	346.08	6.494	5.035	1-JS1t	3.217	4.188	5.284	5.284	9.205	3.668
355.52	355.52	346.27	6.683	5.252	1-JS1t	3.322	4.311	5.391	5.391	9.421	3.709
370.57	370.57	346.46	6.871	5.470	1-JS1t	3.427	4.432	5.495	5.495	9.633	3.748
385.63	385.63	346.65	7.058	5.691	5-JS1t	3.531	4.551	5.597	5.597	9.842	3.787

****

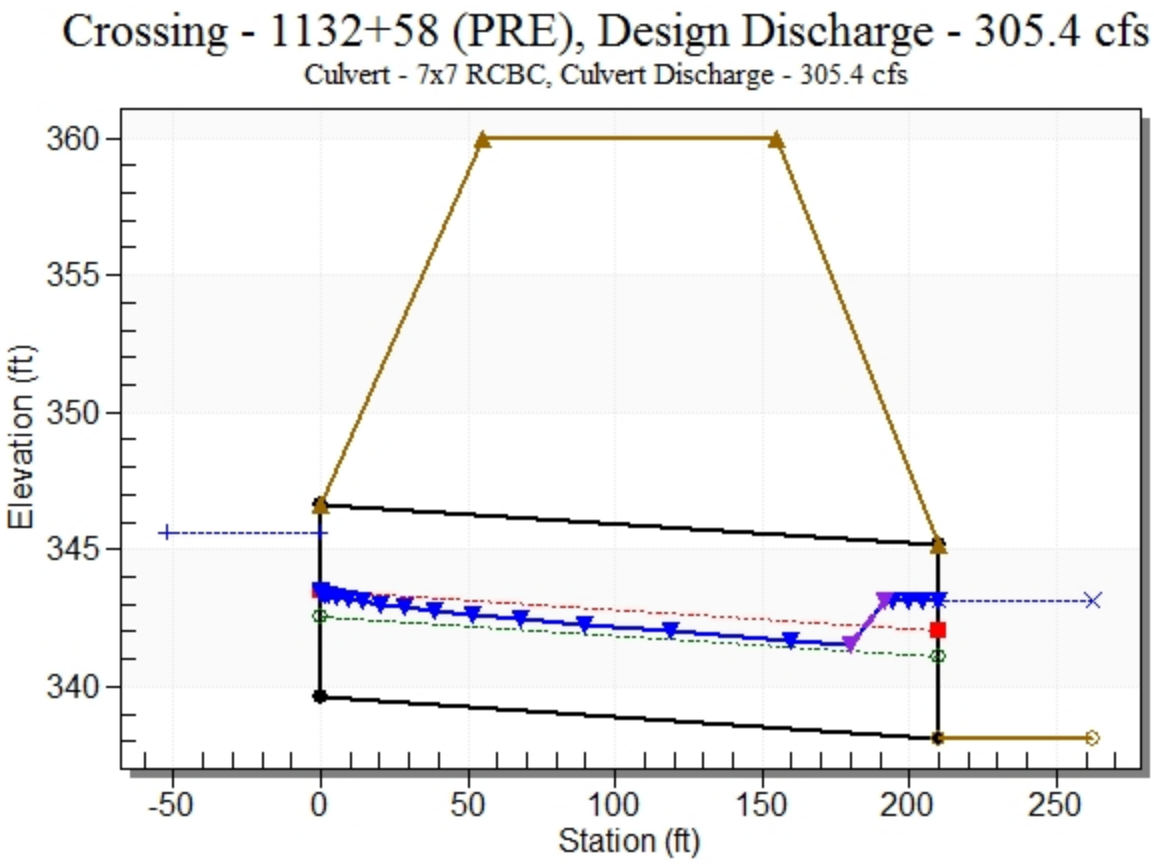
Straight Culvert

Inlet Elevation (invert): 339.59 ft, Outlet Elevation (invert): 338.13 ft

Culvert Length: 210.01 ft, Culvert Slope: 0.0070

****

Water Surface Profile Plot for Culvert: 7x7 RCBC



Site Data - 7x7 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 339.59 ft

Outlet Station: 210.00 ft

Outlet Elevation: 338.13 ft

Number of Barrels: 1

Culvert Data Summary - 7x7 RCBC

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1132+58 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
235.06	342.57	4.44	3.33	1.39	0.35
250.12	342.70	4.57	3.39	1.43	0.35
265.17	342.83	4.70	3.44	1.47	0.35
280.23	342.95	4.82	3.49	1.51	0.35
295.29	343.07	4.94	3.54	1.54	0.35
305.37	343.15	5.02	3.57	1.57	0.35
325.40	343.30	5.17	3.63	1.61	0.35
340.46	343.41	5.28	3.67	1.65	0.36
355.52	343.52	5.39	3.71	1.68	0.36
370.57	343.63	5.50	3.75	1.71	0.36
385.63	343.73	5.60	3.79	1.75	0.36

Tailwater Channel Data - 1132+58 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 7.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0600

Channel Invert Elevation: 338.13 ft

Roadway Data for Crossing: 1132+58 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 360.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 235.06 cfs

Design Flow: 305.37 cfs

Maximum Flow: 385.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1132+58 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	7x7 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
344.68	235.06	235.06	0.00	1
344.89	250.12	250.12	0.00	1
345.10	265.17	265.17	0.00	1
345.30	280.23	280.23	0.00	1
345.50	295.29	295.29	0.00	1
345.63	305.37	305.37	0.00	1
345.89	325.40	325.40	0.00	1
346.08	340.46	340.46	0.00	1
346.27	355.52	355.52	0.00	1
346.46	370.57	370.57	0.00	1
346.65	385.63	385.63	0.00	1
360.00	1110.46	1110.46	0.00	Overtopping

Table 2 - Culvert Summary Table: 7x7 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
235.06	235.06	344.68	5.087	3.558	1-JS1t	2.452	3.272	4.441	4.441	7.562	3.333
250.12	250.12	344.89	5.300	3.767	1-JS1t	2.565	3.410	4.573	4.573	7.813	3.387
265.17	265.17	345.10	5.508	3.976	1-JS1t	2.676	3.545	4.701	4.701	8.058	3.439
280.23	280.23	345.30	5.712	4.186	1-JS1t	2.786	3.678	4.825	4.825	8.297	3.488
295.29	295.29	345.50	5.912	4.396	1-JS1t	2.895	3.809	4.945	4.945	8.531	3.536
305.37	305.37	345.63	6.044	4.538	1-JS1t	2.968	3.895	5.023	5.023	8.685	3.566
325.40	325.40	345.89	6.303	4.821	1-JS1t	3.110	4.064	5.174	5.174	8.984	3.625
340.46	340.46	346.08	6.494	5.035	1-JS1t	3.217	4.188	5.284	5.284	9.205	3.668
355.52	355.52	346.27	6.683	5.252	1-JS1t	3.322	4.311	5.391	5.391	9.421	3.709
370.57	370.57	346.46	6.871	5.470	1-JS1t	3.427	4.432	5.495	5.495	9.633	3.748
385.63	385.63	346.65	7.058	5.691	5-JS1t	3.531	4.551	5.597	5.597	9.842	3.787

****

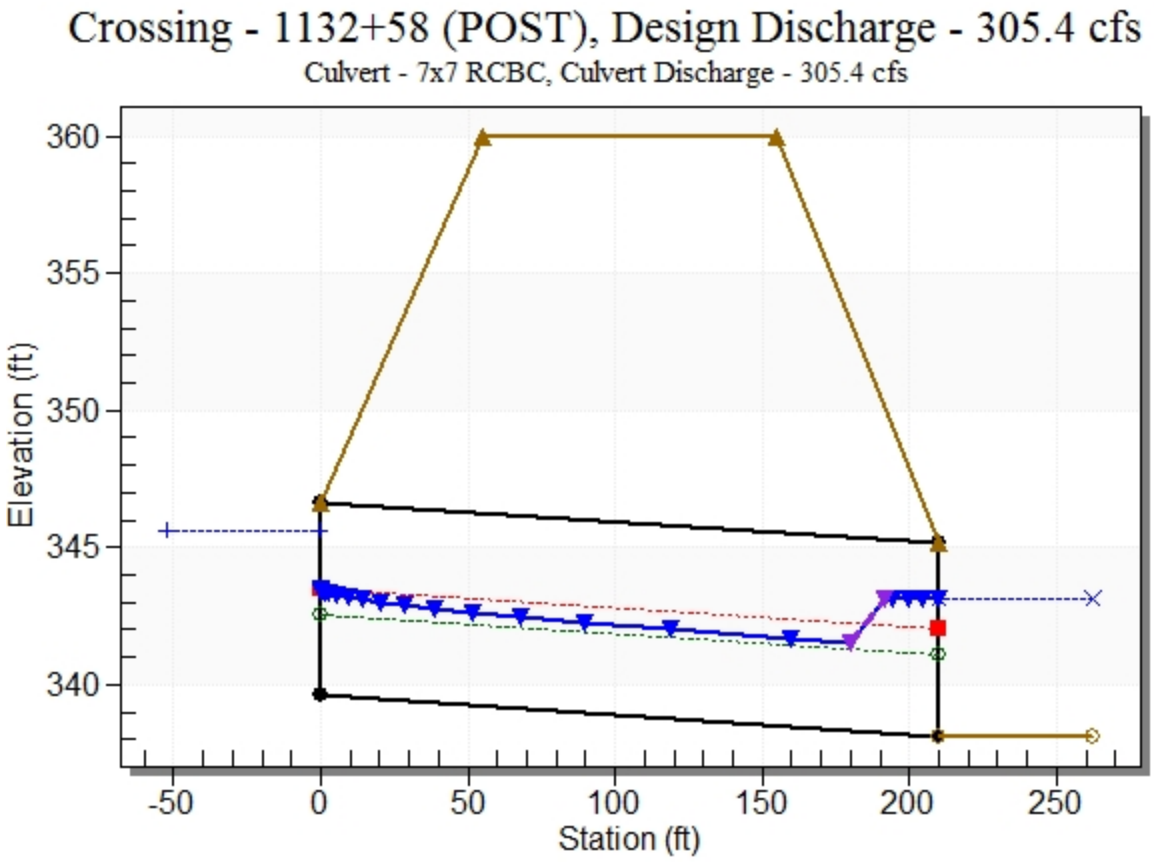
Straight Culvert

Inlet Elevation (invert): 339.59 ft, Outlet Elevation (invert): 338.13 ft

Culvert Length: 210.01 ft, Culvert Slope: 0.0070

****

Water Surface Profile Plot for Culvert: 7x7 RCBC



Site Data - 7x7 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 339.59 ft

Outlet Station: 210.00 ft

Outlet Elevation: 338.13 ft

Number of Barrels: 1

Culvert Data Summary - 7x7 RCBC

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1132+58 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
235.06	342.57	4.44	3.33	1.39	0.35
250.12	342.70	4.57	3.39	1.43	0.35
265.17	342.83	4.70	3.44	1.47	0.35
280.23	342.95	4.82	3.49	1.51	0.35
295.29	343.07	4.94	3.54	1.54	0.35
305.37	343.15	5.02	3.57	1.57	0.35
325.40	343.30	5.17	3.63	1.61	0.35
340.46	343.41	5.28	3.67	1.65	0.36
355.52	343.52	5.39	3.71	1.68	0.36
370.57	343.63	5.50	3.75	1.71	0.36
385.63	343.73	5.60	3.79	1.75	0.36

Tailwater Channel Data - 1132+58 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 7.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0600

Channel Invert Elevation: 338.13 ft

Roadway Data for Crossing: 1132+58 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 360.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 90

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 90a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3861
Grass	0.25	0.19	0.0466
Woods	0.15	0.45	0.0675
	Σ	**1.07**	0.5002

$C_{ave} = \frac{0.5002}{1.07} = 0.47$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.57	0.5166
Grass	0.25	0.19	0.0466
Woods	0.15	0.45	0.0675
	Σ	**1.21**	0.6307

$C_{ave} = \frac{0.6307}{1.21} = 0.52$

T_c =	35.67	min.
I_{05} =	3.46	in / hr
I_{10} =	3.80	in / hr
I_{25} =	4.31	in / hr
I_{50} =	4.70	in / hr
I_{100} =	5.08	in / hr

Pre Construction Runoff:

Q_{05} =	0.47	x	3.46	x	1.07	x	1	=	**1.73**	cfs
Q_{10} =	0.47	x	3.80	x	1.07	x	1	=	**1.90**	cfs
Q_{25} =	0.47	x	4.31	x	1.07	x	1.1	=	**2.37**	cfs
Q_{50} =	0.47	x	4.70	x	1.07	x	1.2	=	**2.82**	cfs
Q_{100} =	0.47	x	5.08	x	1.07	x	1.25	=	**3.18**	cfs

Post Construction Runoff:

Q_{05} =	0.52	x	3.46	x	1.21	x	1	=	**2.18**	cfs
Q_{10} =	0.52	x	3.80	x	1.21	x	1	=	**2.40**	cfs
Q_{25} =	0.52	x	4.31	x	1.21	x	1.1	=	**2.99**	cfs
Q_{50} =	0.52	x	4.70	x	1.21	x	1.2	=	**3.56**	cfs
Q_{100} =	0.52	x	5.08	x	1.21	x	1.25	=	**4.00**	cfs

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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 90b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.40	0.3616
Grass	0.25	0.47	0.1179
Woods	0.15	0.00	0.0000
	Σ	**0.87**	0.4795

$C_{ave} = \frac{0.4795}{0.87} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.47	0.4244
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.47**	0.4244

$C_{ave} = \frac{0.4244}{0.47} = 0.90$

T_c =	5.00 min.
I_{05} =	6.32 in / hr
I_{10} =	7.04 in / hr
I_{25} =	8.10 in / hr
I_{50} =	8.95 in / hr
I_{100} =	9.80 in / hr

Pre Construction Runoff:

Q_{05} =	0.55	x	6.32	x	0.87	x	1	=	**3.03**	cfs
Q_{10} =	0.55	x	7.04	x	0.87	x	1	=	**3.38**	cfs
Q_{25} =	0.55	x	8.10	x	0.87	x	1.1	=	**4.27**	cfs
Q_{50} =	0.55	x	8.95	x	0.87	x	1.2	=	**5.15**	cfs
Q_{100} =	0.55	x	9.80	x	0.87	x	1.25	=	**5.88**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.47	x	1	=	**2.68**	cfs
Q_{10} =	0.90	x	7.04	x	0.47	x	1	=	**2.99**	cfs
Q_{25} =	0.90	x	8.10	x	0.47	x	1.1	=	**3.78**	cfs
Q_{50} =	0.90	x	8.95	x	0.47	x	1.2	=	**4.56**	cfs
Q_{100} =	0.90	x	9.80	x	0.47	x	1.25	=	**5.20**	cfs

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(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 90c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.35	0.3160
Grass	0.25	0.24	0.0601
Woods	0.15	1.41	0.2117
	Σ	**2.00**	0.5878

$C_{ave} = \frac{0.5878}{2.00} =$ **0.29**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.54	0.4842
Grass	0.25	0.24	0.0601
Woods	0.15	1.41	0.2117
	Σ	**2.19**	0.7560

$C_{ave} = \frac{0.7560}{2.19} =$ **0.35**

T_c =	30.35 min.
I_{05} =	3.76 in / hr
I_{10} =	4.13 in / hr
I_{25} =	4.69 in / hr
I_{50} =	5.12 in / hr
I_{100} =	5.54 in / hr

Pre Construction Runoff:

Q_{05} =	0.29	x	3.76	x	2.00	x	1	=	**2.21**	cfs
Q_{10} =	0.29	x	4.13	x	2.00	x	1	=	**2.43**	cfs
Q_{25} =	0.29	x	4.69	x	2.00	x	1.1	=	**3.03**	cfs
Q_{50} =	0.29	x	5.12	x	2.00	x	1.2	=	**3.61**	cfs
Q_{100} =	0.29	x	5.54	x	2.00	x	1.25	=	**4.07**	cfs

Post Construction Runoff:

Q_{05} =	0.35	x	3.76	x	2.19	x	1	=	**2.84**	cfs
Q_{10} =	0.35	x	4.13	x	2.19	x	1	=	**3.13**	cfs
Q_{25} =	0.35	x	4.69	x	2.19	x	1.1	=	**3.90**	cfs
Q_{50} =	0.35	x	5.12	x	2.19	x	1.2	=	**4.64**	cfs
Q_{100} =	0.35	x	5.54	x	2.19	x	1.25	=	**5.24**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 90a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**100**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.005**	+		=	**0.005**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.595**
							min	**35.67**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 90c Checked _____ Date _____

Circle one: Present Developed
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)	----------			Woods				
2 Manning's roughness coeff., n (table 3-1)	----------			**0.800**				
3 Flow length, L (total L < or = 100)	----------		ft	**100**				
4 Two-yr 24-hr rainfall, P_2	----------		in	**3.58**				
5 Land slope, s	----------		ft/ft	**0.0300**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)	----------			unpaved				
8 Flow length, L	----------		ft	**90**				
9 Watercourse slope, s	----------		ft/ft	**0.1000**				
10 Average velocity, V (figure 3-1)	----------		ft/s	**5.10**				
11 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**0.005**	+		=	**0.005**
Channel Flow			Segment ID					
Front Slope, (_ : 1)	----------							
Back Slope, (_ : 1)	----------							
Bottom Width	----------		ft					
Flow Depth	----------		ft					
12 Cross sectional flow area, a	----------		ft^2	**0.00**		**0.00**		
13 Wetted perimeter, p_w	----------		ft	**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	----------	ft	**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s	----------		ft/ft					
16 Manning's roughness coeff., n	----------							
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18 Flow length, L	----------		ft					
19 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------				hr	**0.506**
							min	**30.35**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-90		Outlet	OP	359.95	359.95	0.00	0.48	0.00	36.14	0.00	3.94	0.40	0.00
CB-90c		Other	C.B. TYPE 112	366.19	366.19	2.86	0.30	35.98	35.98	8.85	3.94	0.40	4.71
CB-90b		Other	C.B. TYPE 112	369.73	369.73	3.15	0.03	35.85	35.85	5.55	1.94	0.50	4.72
CB-90a		Other	C.B. TYPE 112	370.95	370.95	3.27	0.00	35.67	35.67	2.85	1.07	0.47	4.73

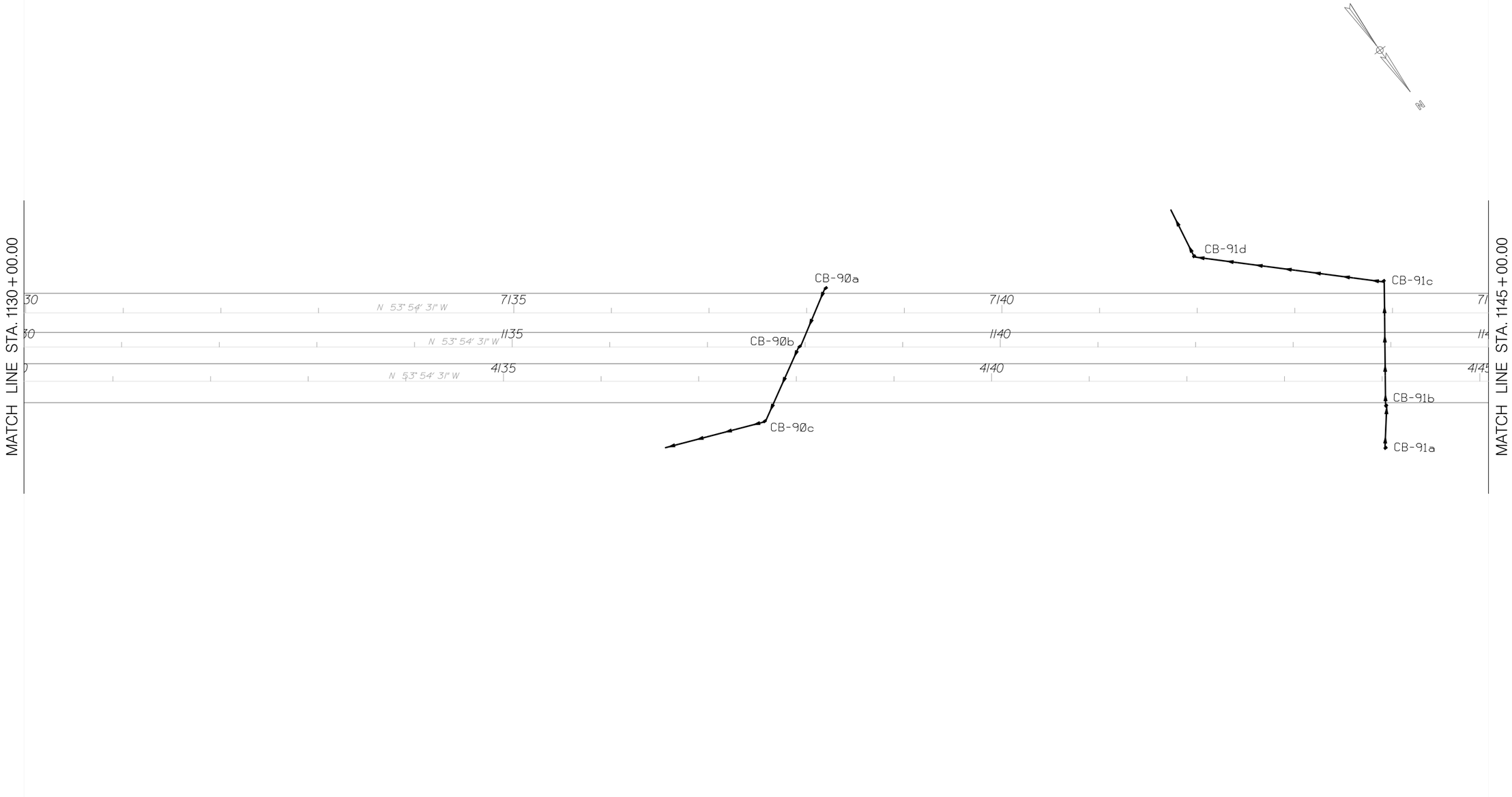
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-13	CB-90c	OF-90	Circular	Concrete	1	1.50	104	3.24	8.85	22.03	0.69	11.17	364.83	364.83	361.45	360.65	363.33	359.95	5.01	10.96	1.50	0.70
NP-12	CB-90b	CB-90c	Circular	Concrete	1	1.50	82	3.68	5.55	23.48	0.52	10.31	368.08	367.63	365.07	364.09	366.58	363.57	4.22	10.13	1.05	0.52
NP-11	CB-90a	CB-90b	Circular	Concrete	1	1.50	63	1.49	2.85	14.96	0.46	6.19	369.18	368.60	368.24	367.20	367.68	366.74	2.51	6.13	0.92	0.46

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-90c	30.35	3.63	5.16	0.29	2.00	0.29	2.00	0.00	0.00
CB-90b	5.00	5.17	9.03	0.55	0.87	0.55	0.87	0.00	0.00
CB-90a	35.67	2.85	4.73	0.47	1.07	0.47	1.07	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	4.3



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

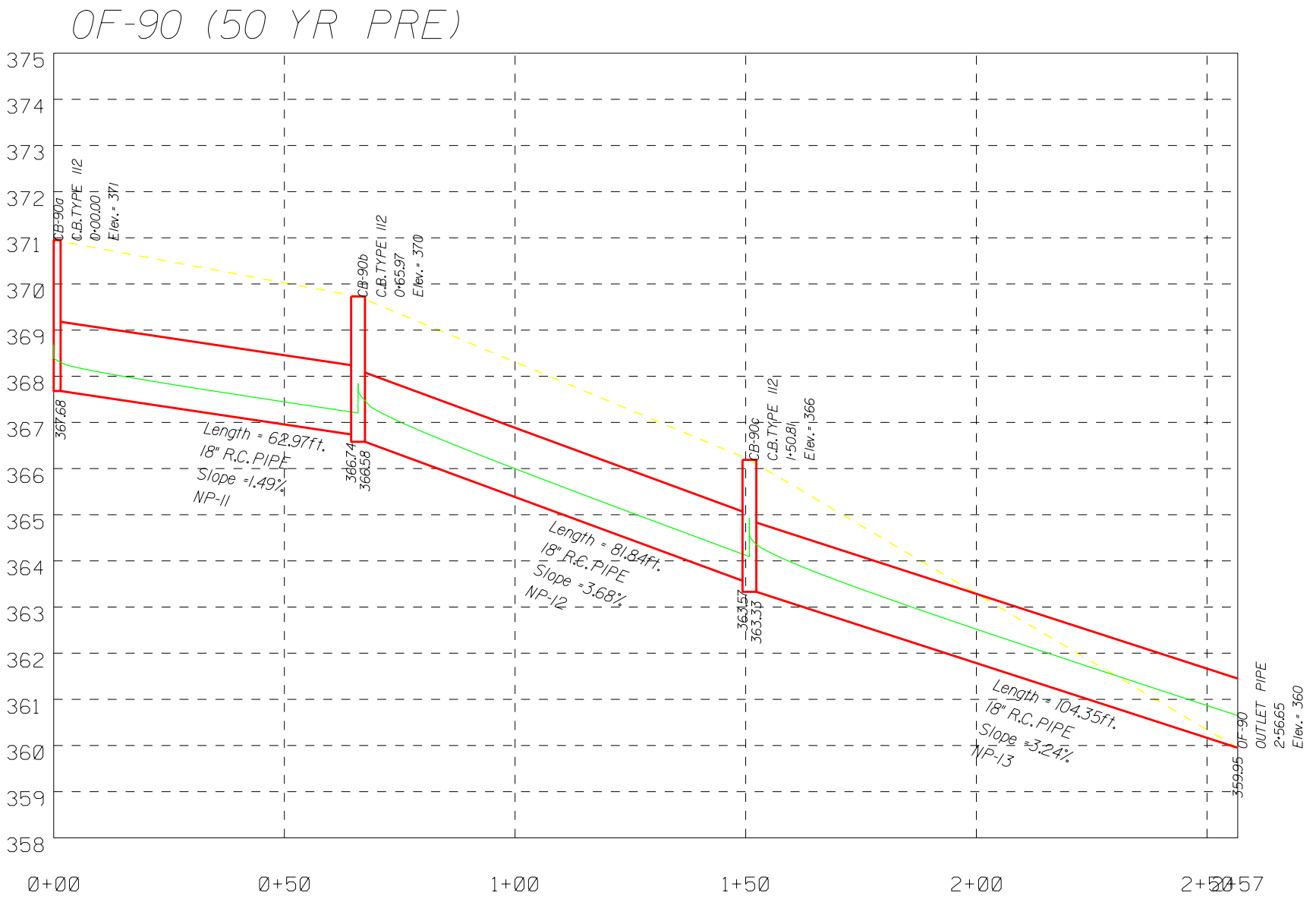
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1130+00.00 TO STA. 1145+00.00

$$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-90 (50 YR PRE)
375
374
373
372
371
370
369
368
367
366
365
364
363
362
361
360
359
358
0+00
0+50
1+00
1+50
2+00
2+50
CB-90a
C.B.TYPE 1\2
0+00.00
Elev.= 371
367.68
CB-90b
C.B.TYPE1 1\2
0+65.97
Elev.= 370
366.74
366.58
CB-90c
C.B.TYPE 1\2
1+50.81
Elev.= 366
363.57
363.33
Length = 62.97ft.
18" R.C. PIPE
Slope =1.49%
NP-11
Length = 81.84ft.
18" R.C. PIPE
Slope =3.68%
NP-12
Length = 104.35ft.
18" R.C. PIPE
Slope =3.24%
NP-13
359.95
OF-90
OUTLET PIPE
2+56.65
Elev.= 360
2+57

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

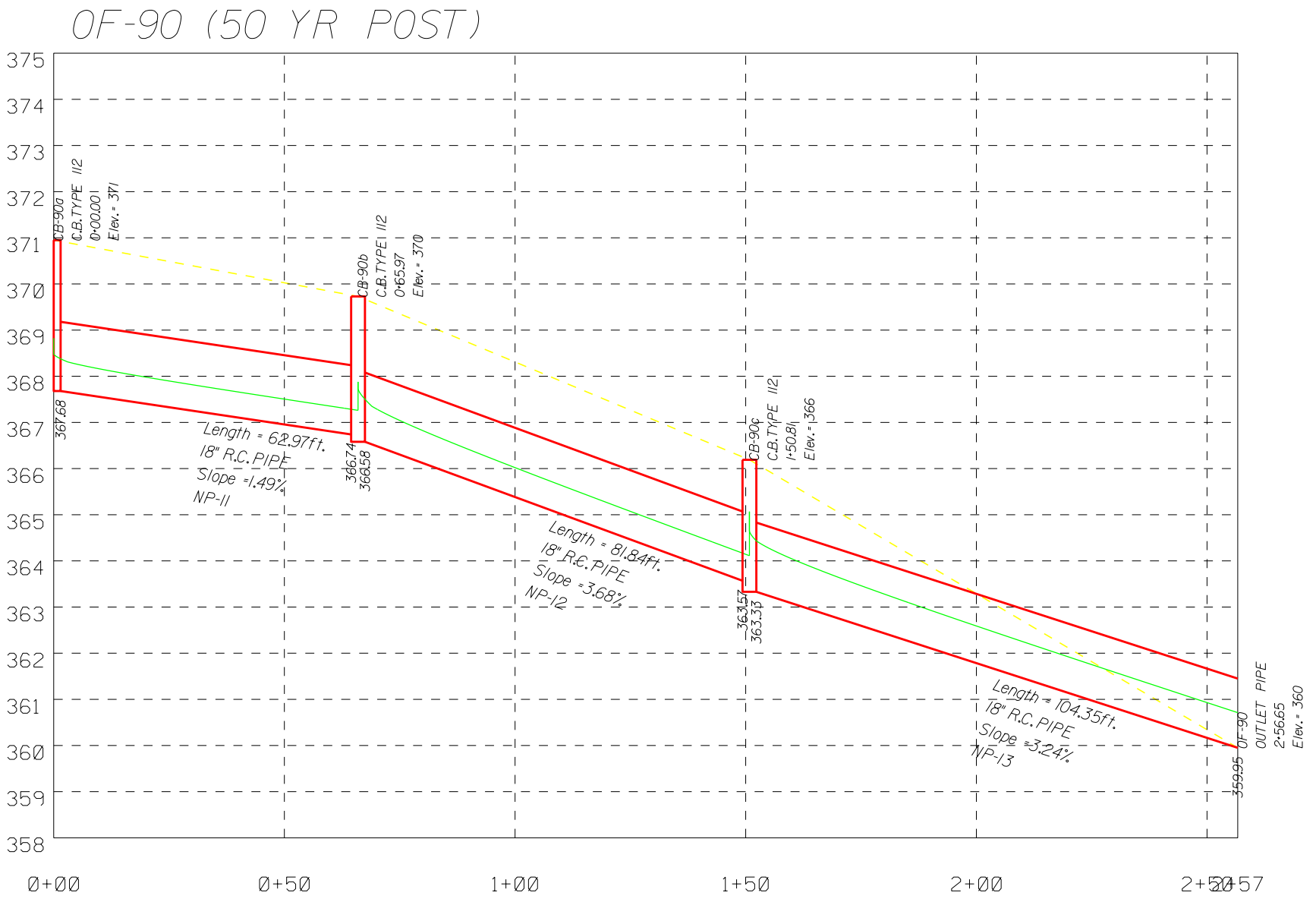
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-90	Outlet	OP	359.95	359.95	0.00	0.48	0.00	36.12	0.00	4.27	0.42	0.00
CB-90c	Other	C.B. TYPE 112	366.19	366.19	2.86	0.36	35.97	35.97	10.22	4.27	0.42	4.71
CB-90b	Other	C.B. TYPE 112	369.73	369.73	3.15	0.03	35.84	35.84	5.95	2.08	0.51	4.72
CB-90a	Other	C.B. TYPE 112	370.95	370.95	3.27	0.00	35.67	35.67	3.57	1.21	0.52	4.73

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-13	CB-90c	OF-90	Circular	Concrete	1	1.50	104	3.24	10.22	22.03	0.75	11.58	364.83	364.97	361.45	360.71	363.33	359.95	5.78	11.34	1.50	0.76
NP-12	CB-90b	CB-90c	Circular	Concrete	1	1.50	82	3.68	5.95	23.48	0.53	10.53	368.08	367.66	365.07	364.11	366.58	363.57	4.38	10.31	1.08	0.54
NP-11	CB-90a	CB-90b	Circular	Concrete	1	1.50	63	1.49	3.57	14.96	0.52	6.58	369.18	368.74	368.24	367.26	367.68	366.74	2.68	6.50	1.06	0.52

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-90c	30.35	4.69	5.16	0.35	2.19	0.35	2.19	0.00	0.00
CB-90b	5.00	4.58	9.03	0.49	0.87	0.90	0.47	0.00	0.40
CB-90a	35.67	3.57	4.73	0.52	1.21	0.52	1.21	0.00	0.00


OF-90 (50 YR POST)
375
374
373
372
371
370
369
368
367
366
365
364
363
362
361
360
359
358
0+00
0+50
1+00
1+50
2+00
2+50
20+57
CB-90a
C.B.TYPE II/2
0+00.00
Elev.= 371
367.68
CB-90b
C.B.TYPE I II/2
0+65.97
Elev.= 370
366.74
366.58
CB-90c
C.B.TYPE II/2
1+50.81
Elev.= 366
363.57
363.33
Length = 62.97ft.
18" R.C. PIPE
Slope =1.49%
NP-II
Length = 81.84ft.
18" R.C. PIPE
Slope =3.68%
NP-12
Length = 104.35ft.
18" R.C. PIPE
Slope =3.24%
NP-13
359.95
OF-90
OUTLET PIPE
2+56.65
Elev.= 360

CULVERT 91

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 91a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.00	0.0000
Woods	0.15	0.99	0.1490
	Σ	**0.99**	0.1490

$C_{ave} = \frac{0.1490}{0.99} = 0.15$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.00	0.0000
Woods	0.15	0.99	0.1490
	Σ	**0.99**	0.1490

$C_{ave} = \frac{0.1490}{0.99} = 0.15$

T_c =	31.52	min.								
I_{05} =	3.69	in / hr								
I_{10} =	4.06	in / hr								
I_{25} =	4.60	in / hr								
I_{50} =	5.02	in / hr								
I_{100} =	5.43	in / hr								

Pre Construction Runoff:

Q_{05} =	0.15	**x**	3.69	**x**	0.99	**x**	1	=	**0.55**	cfs
Q_{10} =	0.15	**x**	4.06	**x**	0.99	**x**	1	=	**0.60**	cfs
Q_{25} =	0.15	**x**	4.60	**x**	0.99	**x**	1.1	=	**0.75**	cfs
Q_{50} =	0.15	**x**	5.02	**x**	0.99	**x**	1.2	=	**0.90**	cfs
Q_{100} =	0.15	**x**	5.43	**x**	0.99	**x**	1.25	=	**1.01**	cfs

Post Construction Runoff:

Q_{05} =	0.15	**x**	3.69	**x**	0.99	**x**	1	=	**0.55**	cfs
Q_{10} =	0.15	**x**	4.06	**x**	0.99	**x**	1	=	**0.60**	cfs
Q_{25} =	0.15	**x**	4.60	**x**	0.99	**x**	1.1	=	**0.75**	cfs
Q_{50} =	0.15	**x**	5.02	**x**	0.99	**x**	1.2	=	**0.90**	cfs
Q_{100} =	0.15	**x**	5.43	**x**	0.99	**x**	1.25	=	**1.01**	cfs

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Columbia, South Carolina 29201
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 91b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.06	0.0561
Grass	0.25	0.04	0.0093
Woods	0.15	0.16	0.0247
	Σ	**0.26**	0.0901

$C_{ave} = \frac{0.0901}{0.26} = 0.34$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.10	0.0872
Grass	0.25	0.04	0.0093
Woods	0.15	0.16	0.0247
	Σ	**0.30**	0.1212

$C_{ave} = \frac{0.1212}{0.30} = 0.41$

T_c =	15.75 min.
I_{05} =	4.91 in / hr
I_{10} =	5.43 in / hr
I_{25} =	6.19 in / hr
I_{50} =	6.79 in / hr
I_{100} =	7.39 in / hr

Pre Construction Runoff:

Q_{05} =	0.34	x	4.91	x	0.26	x	1	=	**0.44**	cfs
Q_{10} =	0.34	x	5.43	x	0.26	x	1	=	**0.49**	cfs
Q_{25} =	0.34	x	6.19	x	0.26	x	1.1	=	**0.61**	cfs
Q_{50} =	0.34	x	6.79	x	0.26	x	1.2	=	**0.73**	cfs
Q_{100} =	0.34	x	7.39	x	0.26	x	1.25	=	**0.83**	cfs

Post Construction Runoff:

Q_{05} =	0.41	x	4.91	x	0.30	x	1	=	**0.59**	cfs
Q_{10} =	0.41	x	5.43	x	0.30	x	1	=	**0.66**	cfs
Q_{25} =	0.41	x	6.19	x	0.30	x	1.1	=	**0.83**	cfs
Q_{50} =	0.41	x	6.79	x	0.30	x	1.2	=	**0.99**	cfs
Q_{100} =	0.41	x	7.39	x	0.30	x	1.25	=	**1.12**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 91c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.09	0.0774
Grass	0.25	0.04	0.0104
Woods	0.15	0.65	0.0970
	Σ	**0.77**	0.1848

$C_{ave} = \frac{0.1848}{0.77} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.11	0.0953
Grass	0.25	0.04	0.0104
Woods	0.15	0.65	0.0970
	Σ	**0.79**	0.2027

$C_{ave} = \frac{0.2027}{0.79} = 0.26$

T_c =	31.26	min.
I_{05} =	3.70	in / hr
I_{10} =	4.07	in / hr
I_{25} =	4.62	in / hr
I_{50} =	5.04	in / hr
I_{100} =	5.46	in / hr

Pre Construction Runoff:

Q_{05} =	0.24	x	3.70	x	0.77	x	1	=	**0.68**	cfs
Q_{10} =	0.24	x	4.07	x	0.77	x	1	=	**0.75**	cfs
Q_{25} =	0.24	x	4.62	x	0.77	x	1.1	=	**0.94**	cfs
Q_{50} =	0.24	x	5.04	x	0.77	x	1.2	=	**1.12**	cfs
Q_{100} =	0.24	x	5.46	x	0.77	x	1.25	=	**1.26**	cfs

Post Construction Runoff:

Q_{05} =	0.26	x	3.70	x	0.79	x	1	=	**0.75**	cfs
Q_{10} =	0.26	x	4.07	x	0.79	x	1	=	**0.83**	cfs
Q_{25} =	0.26	x	4.62	x	0.79	x	1.1	=	**1.03**	cfs
Q_{50} =	0.26	x	5.04	x	0.79	x	1.2	=	**1.23**	cfs
Q_{100} =	0.26	x	5.46	x	0.79	x	1.25	=	**1.38**	cfs

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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 91d**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.18	0.1662
Grass	0.25	0.15	0.0369
Woods	0.15	1.00	0.1495
	Σ	**1.33**	0.3526

$C_{ave} = \frac{0.3526}{1.33} = 0.27$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.20	0.1802
Grass	0.25	0.15	0.0369
Woods	0.15	1.00	0.1495
	Σ	**1.34**	0.3666

$C_{ave} = \frac{0.3666}{1.34} = 0.27$

T_c =	28.16	min.
I_{05} =	3.89	in / hr
I_{10} =	4.29	in / hr
I_{25} =	4.86	in / hr
I_{50} =	5.32	in / hr
I_{100} =	5.76	in / hr

Pre Construction Runoff:

Q_{05} =	0.27	x	3.89	x	1.33	x	1	=	**1.37**	cfs
Q_{10} =	0.27	x	4.29	x	1.33	x	1	=	**1.51**	cfs
Q_{25} =	0.27	x	4.86	x	1.33	x	1.1	=	**1.89**	cfs
Q_{50} =	0.27	x	5.32	x	1.33	x	1.2	=	**2.25**	cfs
Q_{100} =	0.27	x	5.76	x	1.33	x	1.25	=	**2.54**	cfs

Post Construction Runoff:

Q_{05} =	0.27	x	3.89	x	1.34	x	1	=	**1.43**	cfs
Q_{10} =	0.27	x	4.29	x	1.34	x	1	=	**1.57**	cfs
Q_{25} =	0.27	x	4.86	x	1.34	x	1.1	=	**1.96**	cfs
Q_{50} =	0.27	x	5.32	x	1.34	x	1.2	=	**2.34**	cfs
Q_{100} =	0.27	x	5.76	x	1.34	x	1.25	=	**2.64**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 91a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**200**				
9	Watercourse slope, s	----------	ft/ft	**0.0200**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**2.28**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.024**	+		=	**0.024**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.525**
						min		**31.52**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 91b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**50**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.256**	+		=	**0.256**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**100**				
9	Watercourse slope, s	----------	ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.006**	+		=	**0.006**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.263**
							min	**15.75**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 91c	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**300**				
9	Watercourse slope, s	----------	ft/ft	**0.0667**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.17**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.020**	+		=	**0.020**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+ **#DIV/0!**		=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.521**
						min		**31.26**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 91d	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**325**				
9	Watercourse slope, s	----------	ft/ft	**0.0600**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.95**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.023**	+		=	**0.023**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.469**
						min		**28.16**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-91		Outlet	OP	376.00	376.00	0.00	0.48	0.00	33.10	0.00	3.35	0.23	0.00
CB-91d		Other	C.B. TYPE 112	380.31	380.31	3.81	0.20	32.95	32.95	4.58	3.35	0.23	4.94
CB-91c		Other	C.B. TYPE 112	381.45	381.45	3.81	0.16	32.19	32.19	2.54	2.02	0.21	5.00
CB-91b		Other	C.B. TYPE 112	382.00	382.00	2.29	0.01	31.77	31.77	1.43	1.25	0.19	5.04
CB-91a		Other	C.B. TYPE 9	385.00	385.00	4.50	0.00	31.52	31.52	0.90	0.99	0.15	5.06

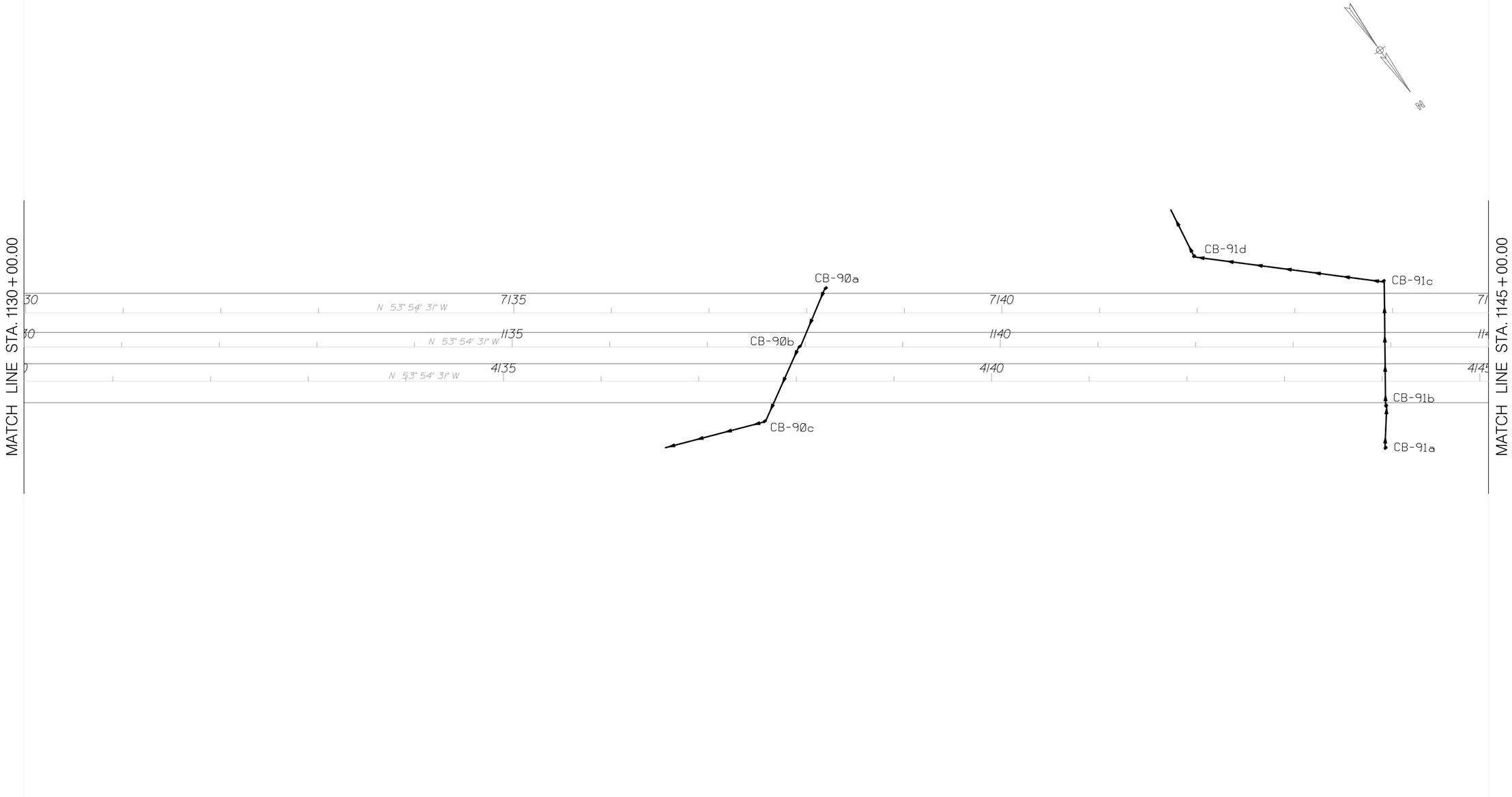
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-17	CB-91d	OF-91	Circular	Concrete	1	1.50	53	0.95	4.58	11.94	0.67	5.99	378.00	377.53	377.50	376.68	376.50	376.00	3.55	5.92	1.03	0.68
NP-16	CB-91c	CB-91d	Circular	Concrete	1	1.50	194	0.59	2.54	9.38	0.56	4.27	379.14	378.41	378.00	377.06	377.64	376.50	2.76	4.27	0.77	0.56
NP-15	CB-91b	CB-91c	Circular	Concrete	1	1.50	126	1.52	1.43	15.07	0.32	5.11	381.21	380.20	379.30	378.12	379.71	377.80	2.84	5.08	0.49	0.32
NP-14	CB-91a	CB-91b	Circular	Concrete	1	1.50	42	0.45	0.90	8.26	0.35	2.92	382.00	380.94	381.81	380.66	380.50	380.31	2.08	2.92	0.44	0.35

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-91d	28.16	2.25	5.35	0.26	1.33	0.26	1.33	0.00	0.00
CB-91c	31.26	1.14	5.08	0.24	0.77	0.24	0.77	0.00	0.00
CB-91b	15.75	0.72	6.84	0.34	0.26	0.34	0.26	0.00	0.00
CB-91a	31.52	0.90	5.06	0.15	0.99	0.15	0.99	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	4.3



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

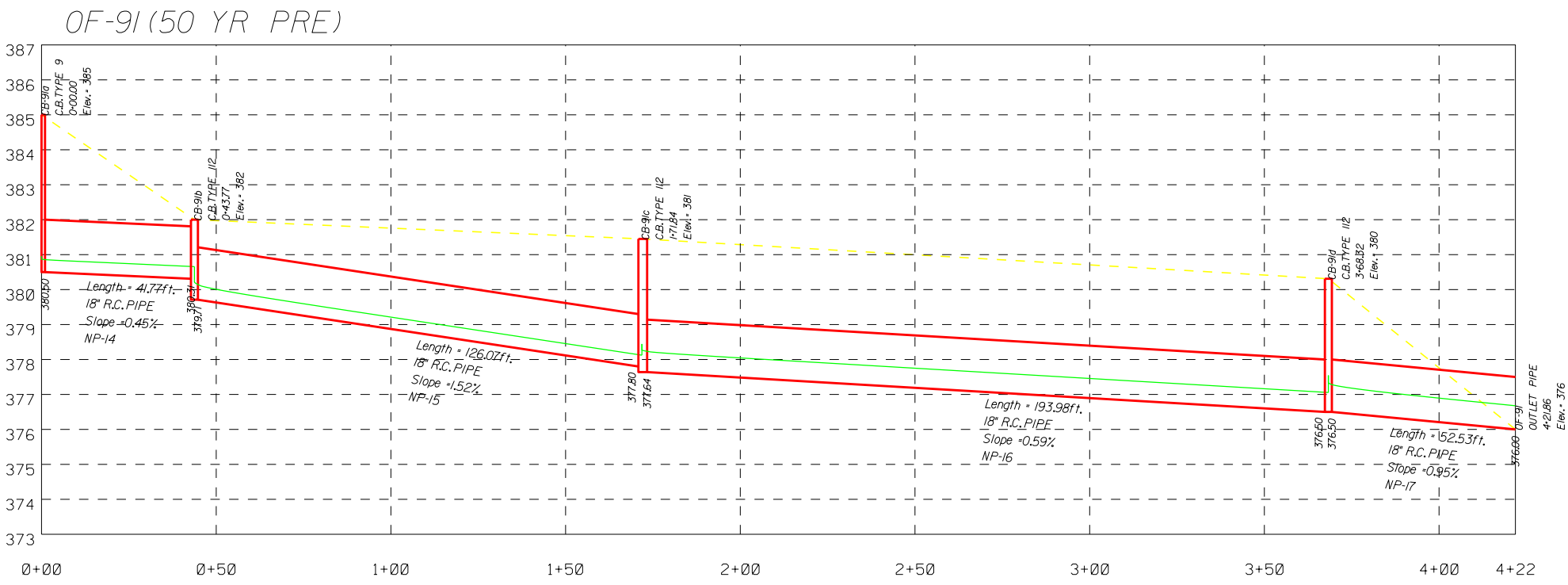
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1130+00.00 TO STA. 1145+00.00

$$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-9I (50 YR PRE)
387
386
385
384
383
382
381
380
379
378
377
376
375
374
373
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+22
CB-9Ia
C.B.TYPE 9
0+00.00
Elev.= 385
380.50
CB-9Ib
C.B.TYPE 1/2
0+43.77
Elev.= 382
380.37
379.37
Length = 41.77ft.
18" R.C.PIPE
Slope =0.45%
NP-14
CB-9Ic
C.B.TYPE 1/2
1+71.84
Elev.= 381
377.80
377.64
Length = 126.02ft.
18" R.C.PIPE
Slope =1.52%
NP-15
CB-9Id
C.B.TYPE 1/2
3+68.82
Elev.1 380
376.50
376.50
Length = 193.98ft.
18" R.C.PIPE
Slope =0.59%
NP-16
376.00
OF-9I
OUTLET PIPE
4+21.86
Elev.= 376
Length = 152.53ft.
18" R.C.PIPE
Slope =0.95%
NP-17

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

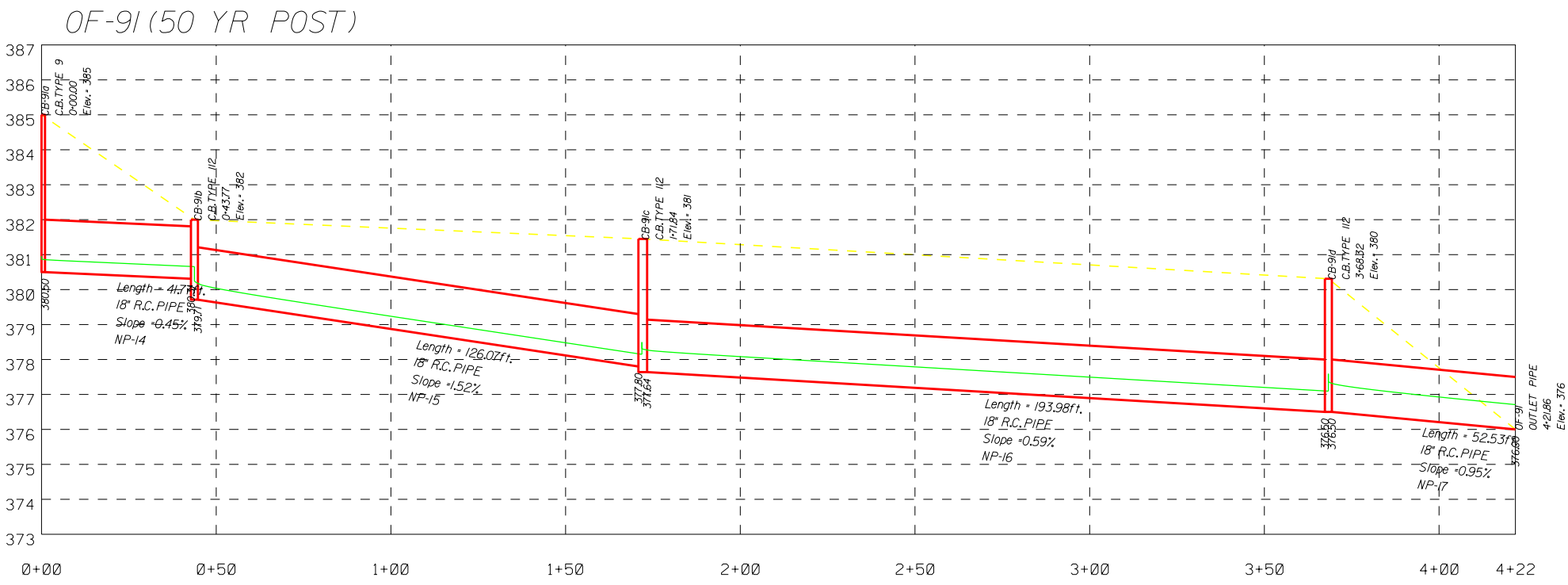
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-91	Outlet	OP	376.00	376.00	0.00	0.48	0.00	33.06	0.00	3.42	0.24	0.00
CB-91d	Other	C.B. TYPE 112	380.31	380.31	3.81	0.21	32.92	32.92	4.96	3.42	0.24	4.94
CB-91c	Other	C.B. TYPE 112	381.45	381.45	3.81	0.17	32.17	32.17	2.87	2.08	0.23	5.00
CB-91b	Other	C.B. TYPE 112	382.00	382.00	2.29	0.02	31.77	31.77	1.65	1.29	0.21	5.04
CB-91a	Other	C.B. TYPE 9	385.00	385.00	4.50	0.00	31.52	31.52	0.90	0.99	0.15	5.06

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-17	CB-91d	OF-91	Circular	Concrete	1	1.50	53	0.95	4.96	11.94	0.70	6.09	378.00	377.57	377.50	376.71	376.50	376.00	3.67	6.03	1.07	0.71
NP-16	CB-91c	CB-91d	Circular	Concrete	1	1.50	194	0.59	2.87	9.38	0.59	4.40	379.14	378.47	378.00	377.09	377.64	376.50	2.87	4.40	0.83	0.59
NP-15	CB-91b	CB-91c	Circular	Concrete	1	1.50	126	1.52	1.65	15.07	0.35	5.31	381.21	380.24	379.30	378.15	379.71	377.80	2.95	5.31	0.53	0.35
NP-14	CB-91a	CB-91b	Circular	Concrete	1	1.50	42	0.45	0.90	8.26	0.35	2.92	382.00	380.94	381.81	380.66	380.50	380.31	2.08	2.92	0.44	0.35

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-91d	28.16	2.30	5.35	0.27	1.34	0.27	1.34	0.00	0.00
CB-91c	31.26	1.25	5.08	0.26	0.79	0.26	0.79	0.00	0.00
CB-91b	15.75	1.02	6.84	0.41	0.30	0.41	0.30	0.00	0.00
CB-91a	31.52	0.90	5.06	0.15	0.99	0.15	0.99	0.00	0.00


OF-9I (50 YR POST)
387
386
385
384
383
382
381
380
379
378
377
376
375
374
373
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+22
CB-9Ia
C.B.TYPE 9
0+00.00
Elev.= 385
380.50
CB-9Ib
C.B.TYPE 1/2
0+43.77
Elev.= 382
379.70
Length = 41.77ft.
18" R.C.PIPE
Slope =0.45%
NP-14
CB-9Ic
C.B.TYPE 1/2
1+71.84
Elev.= 381
377.80
377.64
Length = 126.02ft.
18" R.C.PIPE
Slope =1.52%
NP-15
CB-9Id
C.B.TYPE 1/2
3+68.82
Elev.= 380
376.50
376.30
Length = 193.98ft.
18" R.C.PIPE
Slope =0.59%
NP-16
OF-9I
OUTLET PIPE
4+21.86
Elev.= 376
376.00
Length = 52.53ft.
18" R.C.PIPE
Slope =0.95%
NP-17

CULVERT 92/93

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 92a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.28	0.2544
Grass	0.25	0.44	0.1103
Woods	0.15	2.07	0.3111
	Σ	**2.80**	0.6758

$C_{ave} = \frac{0.6758}{2.80} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.28	0.2544
Grass	0.25	0.44	0.1103
Woods	0.15	2.07	0.3111
	Σ	**2.80**	0.6758

$C_{ave} = \frac{0.6758}{2.80} = 0.24$

T_c =	48.96	min.
I_{05} =	2.89	in / hr
I_{10} =	3.17	in / hr
I_{25} =	3.58	in / hr
I_{50} =	3.90	in / hr
I_{100} =	4.21	in / hr

Pre Construction Runoff:

Q_{05} =	0.24	x	2.89	x	2.80	x	1	=	**1.95**	cfs
Q_{10} =	0.24	x	3.17	x	2.80	x	1	=	**2.14**	cfs
Q_{25} =	0.24	x	3.58	x	2.80	x	1.1	=	**2.66**	cfs
Q_{50} =	0.24	x	3.90	x	2.80	x	1.2	=	**3.16**	cfs
Q_{100} =	0.24	x	4.21	x	2.80	x	1.25	=	**3.55**	cfs

Post Construction Runoff:

Q_{05} =	0.24	x	2.89	x	2.80	x	1	=	**1.95**	cfs
Q_{10} =	0.24	x	3.17	x	2.80	x	1	=	**2.14**	cfs
Q_{25} =	0.24	x	3.58	x	2.80	x	1.1	=	**2.66**	cfs
Q_{50} =	0.24	x	3.90	x	2.80	x	1.2	=	**3.16**	cfs
Q_{100} =	0.24	x	4.21	x	2.80	x	1.25	=	**3.55**	cfs

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Columbia, South Carolina 29201
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 92b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.22	0.1940
Grass	0.25	0.15	0.0371
Woods	0.15	0.48	0.0721
	Σ	**0.84**	0.3032

$C_{ave} = \frac{0.3032}{0.84} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.30	0.2674
Grass	0.25	0.15	0.0371
Woods	0.15	0.48	0.0721
	Σ	**0.93**	0.3766

$C_{ave} = \frac{0.3766}{0.93} = 0.41$

T_c =	24.89	min.								
I_{05} =	4.12	in / hr								
I_{10} =	4.54	in / hr								
I_{25} =	5.15	in / hr								
I_{50} =	5.64	in / hr								
I_{100} =	6.11	in / hr								

Pre Construction Runoff:

Q_{05} =	0.36	**x**	4.12	**x**	0.84	**x**	1	=	**1.25**	cfs
Q_{10} =	0.36	**x**	4.54	**x**	0.84	**x**	1	=	**1.38**	cfs
Q_{25} =	0.36	**x**	5.15	**x**	0.84	**x**	1.1	=	**1.72**	cfs
Q_{50} =	0.36	**x**	5.64	**x**	0.84	**x**	1.2	=	**2.05**	cfs
Q_{100} =	0.36	**x**	6.11	**x**	0.84	**x**	1.25	=	**2.32**	cfs

Post Construction Runoff:

Q_{05} =	0.41	**x**	4.12	**x**	0.93	**x**	1	=	**1.55**	cfs
Q_{10} =	0.41	**x**	4.54	**x**	0.93	**x**	1	=	**1.71**	cfs
Q_{25} =	0.41	**x**	5.15	**x**	0.93	**x**	1.1	=	**2.14**	cfs
Q_{50} =	0.41	**x**	5.64	**x**	0.93	**x**	1.2	=	**2.55**	cfs
Q_{100} =	0.41	**x**	6.11	**x**	0.93	**x**	1.25	=	**2.88**	cfs

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700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 93a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.26	0.2330
Grass	0.25	0.21	0.0514
Woods	0.15	0.71	0.1067
	Σ	**1.18**	0.3911

$C_{ave} = \frac{0.3911}{1.18} = 0.33$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3351
Grass	0.25	0.21	0.0514
Woods	0.15	0.71	0.1067
	Σ	**1.29**	0.4931

$C_{ave} = \frac{0.4931}{1.29} = 0.38$

T_c =	17.46	min.
I_{05} =	4.74	in / hr
I_{10} =	5.23	in / hr
I_{25} =	5.97	in / hr
I_{50} =	6.54	in / hr
I_{100} =	7.11	in / hr

Pre Construction Runoff:

Q_{05} =	0.33	x	4.74	x	1.18	x	1	=	**1.85**	cfs
Q_{10} =	0.33	x	5.23	x	1.18	x	1	=	**2.05**	cfs
Q_{25} =	0.33	x	5.97	x	1.18	x	1.1	=	**2.57**	cfs
Q_{50} =	0.33	x	6.54	x	1.18	x	1.2	=	**3.07**	cfs
Q_{100} =	0.33	x	7.11	x	1.18	x	1.25	=	**3.47**	cfs

Post Construction Runoff:

Q_{05} =	0.38	x	4.74	x	1.29	x	1	=	**2.34**	cfs
Q_{10} =	0.38	x	5.23	x	1.29	x	1	=	**2.58**	cfs
Q_{25} =	0.38	x	5.97	x	1.29	x	1.1	=	**3.24**	cfs
Q_{50} =	0.38	x	6.54	x	1.29	x	1.2	=	**3.87**	cfs
Q_{100} =	0.38	x	7.11	x	1.29	x	1.25	=	**4.38**	cfs

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700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 93b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3970
Grass	0.25	0.48	0.1190
Woods	0.15	0.00	0.0000
	Σ	**0.92**	0.5160

$C_{ave} = \frac{0.5160}{0.92} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.47	0.4272
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.47**	0.4272

$C_{ave} = \frac{0.4272}{0.47} = 0.90$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.32	x	0.92	x	1	=	**3.26**	cfs
Q_{10} =	0.56	x	7.04	x	0.92	x	1	=	**3.63**	cfs
Q_{25} =	0.56	x	8.10	x	0.92	x	1.1	=	**4.60**	cfs
Q_{50} =	0.56	x	8.95	x	0.92	x	1.2	=	**5.54**	cfs
Q_{100} =	0.56	x	9.80	x	0.92	x	1.25	=	**6.32**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.47	x	1	=	**2.70**	cfs
Q_{10} =	0.90	x	7.04	x	0.47	x	1	=	**3.01**	cfs
Q_{25} =	0.90	x	8.10	x	0.47	x	1.1	=	**3.81**	cfs
Q_{50} =	0.90	x	8.95	x	0.47	x	1.2	=	**4.59**	cfs
Q_{100} =	0.90	x	9.80	x	0.47	x	1.25	=	**5.24**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 92a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**480**				
9	Watercourse slope, s	----------	ft/ft	**0.0458**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.45**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.039**	+		=	**0.039**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.816**
						min		**48.96**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 92b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**120**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.007**	+		=	**0.007**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.415**
						min		**24.89**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 93a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.1200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.288**	+		=	**0.288**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**60**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.003**	+		=	**0.003**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.291**
						min		**17.46**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-92/93		Outlet	OP	366.21	366.21	0.00	0.48	0.00	50.43	0.00	5.74	0.33	0.00
CB-93b		Other	C.B. TYPE 112	376.76	376.76	5.56	0.03	50.32	50.32	8.74	5.74	0.33	3.86
CB-93a		Other	C.B. TYPE 112	376.85	376.85	2.41	0.25	50.23	50.23	6.36	4.82	0.28	3.86
CB-92b		Other	C.B. TYPE 112	380.52	380.52	2.25	0.23	49.08	49.08	4.60	3.64	0.27	3.92
CB-92a		Other	C.B. TYPE 9	386.00	386.00	7.00	0.00	48.96	48.96	3.17	2.80	0.24	3.93

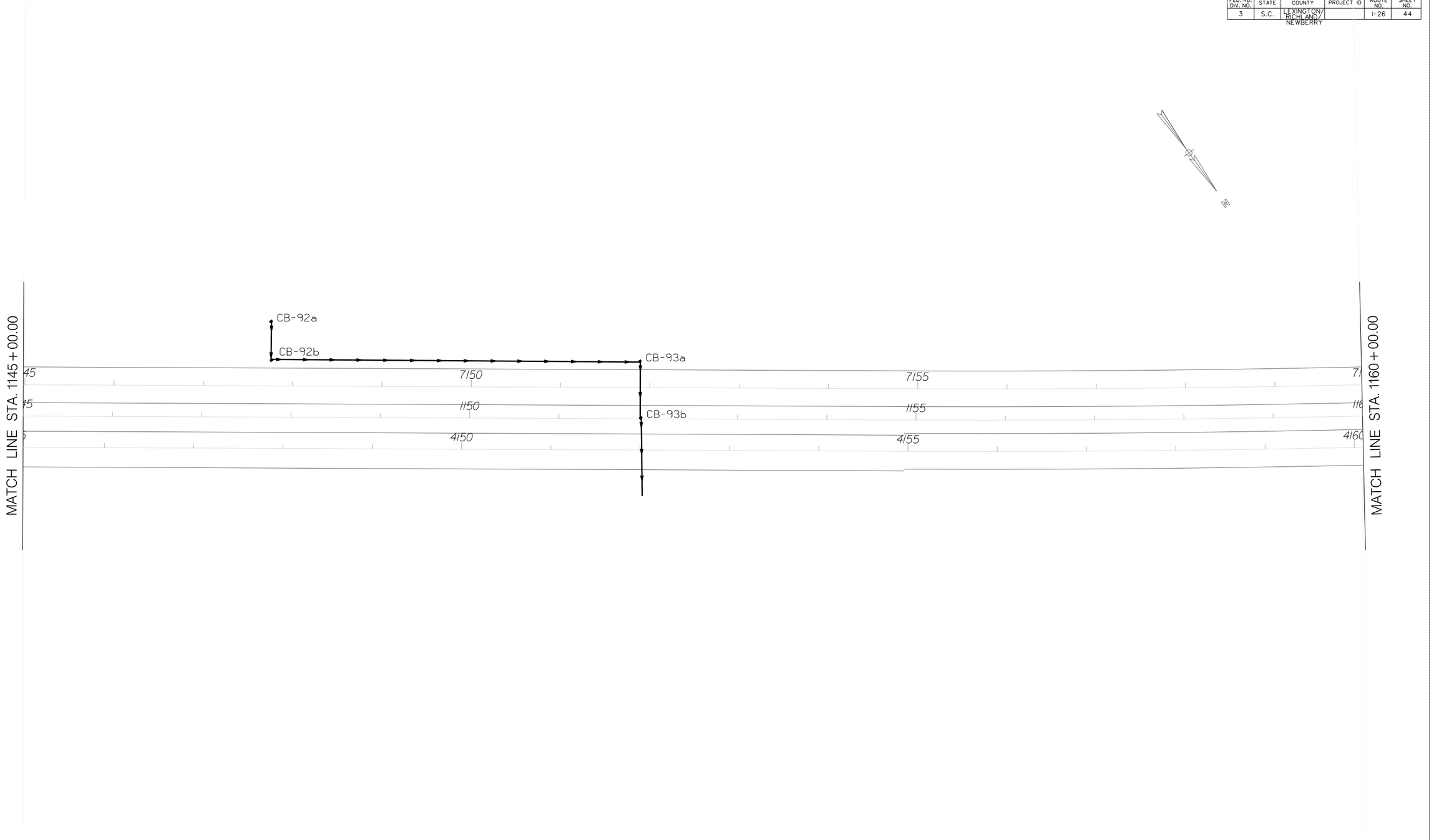
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-21	CB-93b	OF-92/93	Circular	Concrete	1	1.50	87	5.76	8.74	29.37	0.58	13.75	372.70	372.43	367.71	366.81	371.20	366.21	5.63	13.34	1.23	0.60
NP-20	CB-93a	CB-93b	Circular	Concrete	1	1.50	62	5.08	6.36	27.60	0.51	12.04	375.94	375.77	372.80	371.82	374.44	371.30	3.83	11.53	1.33	0.52
NP-19	CB-92b	CB-93a	Circular	Concrete	1	1.50	410	0.93	4.60	11.80	0.68	5.95	379.77	379.35	375.96	375.14	378.27	374.46	3.39	5.95	1.08	0.68
NP-18	CB-92a	CB-92b	Circular	Concrete	1	1.25	42	1.34	3.17	8.71	0.54	6.19	380.25	380.08	379.69	378.99	379.00	378.44	2.80	6.06	1.08	0.55

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-93b	5.00	5.59	9.03	0.56	0.92	0.56	0.92	0.00	0.00
CB-93a	17.46	3.11	6.59	0.33	1.18	0.33	1.18	0.00	0.00
CB-92b	24.89	2.09	5.68	0.36	0.84	0.36	0.84	0.00	0.00
CB-92a	48.96	3.17	3.93	0.24	2.80	0.24	2.79	0.00	0.01

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	44



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

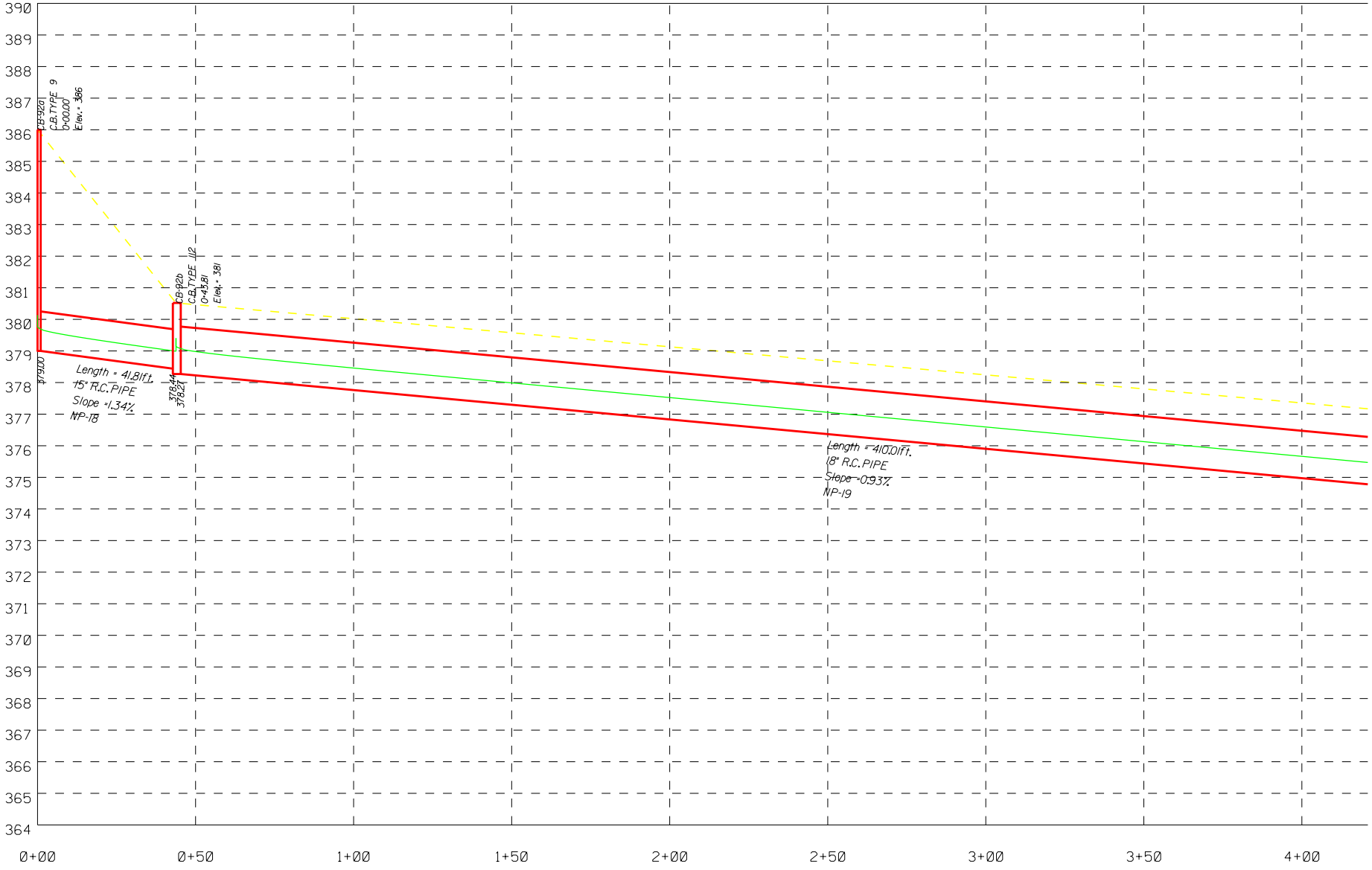
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

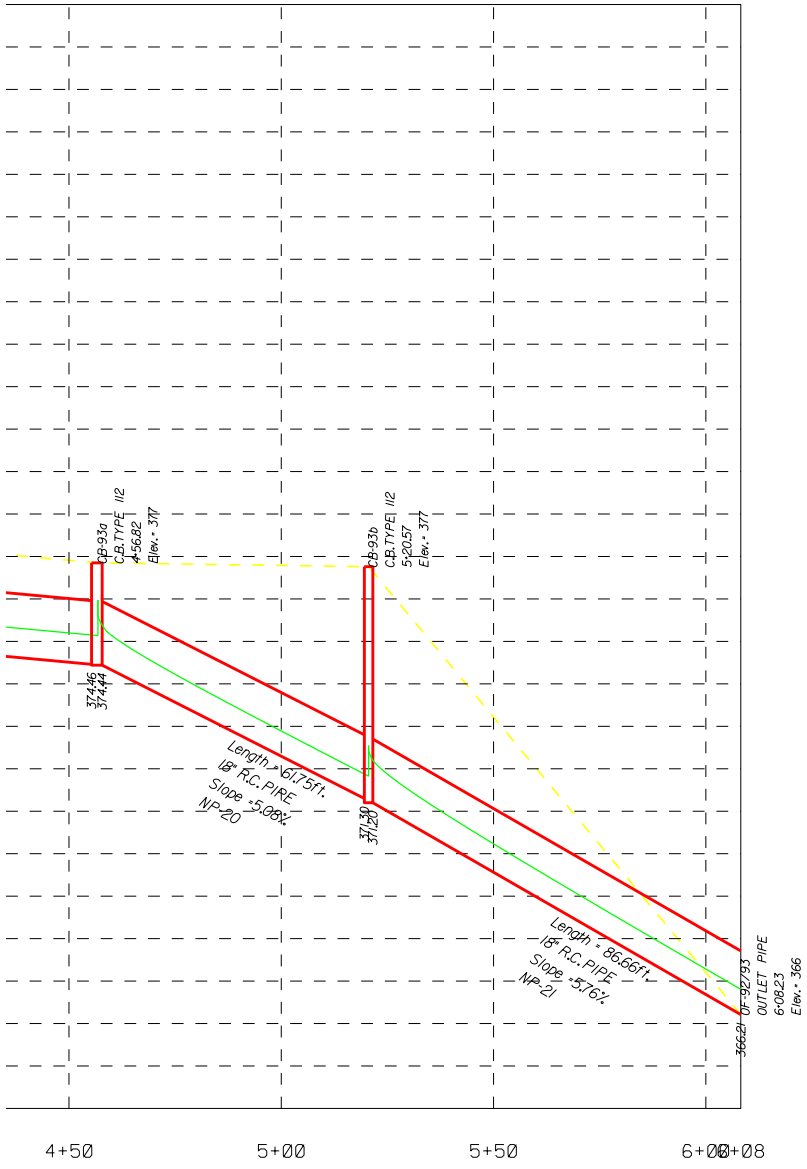
PLAN SHEET
STA. 1145+00.00 TO STA. 1160+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$

OF-92/93 (50 YR PRE) (page 1 of 2)



OF-92/93 (50 YR PRE)(page 2 of 2)



SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-92/93	Outlet	OP	366.21	366.21	0.00	0.48	0.00	50.41	0.00	5.49	0.36	0.00
CB-93b	Other	C.B. TYPE 112	376.76	376.76	5.56	0.03	50.30	50.30	9.11	5.49	0.36	3.86
CB-93a	Other	C.B. TYPE 112	376.85	376.85	2.41	0.29	50.22	50.22	7.16	5.02	0.31	3.86
CB-92b	Other	C.B. TYPE 112	380.52	380.52	2.25	0.24	49.08	49.08	4.95	3.73	0.28	3.92
CB-92a	Other	C.B. TYPE 9	386.00	386.00	7.00	0.00	48.96	48.96	3.17	2.80	0.24	3.93

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-21	CB-93b	OF-92/93	Circular	Concrete	1	1.50	87	5.76	9.11	29.37	0.60	13.90	372.70	372.45	367.71	366.82	371.20	366.21	5.78	13.46	1.25	0.61
NP-20	CB-93a	CB-93b	Circular	Concrete	1	1.50	62	5.08	7.16	27.60	0.54	12.44	375.94	375.87	372.80	371.86	374.44	371.30	4.12	11.84	1.43	0.56
NP-19	CB-92b	CB-93a	Circular	Concrete	1	1.50	410	0.93	4.95	11.80	0.71	6.04	379.77	379.39	375.96	375.17	378.27	374.46	3.48	6.04	1.12	0.71
NP-18	CB-92a	CB-92b	Circular	Concrete	1	1.25	42	1.34	3.17	8.71	0.54	6.19	380.25	380.08	379.69	378.99	379.00	378.44	2.80	6.06	1.08	0.55

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-93b	5.00	4.58	9.03	0.90	0.47	0.90	0.47	0.00	0.00
CB-93a	17.46	3.89	6.59	0.38	1.29	0.38	1.29	0.00	0.00
CB-92b	24.89	2.59	5.68	0.41	0.93	0.41	0.93	0.00	0.00
CB-92a	48.96	3.17	3.93	0.24	2.80	0.24	2.79	0.00	0.01


OF-92/93 (50 YR POST)(page 1 of 2)
390
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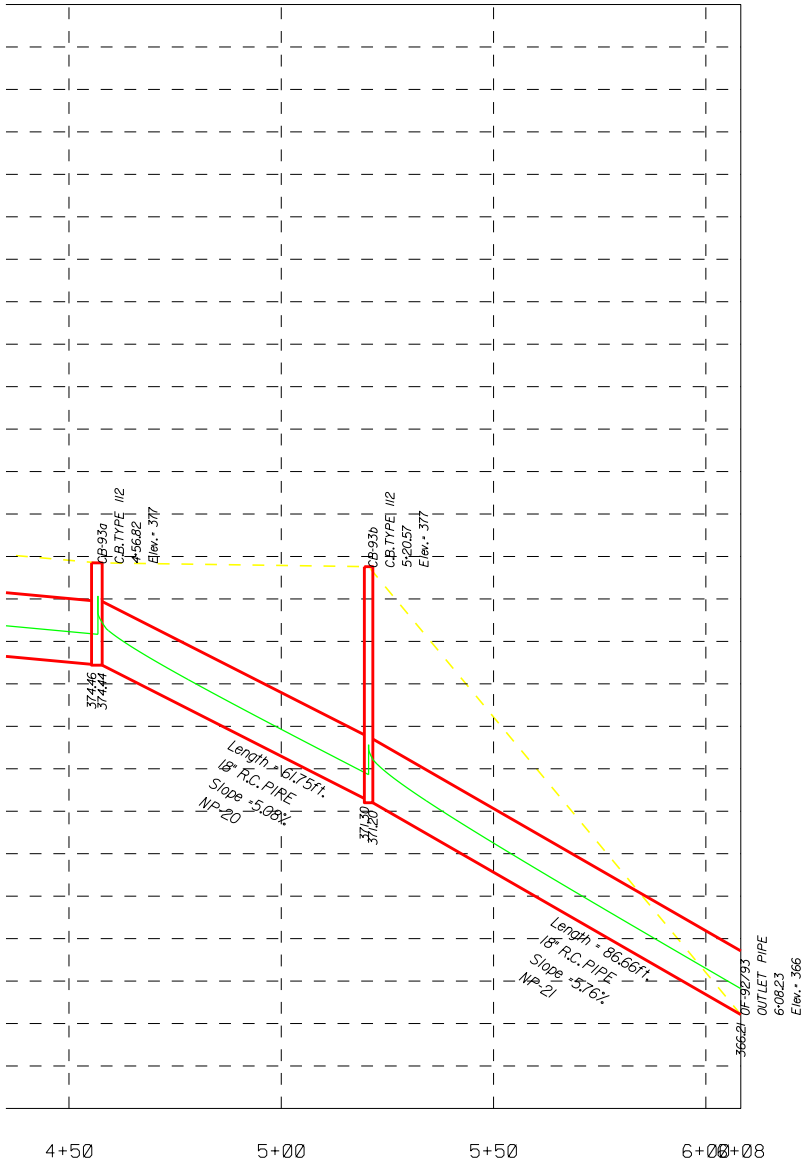
373
372
371
370
369
368
367
366
365
364
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
CB-92a
C.B. TYPE 9
0-00.00
Elev. = 386
CB-92b
C.B. TYPE 1/2
0+43.81
Elev. = 381
379.00
Length = 41.81ft.
15" R.C. PIPE
Slope =1.34%
NP-18
Length = 410.01ft.
18" R.C. PIPE
Slope =0.93%
NP-19

OF-92/93 (50 YR POST)(page 2 of 2)



CULVERT 94

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 94**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.29	0.2592
Grass	0.25	0.15	0.0365
Woods	0.15	3.36	0.5034
	Σ	**3.79**	0.7991

$C_{ave} = \frac{0.7991}{3.79} = 0.21$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3287
Grass	0.25	0.15	0.0365
Woods	0.15	3.36	0.5034
	Σ	**3.87**	0.8686

$C_{ave} = \frac{0.8686}{3.87} = 0.22$

T_c =	26.97	min.
I_{05} =	3.97	in / hr
I_{10} =	4.38	in / hr
I_{25} =	4.97	in / hr
I_{50} =	5.43	in / hr
I_{100} =	5.88	in / hr

Pre Construction Runoff:

Q_{05} =	0.21	x	3.97	x	3.79	x	1	=	**3.17**	cfs
Q_{10} =	0.21	x	4.38	x	3.79	x	1	=	**3.50**	cfs
Q_{25} =	0.21	x	4.97	x	3.79	x	1.1	=	**4.37**	cfs
Q_{50} =	0.21	x	5.43	x	3.79	x	1.2	=	**5.21**	cfs
Q_{100} =	0.21	x	5.88	x	3.79	x	1.25	=	**5.87**	cfs

Post Construction Runoff:

Q_{05} =	0.22	x	3.97	x	3.87	x	1	=	**3.45**	cfs
Q_{10} =	0.22	x	4.38	x	3.87	x	1	=	**3.80**	cfs
Q_{25} =	0.22	x	4.97	x	3.87	x	1.1	=	**4.74**	cfs
Q_{50} =	0.22	x	5.43	x	3.87	x	1.2	=	**5.66**	cfs
Q_{100} =	0.22	x	5.88	x	3.87	x	1.25	=	**6.38**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 94	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**590**				
9	Watercourse slope, s	----------	ft/ft	**0.0610**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.99**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.041**	+		=	**0.041**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.449**
						min		**26.97**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.37 cfs

Design Flow: 5.21 cfs

Maximum Flow: 5.87 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1155+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
372.03	4.37	4.37	0.00	1
372.05	4.52	4.52	0.00	1
372.08	4.67	4.67	0.00	1
372.10	4.82	4.82	0.00	1
372.12	4.97	4.97	0.00	1
372.15	5.12	5.12	0.00	1
372.16	5.21	5.21	0.00	1
372.20	5.42	5.42	0.00	1
372.22	5.57	5.57	0.00	1
372.25	5.72	5.72	0.00	1
372.27	5.87	5.87	0.00	1
372.73	8.37	8.37	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.37	4.37	372.03	1.125	0.0*	1-S2n	0.348	0.800	0.348	0.413	13.656	3.749
4.52	4.52	372.05	1.150	0.0*	1-S2n	0.354	0.814	0.354	0.420	13.821	3.787
4.67	4.67	372.08	1.175	0.0*	1-S2n	0.359	0.827	0.359	0.428	13.855	3.823
4.82	4.82	372.10	1.200	0.0*	1-S2n	0.365	0.840	0.365	0.435	13.995	3.859
4.97	4.97	372.12	1.225	0.0*	1-S2n	0.371	0.853	0.371	0.442	14.128	3.893
5.12	5.12	372.15	1.249	0.0*	1-S2n	0.377	0.866	0.377	0.450	14.256	3.927
5.21	5.21	372.16	1.264	0.0*	1-S2n	0.380	0.877	0.380	0.454	14.322	3.947
5.42	5.42	372.20	1.299	0.0*	1-S2n	0.388	0.894	0.388	0.464	14.511	3.992
5.57	5.57	372.22	1.323	0.0*	1-S2n	0.393	0.907	0.393	0.471	14.647	4.025
5.72	5.72	372.25	1.348	0.0*	1-S2n	0.398	0.919	0.398	0.477	14.679	4.055
5.87	5.87	372.27	1.373	0.0*	1-S2n	0.404	0.931	0.404	0.484	14.797	4.086

* Full Flow Headwater elevation is below inlet invert.

****

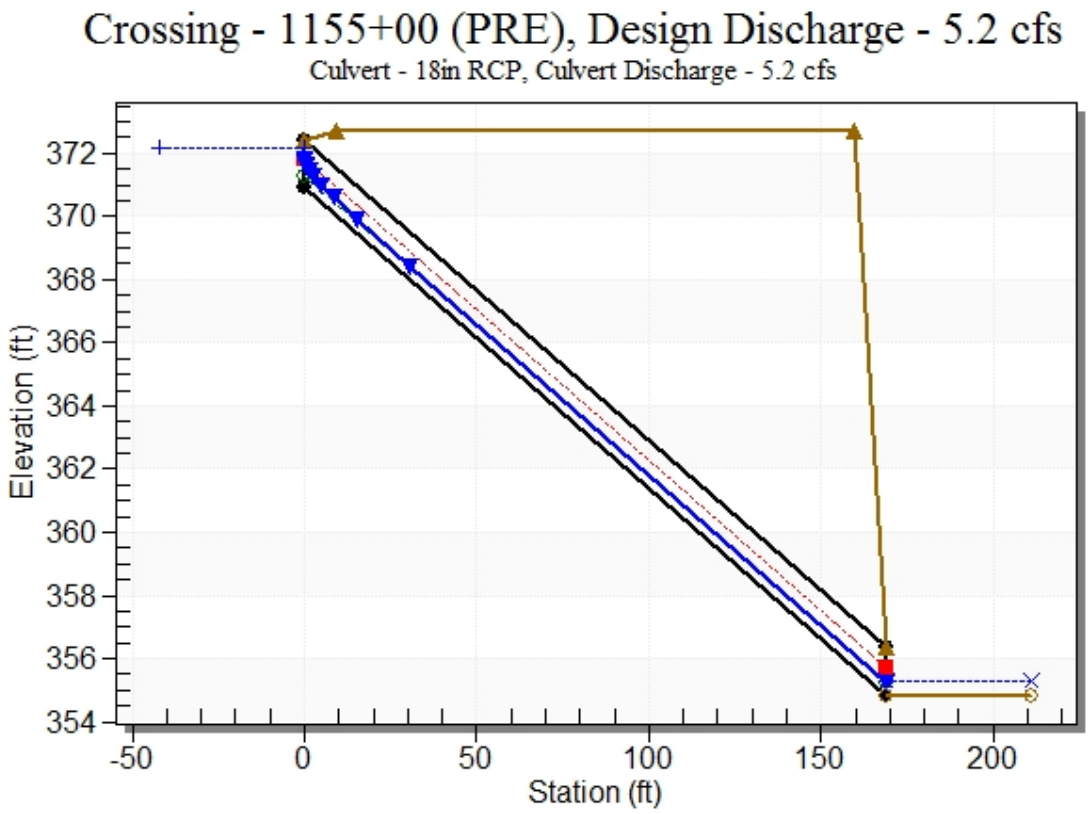
Straight Culvert

Inlet Elevation (invert): 370.90 ft, Outlet Elevation (invert): 354.84 ft

Culvert Length: 169.76 ft, Culvert Slope: 0.0950

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 370.90 ft

Outlet Station: 169.00 ft

Outlet Elevation: 354.84 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1155+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.37	355.25	0.41	3.75	1.29	1.17
4.52	355.26	0.42	3.79	1.31	1.17
4.67	355.27	0.43	3.82	1.33	1.17
4.82	355.28	0.44	3.86	1.36	1.18
4.97	355.28	0.44	3.89	1.38	1.18
5.12	355.29	0.45	3.93	1.40	1.18
5.21	355.29	0.45	3.95	1.42	1.18
5.42	355.30	0.46	3.99	1.45	1.19
5.57	355.31	0.47	4.02	1.47	1.19
5.72	355.32	0.48	4.06	1.49	1.19
5.87	355.32	0.48	4.09	1.51	1.19

Tailwater Channel Data - 1155+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0400

Channel Invert Elevation: 354.84 ft

Roadway Data for Crossing: 1155+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 372.73 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.74 cfs

Design Flow: 5.66 cfs

Maximum Flow: 6.38 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1155+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
372.09	4.74	4.74	0.00	1
372.11	4.90	4.90	0.00	1
372.14	5.07	5.07	0.00	1
372.17	5.23	5.23	0.00	1
372.19	5.40	5.40	0.00	1
372.22	5.56	5.56	0.00	1
372.24	5.66	5.66	0.00	1
372.28	5.89	5.89	0.00	1
372.30	6.05	6.05	0.00	1
372.33	6.22	6.22	0.00	1
372.36	6.38	6.38	0.00	1
372.73	8.37	8.37	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.74	4.74	372.09	1.187	0.0*	1-S2n	0.362	0.833	0.362	0.431	13.921	3.840
4.90	4.90	372.11	1.214	0.0*	1-S2n	0.368	0.847	0.368	0.439	14.070	3.878
5.07	5.07	372.14	1.241	0.0*	1-S2n	0.375	0.861	0.375	0.447	14.212	3.915
5.23	5.23	372.17	1.268	0.0*	1-S2n	0.381	0.879	0.381	0.455	14.348	3.952
5.40	5.40	372.19	1.295	0.0*	1-S2n	0.387	0.892	0.387	0.463	14.488	3.987
5.56	5.56	372.22	1.322	0.0*	1-S2n	0.393	0.906	0.393	0.470	14.638	4.022
5.66	5.66	372.24	1.338	0.0*	1-S2n	0.396	0.914	0.396	0.475	14.631	4.043
5.89	5.89	372.28	1.376	0.0*	1-S2n	0.404	0.933	0.404	0.485	14.811	4.090
6.05	6.05	372.30	1.403	0.0*	1-S2n	0.410	0.946	0.410	0.492	14.934	4.122
6.22	6.22	372.33	1.431	0.0*	1-S2n	0.416	0.958	0.446	0.499	13.644	4.154
6.38	6.38	372.36	1.459	0.0*	1-S2n	0.422	0.971	0.422	0.506	15.168	4.184

* Full Flow Headwater elevation is below inlet invert.

****

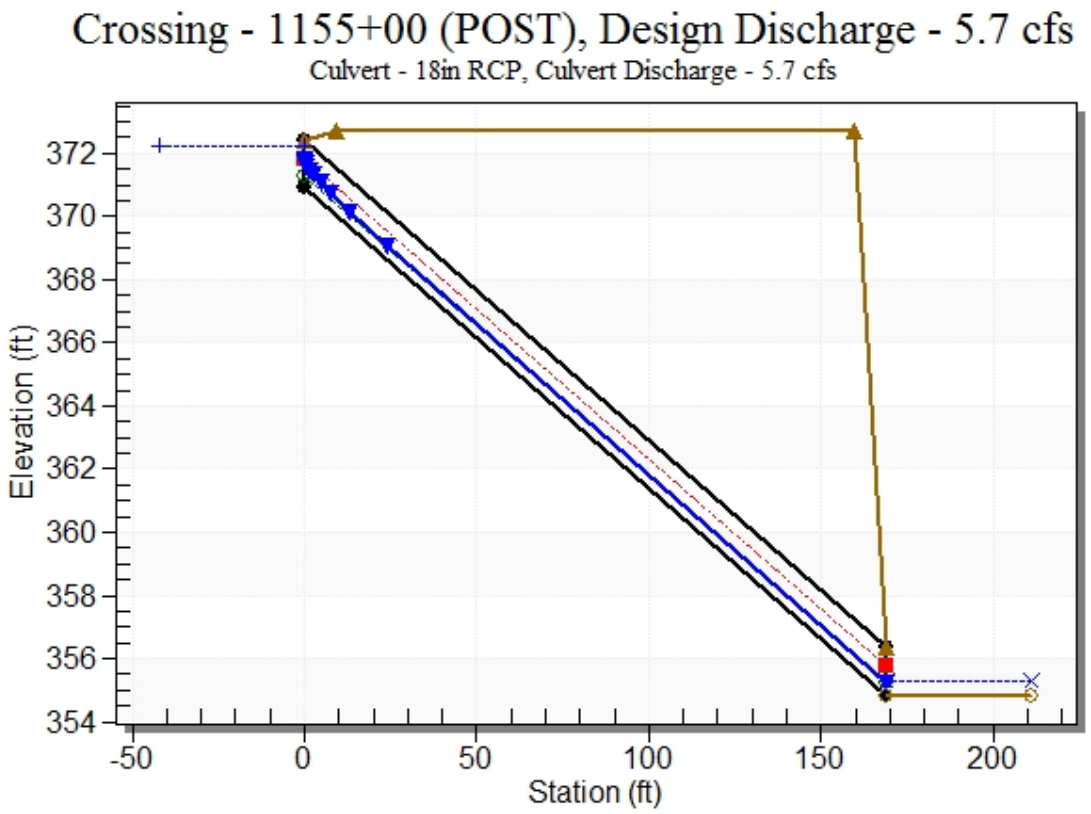
Straight Culvert

Inlet Elevation (invert): 370.90 ft, Outlet Elevation (invert): 354.84 ft

Culvert Length: 169.76 ft, Culvert Slope: 0.0950

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 370.90 ft

Outlet Station: 169.00 ft

Outlet Elevation: 354.84 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1155+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.74	355.27	0.43	3.84	1.35	1.18
4.90	355.28	0.44	3.88	1.37	1.18
5.07	355.29	0.45	3.92	1.40	1.18
5.23	355.29	0.45	3.95	1.42	1.18
5.40	355.30	0.46	3.99	1.44	1.19
5.56	355.31	0.47	4.02	1.47	1.19
5.66	355.31	0.47	4.04	1.48	1.19
5.89	355.32	0.48	4.09	1.51	1.19
6.05	355.33	0.49	4.12	1.54	1.19
6.22	355.34	0.50	4.15	1.56	1.20
6.38	355.35	0.51	4.18	1.58	1.20

Tailwater Channel Data - 1155+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0400

Channel Invert Elevation: 354.84 ft

Roadway Data for Crossing: 1155+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 372.73 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

CULVERT 95

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 95**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.45	0.4037
Grass	0.25	0.43	0.1073
Woods	0.15	1.32	0.1978
	Σ	**2.20**	0.7088

$C_{ave} = \frac{0.7088}{2.20} = 0.32$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.52	0.4699
Grass	0.25	0.10	0.0244
Woods	0.15	1.32	0.1978
	Σ	**1.94**	0.6921

$C_{ave} = \frac{0.6921}{1.94} = 0.36$

T_c =	22.11	min.								
I_{05} =	4.33	in / hr								
I_{10} =	4.78	in / hr								
I_{25} =	5.43	in / hr								
I_{50} =	5.95	in / hr								
I_{100} =	6.45	in / hr								

Pre Construction Runoff:

Q_{05} =	0.32	**x**	4.33	**x**	2.20	**x**	1	=	**3.07**	cfs
Q_{10} =	0.32	**x**	4.78	**x**	2.20	**x**	1	=	**3.39**	cfs
Q_{25} =	0.32	**x**	5.43	**x**	2.20	**x**	1.1	=	**4.23**	cfs
Q_{50} =	0.32	**x**	5.95	**x**	2.20	**x**	1.2	=	**5.06**	cfs
Q_{100} =	0.32	**x**	6.45	**x**	2.20	**x**	1.25	=	**5.71**	cfs

Post Construction Runoff:

Q_{05} =	0.36	**x**	4.33	**x**	1.94	**x**	1	=	**3.00**	cfs
Q_{10} =	0.36	**x**	4.78	**x**	1.94	**x**	1	=	**3.31**	cfs
Q_{25} =	0.36	**x**	5.43	**x**	1.94	**x**	1.1	=	**4.13**	cfs
Q_{50} =	0.36	**x**	5.95	**x**	1.94	**x**	1.2	=	**4.94**	cfs
Q_{100} =	0.36	**x**	6.45	**x**	1.94	**x**	1.25	=	**5.58**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 95	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0700**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.357**	+		=	**0.357**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**175**				
9	Watercourse slope, s	----------	ft/ft	**0.0686**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.23**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w	----------	ft	**0.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**	**#DIV/0!**			
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**	**#DIV/0!**			
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+ **#DIV/0!**		=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.368**
						min		**22.11**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.23 cfs

Design Flow: 5.06 cfs

Maximum Flow: 5.71 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1157+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18 in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
367.32	4.23	4.23	0.00	1
367.35	4.38	4.38	0.00	1
367.37	4.53	4.53	0.00	1
367.40	4.67	4.67	0.00	1
367.42	4.82	4.82	0.00	1
367.45	4.97	4.97	0.00	1
367.46	5.06	5.06	0.00	1
367.49	5.27	5.27	0.00	1
367.52	5.41	5.41	0.00	1
367.54	5.56	5.56	0.00	1
367.57	5.71	5.71	0.00	1
369.10	12.41	12.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 18 in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.23	4.23	367.32	1.162	0.0*	1-S2n	0.562	0.787	0.562	0.386	6.766	3.958
4.38	4.38	367.35	1.187	0.0*	1-S2n	0.572	0.801	0.572	0.393	6.831	3.999
4.53	4.53	367.37	1.212	0.0*	1-S2n	0.583	0.814	0.583	0.400	6.896	4.039
4.67	4.67	367.40	1.237	0.0*	1-S2n	0.593	0.828	0.593	0.407	6.948	4.077
4.82	4.82	367.42	1.261	0.0*	1-S2n	0.603	0.840	0.603	0.414	7.008	4.116
4.97	4.97	367.45	1.285	0.0*	1-S2n	0.614	0.853	0.614	0.421	7.065	4.152
5.06	5.06	367.46	1.300	0.0*	1-S2n	0.620	0.861	0.620	0.425	7.101	4.174
5.27	5.27	367.49	1.334	0.0*	1-S2n	0.634	0.881	0.634	0.435	7.171	4.224
5.41	5.41	367.52	1.358	0.0*	1-S2n	0.644	0.894	0.644	0.441	7.225	4.257
5.56	5.56	367.54	1.383	0.0*	1-S2n	0.654	0.906	0.654	0.448	7.276	4.292
5.71	5.71	367.57	1.407	0.0*	1-S2n	0.663	0.918	0.663	0.454	7.329	4.325

* Full Flow Headwater elevation is below inlet invert.

****

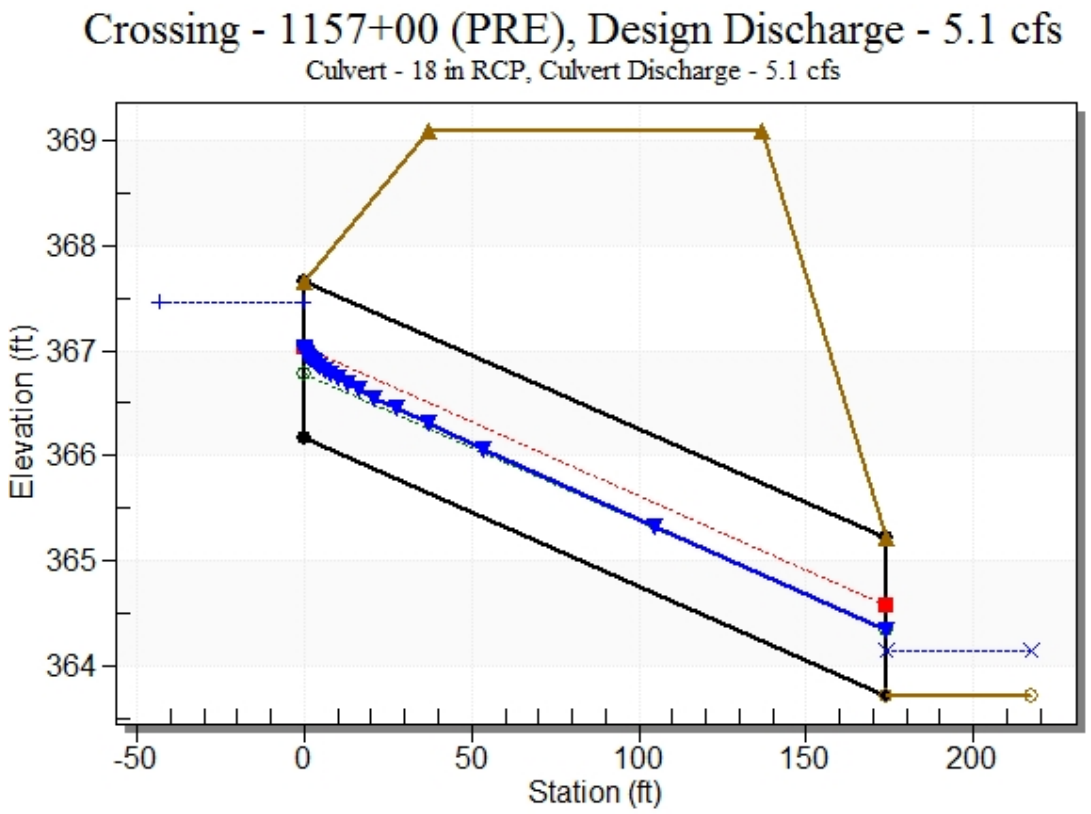
Straight Culvert

Inlet Elevation (invert): 366.16 ft, Outlet Elevation (invert): 363.72 ft

Culvert Length: 174.02 ft, Culvert Slope: 0.0140

****

Water Surface Profile Plot for Culvert: 18 in RCP



Site Data - 18 in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 366.16 ft

Outlet Station: 174.00 ft

Outlet Elevation: 363.72 ft

Number of Barrels: 1

Culvert Data Summary - 18 in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1157+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.23	364.11	0.39	3.96	1.44	1.27
4.38	364.11	0.39	4.00	1.47	1.27
4.53	364.12	0.40	4.04	1.50	1.28
4.67	364.13	0.41	4.08	1.52	1.28
4.82	364.13	0.41	4.12	1.55	1.28
4.97	364.14	0.42	4.15	1.58	1.28
5.06	364.15	0.43	4.17	1.59	1.29
5.27	364.15	0.43	4.22	1.63	1.29
5.41	364.16	0.44	4.26	1.65	1.29
5.56	364.17	0.45	4.29	1.68	1.29
5.71	364.17	0.45	4.32	1.70	1.30

Tailwater Channel Data - 1157+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0400

Channel Invert Elevation: 363.72 ft

Roadway Data for Crossing: 1157+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 369.10 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.13 cfs

Design Flow: 4.94 cfs

Maximum Flow: 5.58 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1157+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18 in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
367.31	4.13	4.13	0.00	1
367.33	4.28	4.28	0.00	1
367.35	4.42	4.42	0.00	1
367.38	4.56	4.56	0.00	1
367.40	4.71	4.71	0.00	1
367.43	4.86	4.86	0.00	1
367.44	4.94	4.94	0.00	1
367.47	5.14	5.14	0.00	1
367.50	5.29	5.29	0.00	1
367.52	5.44	5.44	0.00	1
367.55	5.58	5.58	0.00	1
369.10	12.41	12.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 18 in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.13	4.13	367.31	1.145	0.0*	1-S2n	0.554	0.778	0.554	0.381	6.721	3.931
4.28	4.28	367.33	1.170	0.0*	1-S2n	0.565	0.791	0.565	0.388	6.786	3.971
4.42	4.42	367.35	1.194	0.0*	1-S2n	0.575	0.805	0.575	0.395	6.849	4.011
4.56	4.56	367.38	1.219	0.0*	1-S2n	0.586	0.818	0.586	0.402	6.913	4.050
4.71	4.71	367.40	1.243	0.0*	1-S2n	0.596	0.831	0.596	0.409	6.963	4.087
4.86	4.86	367.43	1.267	0.0*	1-S2n	0.606	0.843	0.606	0.416	7.021	4.123
4.94	4.94	367.44	1.281	0.0*	1-S2n	0.612	0.850	0.612	0.420	7.054	4.145
5.14	5.14	367.47	1.314	0.0*	1-S2n	0.625	0.868	0.625	0.429	7.135	4.194
5.29	5.29	367.50	1.338	0.0*	1-S2n	0.635	0.884	0.651	0.436	6.962	4.229
5.44	5.44	367.52	1.362	0.0*	1-S2n	0.645	0.896	0.645	0.442	7.232	4.263
5.58	5.58	367.55	1.386	0.0*	1-S2n	0.655	0.908	0.655	0.448	7.282	4.296

* Full Flow Headwater elevation is below inlet invert.

****

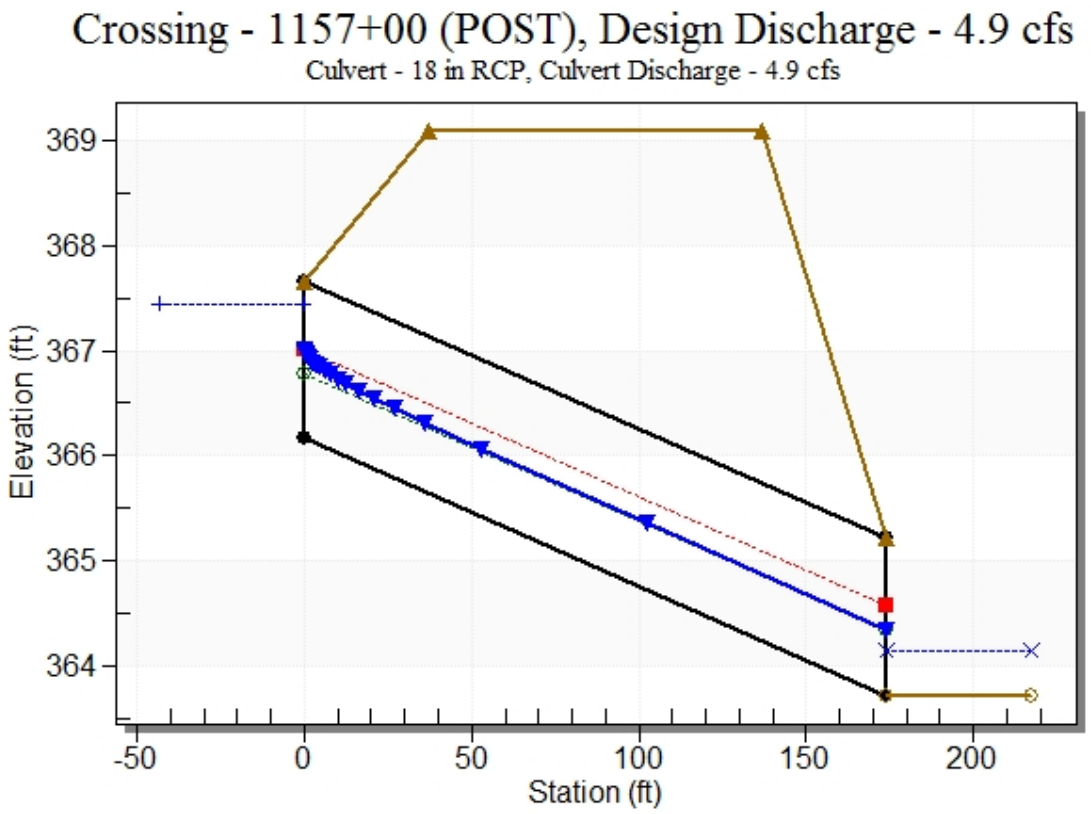
Straight Culvert

Inlet Elevation (invert): 366.16 ft, Outlet Elevation (invert): 363.72 ft

Culvert Length: 174.02 ft, Culvert Slope: 0.0140

****

Water Surface Profile Plot for Culvert: 18 in RCP



Site Data - 18 in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 366.16 ft

Outlet Station: 174.00 ft

Outlet Elevation: 363.72 ft

Number of Barrels: 1

Culvert Data Summary - 18 in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1157+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.13	364.10	0.38	3.93	1.42	1.27
4.28	364.11	0.39	3.97	1.45	1.27
4.42	364.12	0.40	4.01	1.48	1.27
4.56	364.12	0.40	4.05	1.51	1.28
4.71	364.13	0.41	4.09	1.53	1.28
4.86	364.14	0.42	4.12	1.56	1.28
4.94	364.14	0.42	4.15	1.57	1.28
5.14	364.15	0.43	4.19	1.61	1.29
5.29	364.16	0.44	4.23	1.63	1.29
5.44	364.16	0.44	4.26	1.66	1.29
5.58	364.17	0.45	4.30	1.68	1.29

Tailwater Channel Data - 1157+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0400

Channel Invert Elevation: 363.72 ft

Roadway Data for Crossing: 1157+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 369.10 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 96

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 96a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.34	0.3089
Grass	0.25	0.39	0.0971
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.4059

$C_{ave} = \frac{0.4059}{0.73} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.73	0.6583
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.6583

$C_{ave} = \frac{0.6583}{0.73} = 0.90$

T_c =	5.00 min.
I_{05} =	6.32 in / hr
I_{10} =	7.04 in / hr
I_{25} =	8.10 in / hr
I_{50} =	8.95 in / hr
I_{100} =	9.80 in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.32	x	0.73	x	1	=	**2.57**	cfs
Q_{10} =	0.56	x	7.04	x	0.73	x	1	=	**2.86**	cfs
Q_{25} =	0.56	x	8.10	x	0.73	x	1.1	=	**3.62**	cfs
Q_{50} =	0.56	x	8.95	x	0.73	x	1.2	=	**4.36**	cfs
Q_{100} =	0.56	x	9.80	x	0.73	x	1.25	=	**4.97**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.73	x	1	=	**4.16**	cfs
Q_{10} =	0.90	x	7.04	x	0.73	x	1	=	**4.63**	cfs
Q_{25} =	0.90	x	8.10	x	0.73	x	1.1	=	**5.87**	cfs
Q_{50} =	0.90	x	8.95	x	0.73	x	1.2	=	**7.07**	cfs
Q_{100} =	0.90	x	9.80	x	0.73	x	1.25	=	**8.07**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 96b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.08	0.0688
Grass	0.25	0.22	0.0562
Woods	0.15	0.48	0.0717
	Σ	**0.78**	0.1966

$C_{ave} = \frac{0.1966}{0.78} = 0.25$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.08	0.0688
Grass	0.25	0.22	0.0562
Woods	0.15	0.48	0.0717
	Σ	**0.78**	0.1966

$C_{ave} = \frac{0.1966}{0.78} = 0.25$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.25	x	6.32	x	0.78	x	1	=	**1.24**	cfs
Q_{10} =	0.25	x	7.04	x	0.78	x	1	=	**1.38**	cfs
Q_{25} =	0.25	x	8.10	x	0.78	x	1.1	=	**1.75**	cfs
Q_{50} =	0.25	x	8.95	x	0.78	x	1.2	=	**2.11**	cfs
Q_{100} =	0.25	x	9.80	x	0.78	x	1.25	=	**2.41**	cfs

Post Construction Runoff:

Q_{05} =	0.25	x	6.32	x	0.78	x	1	=	**1.24**	cfs
Q_{10} =	0.25	x	7.04	x	0.78	x	1	=	**1.38**	cfs
Q_{25} =	0.25	x	8.10	x	0.78	x	1.1	=	**1.75**	cfs
Q_{50} =	0.25	x	8.95	x	0.78	x	1.2	=	**2.11**	cfs
Q_{100} =	0.25	x	9.80	x	0.78	x	1.25	=	**2.41**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-96		Outlet	OP	351.56	351.56	0.00	0.77	0.00	5.25	0.00	1.51	0.40	0.00
CB-96b		Other	C.B. TYPE 112	355.36	355.36	2.93	0.41	5.19	5.19	6.49	1.51	0.40	8.98
CB-96a		Other	C.B. TYPE 112	356.85	356.85	3.32	0.00	5.00	5.00	4.37	0.73	0.55	9.03

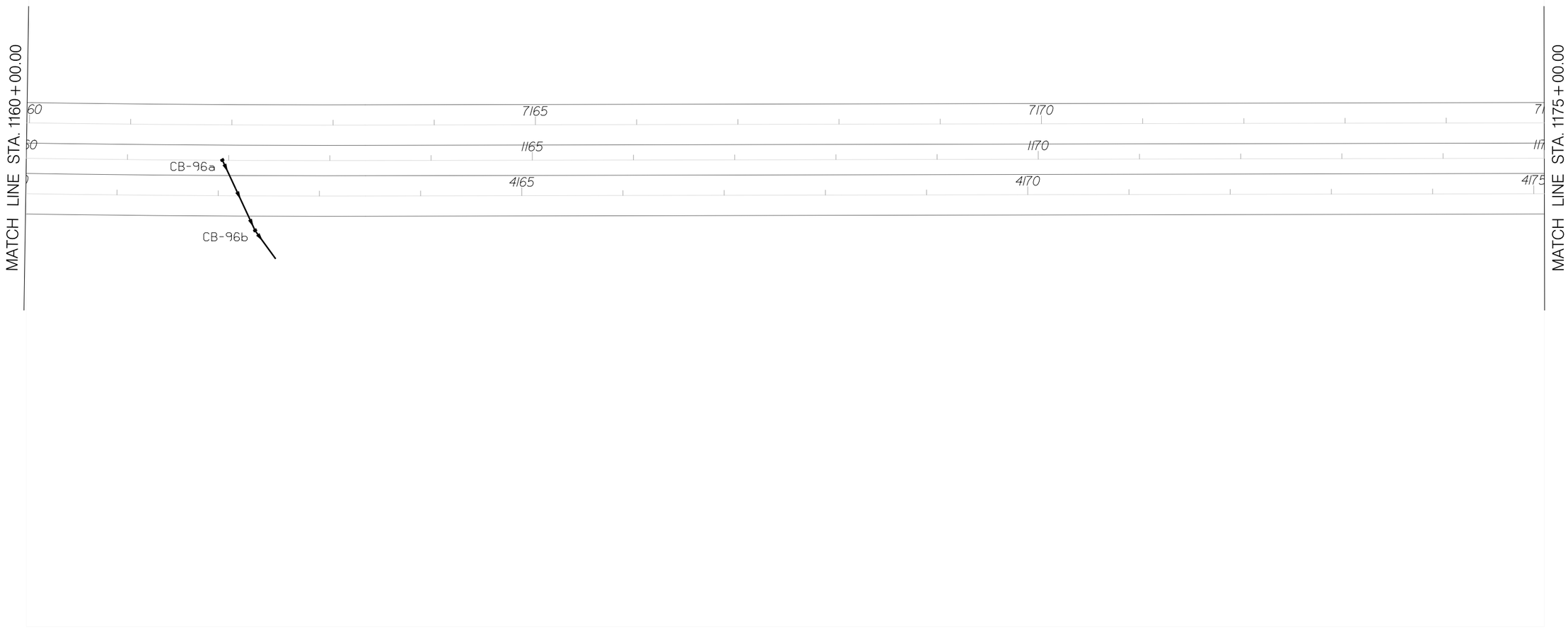
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-50	CB-96b	OF-96	Circular	Concrete	1	1.25	34	2.58	6.49	12.10	0.68	9.50	353.68	353.89	352.81	352.29	352.43	351.56	5.29	8.71	1.25	0.73
NP-49	CB-96a	CB-96b	Circular	Concrete	1	1.25	75	1.38	4.37	8.84	0.65	6.80	354.78	354.88	353.75	353.15	353.53	352.50	3.56	6.75	1.25	0.65

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-96b	5.00	2.16	9.03	0.26	0.78	0.26	0.78	0.00	0.00
CB-96a	5.00	4.37	9.03	0.55	0.73	0.55	0.73	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	45



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

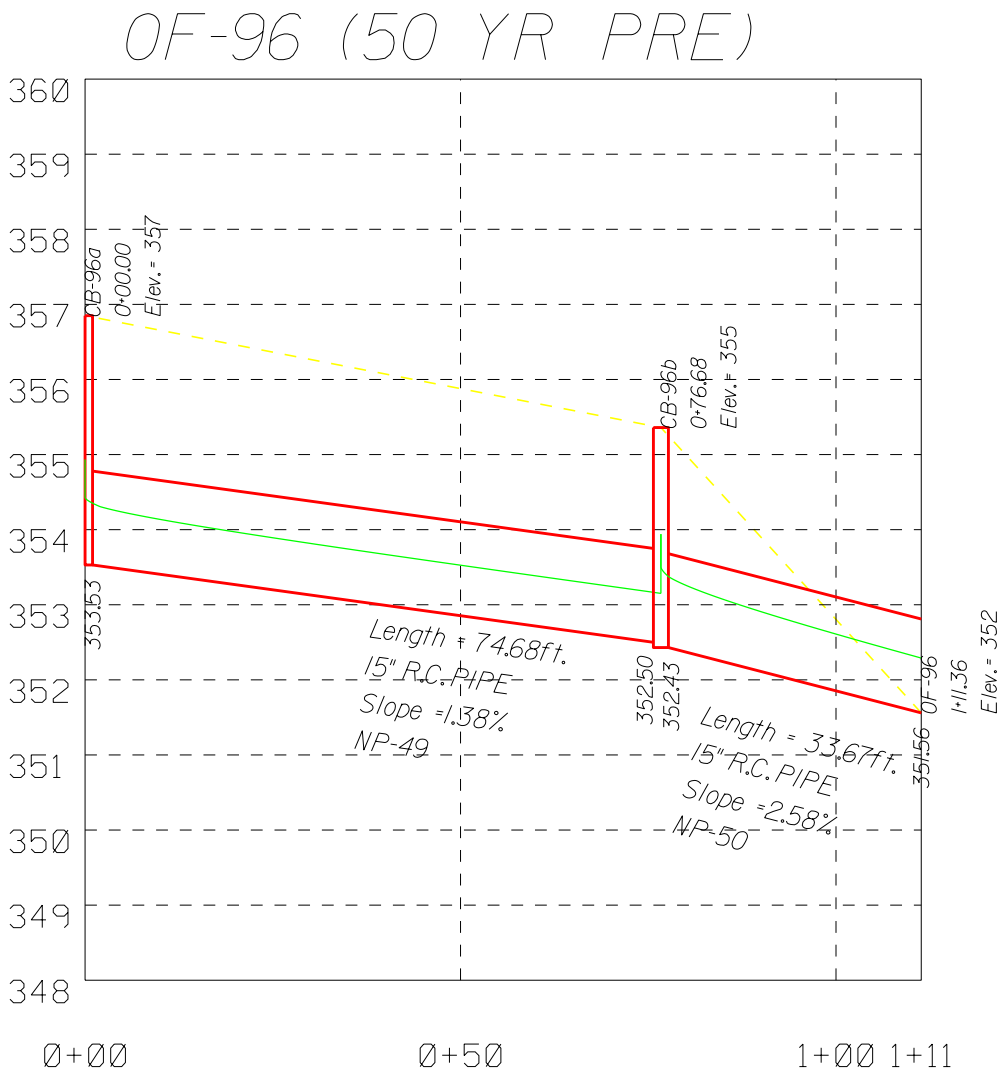
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1160+00.00 TO STA. 1175+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-96 (50 YR PRE)
360
359
358
357
356
355
354
353
352
351
350
349
348
0+00
0+50
1+00
1+11
CB-96a
0+00.00
Elev.= 357
353.53
Length = 74.68ft.
15" R.C. PIPE
Slope =1.38%
NP-49
CB-96b
0+76.68
Elev.= 355
352.50
352.43
Length = 33.67ft.
15" R.C. PIPE
Slope =2.58%
NP-50
OF-96
1+11.36
Elev.= 352
351.56

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

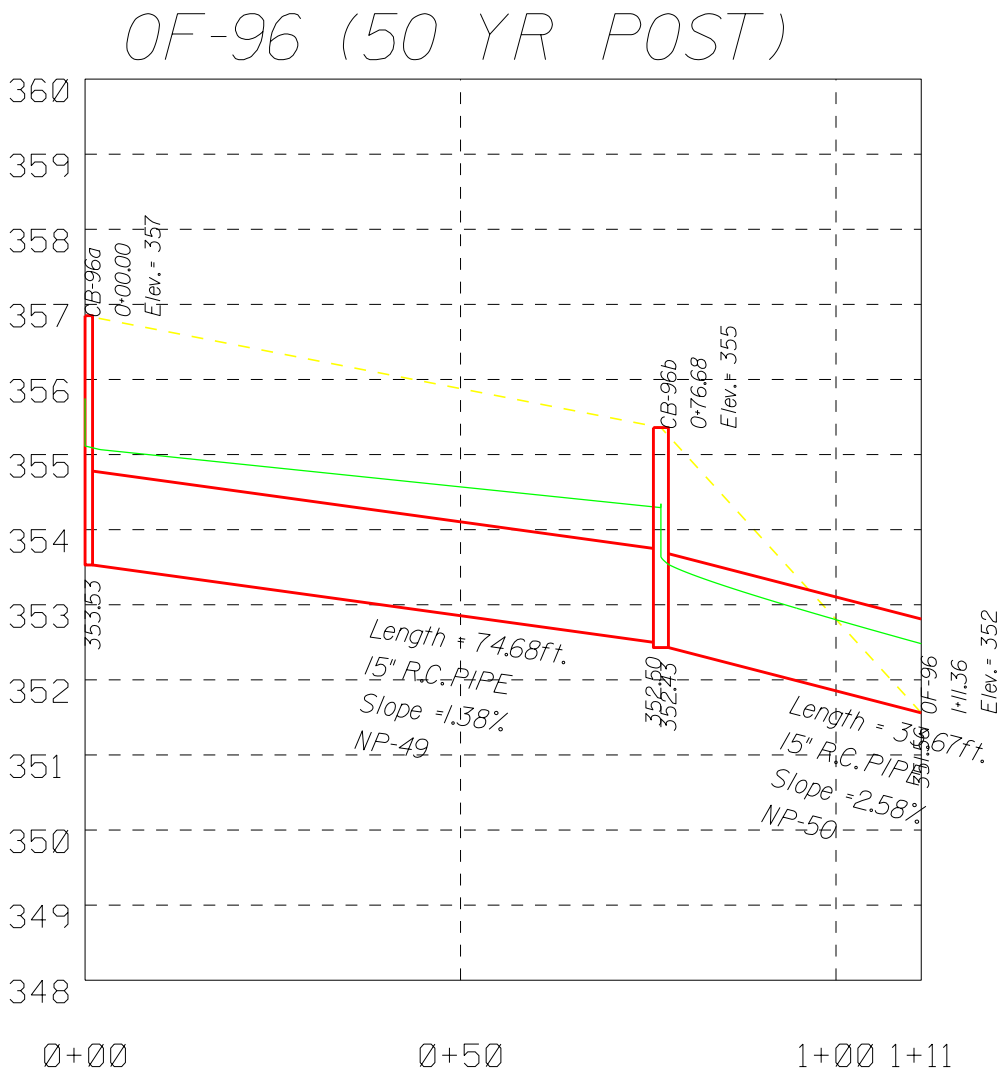
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-96	Outlet	OP	351.56	351.56	0.00	0.77	0.00	5.23	0.00	1.51	0.57	0.00
CB-96b	Other	C.B. TYPE 112	355.36	355.36	2.93	0.67	5.17	5.17	9.23	1.51	0.57	8.98
CB-96a	Other	C.B. TYPE 112	356.85	356.85	3.32	0.00	5.00	5.00	7.12	0.73	0.90	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-50	CB-96b	OF-96	Circular	Concrete	1	1.25	34	2.58	9.23	12.10	0.86	10.23	353.68	354.29	352.81	352.48	352.43	351.56	7.52	9.51	1.25	0.92
NP-49	CB-96a	CB-96b	Circular	Concrete	1	1.25	75	1.38	7.12	8.84	0.90	7.54	354.78	355.69	353.75	354.29	353.53	352.50	5.80	5.80	1.25	1.25

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-96b	5.00	2.16	9.03	0.26	0.78	0.26	0.78	0.00	0.00
CB-96a	5.00	7.12	9.03	0.90	0.73	0.90	0.73	0.00	0.00


OF-96 (50 YR POST)
360
359
358
357
356
355
354
353
352
351
350
349
348
0+00
0+50
1+00
1+11
CB-96a
0+00.00
Elev.= 357
353.53
Length = 74.68ft.
15" R.C. PIPE
Slope =1.38%
NP-49
CB-96b
0+76.68
Elev.= 355
352.50
352.43
Length = 36.67ft.
15" R.C. PIPE
Slope =2.58%
NP-50
OF-96
1+11.36
Elev.= 352

CULVERT 97

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 97**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.22	0.1975
Grass	0.25	0.20	0.0499
Woods	0.15	0.00	0.0000
	Σ	**0.42**	0.2473

$C_{ave} = \frac{0.2473}{0.42} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.42	0.3769
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.42**	0.3769

$C_{ave} = \frac{0.3769}{0.42} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.59	**x**	6.32	**x**	0.42	**x**	1	=	**1.56**	cfs
Q_{10} =	0.59	**x**	7.04	**x**	0.42	**x**	1	=	**1.74**	cfs
Q_{25} =	0.59	**x**	8.10	**x**	0.42	**x**	1.1	=	**2.20**	cfs
Q_{50} =	0.59	**x**	8.95	**x**	0.42	**x**	1.2	=	**2.66**	cfs
Q_{100} =	0.59	**x**	9.80	**x**	0.42	**x**	1.25	=	**3.03**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.32	**x**	0.42	**x**	1	=	**2.38**	cfs
Q_{10} =	0.90	**x**	7.04	**x**	0.42	**x**	1	=	**2.65**	cfs
Q_{25} =	0.90	**x**	8.10	**x**	0.42	**x**	1.1	=	**3.36**	cfs
Q_{50} =	0.90	**x**	8.95	**x**	0.42	**x**	1.2	=	**4.05**	cfs
Q_{100} =	0.90	**x**	9.80	**x**	0.42	**x**	1.25	=	**4.62**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.2 cfs

Design Flow: 2.66 cfs

Maximum Flow: 3.03 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1165+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
343.96	2.20	2.20	0.00	1
343.98	2.28	2.28	0.00	1
344.00	2.37	2.37	0.00	1
344.02	2.45	2.45	0.00	1
344.04	2.53	2.53	0.00	1
344.06	2.62	2.62	0.00	1
344.07	2.66	2.66	0.00	1
344.10	2.78	2.78	0.00	1
344.11	2.86	2.86	0.00	1
344.13	2.95	2.95	0.00	1
344.15	3.03	3.03	0.00	1
346.43	9.73	9.73	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.20	2.20	343.96	0.853	0.0*	1-S2n	0.387	0.592	0.387	0.547	6.574	1.301
2.28	2.28	343.98	0.873	0.0*	1-S2n	0.395	0.604	0.395	0.558	6.652	1.314
2.37	2.37	344.00	0.893	0.0*	1-S2n	0.402	0.615	0.402	0.568	6.727	1.328
2.45	2.45	344.02	0.912	0.0*	1-S2n	0.410	0.626	0.410	0.579	6.764	1.341
2.53	2.53	344.04	0.931	0.0*	1-S2n	0.417	0.637	0.417	0.589	6.829	1.353
2.62	2.62	344.06	0.950	0.0*	1-S2n	0.424	0.648	0.424	0.599	6.898	1.365
2.66	2.66	344.07	0.960	0.0*	1-S2n	0.428	0.653	0.428	0.604	6.934	1.372
2.78	2.78	344.10	0.987	0.0*	1-S2n	0.438	0.668	0.438	0.618	7.003	1.389
2.86	2.86	344.11	1.005	0.0*	1-S2n	0.445	0.678	0.445	0.628	7.061	1.400
2.95	2.95	344.13	1.023	0.0*	1-S2n	0.452	0.688	0.452	0.637	7.120	1.412
3.03	3.03	344.15	1.041	0.0*	1-S2n	0.459	0.697	0.459	0.647	7.179	1.423

* Full Flow Headwater elevation is below inlet invert.

****

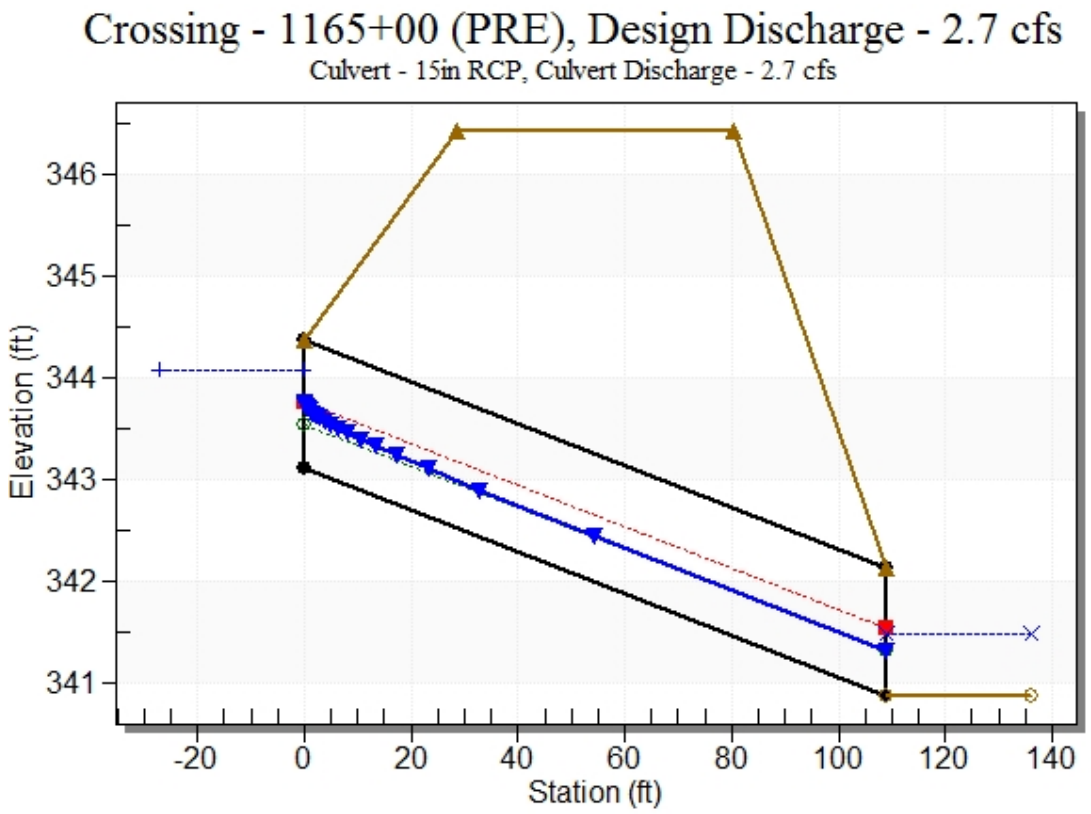
Straight Culvert

Inlet Elevation (invert): 343.11 ft, Outlet Elevation (invert): 340.88 ft

Culvert Length: 109.02 ft, Culvert Slope: 0.0205

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 343.11 ft

Outlet Station: 109.00 ft

Outlet Elevation: 340.88 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1165+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.20	341.43	0.55	1.30	0.34	0.36
2.28	341.44	0.56	1.31	0.35	0.36
2.37	341.45	0.57	1.33	0.35	0.36
2.45	341.46	0.58	1.34	0.36	0.36
2.53	341.47	0.59	1.35	0.37	0.36
2.62	341.48	0.60	1.37	0.37	0.36
2.66	341.48	0.60	1.37	0.38	0.36
2.78	341.50	0.62	1.39	0.39	0.37
2.86	341.51	0.63	1.40	0.39	0.37
2.95	341.52	0.64	1.41	0.40	0.37
3.03	341.53	0.65	1.42	0.40	0.37

Tailwater Channel Data - 1165+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 340.88 ft

Roadway Data for Crossing: 1165+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 346.43 ft

Roadway Surface: Paved

Roadway Top Width: 52.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.36 cfs

Design Flow: 4.05 cfs

Maximum Flow: 4.62 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1165+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
344.22	3.36	3.36	0.00	1
344.25	3.49	3.49	0.00	1
344.28	3.61	3.61	0.00	1
344.30	3.74	3.74	0.00	1
344.33	3.86	3.86	0.00	1
344.36	3.99	3.99	0.00	1
344.37	4.05	4.05	0.00	1
344.42	4.24	4.24	0.00	1
344.45	4.37	4.37	0.00	1
344.48	4.49	4.49	0.00	1
344.51	4.62	4.62	0.00	1
346.43	9.73	9.73	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.36	3.36	344.22	1.112	0.0*	1-S2n	0.486	0.733	0.486	0.682	7.375	1.464
3.49	3.49	344.25	1.140	0.0*	1-S2n	0.495	0.751	0.495	0.695	7.454	1.479
3.61	3.61	344.28	1.167	0.0*	1-S2n	0.505	0.764	0.505	0.708	7.513	1.493
3.74	3.74	344.30	1.194	0.0*	1-S2n	0.515	0.778	0.515	0.721	7.583	1.507
3.86	3.86	344.33	1.222	0.0*	1-S2n	0.524	0.791	0.524	0.733	7.655	1.521
3.99	3.99	344.36	1.250	0.0*	1-S2n	0.534	0.804	0.534	0.745	7.712	1.534
4.05	4.05	344.37	1.263	0.0*	5-S2n	0.538	0.810	0.538	0.751	7.742	1.541
4.24	4.24	344.42	1.307	0.0*	5-S2n	0.553	0.828	0.553	0.769	7.839	1.560
4.37	4.37	344.45	1.336	0.0*	5-S2n	0.562	0.844	0.562	0.780	7.902	1.573
4.49	4.49	344.48	1.366	0.0*	5-S2n	0.571	0.857	0.571	0.791	7.952	1.585
4.62	4.62	344.51	1.396	0.0*	5-S2n	0.581	0.869	0.581	0.803	8.010	1.597

* Full Flow Headwater elevation is below inlet invert.

****

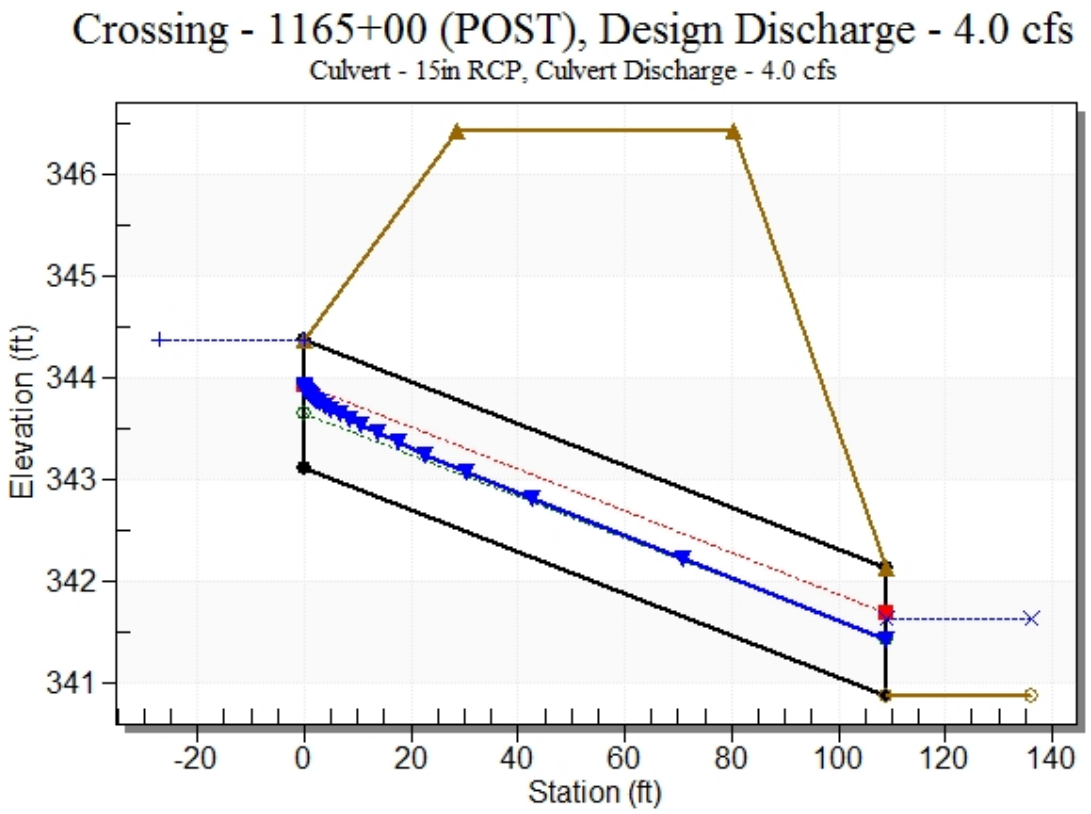
Straight Culvert

Inlet Elevation (invert): 343.11 ft, Outlet Elevation (invert): 340.88 ft

Culvert Length: 109.02 ft, Culvert Slope: 0.0205

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 343.11 ft

Outlet Station: 109.00 ft

Outlet Elevation: 340.88 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1165+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.36	341.56	0.68	1.46	0.43	0.37
3.49	341.58	0.70	1.48	0.43	0.37
3.61	341.59	0.71	1.49	0.44	0.37
3.74	341.60	0.72	1.51	0.45	0.37
3.86	341.61	0.73	1.52	0.46	0.37
3.99	341.63	0.75	1.53	0.46	0.37
4.05	341.63	0.75	1.54	0.47	0.37
4.24	341.65	0.77	1.56	0.48	0.38
4.37	341.66	0.78	1.57	0.49	0.38
4.49	341.67	0.79	1.58	0.49	0.38
4.62	341.68	0.80	1.60	0.50	0.38

Tailwater Channel Data - 1165+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 340.88 ft

Roadway Data for Crossing: 1165+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 346.43 ft

Roadway Surface: Paved

Roadway Top Width: 52.00 ft

CULVERT 16

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 16, South_Carolina
User:
Date: Sunday, December 17, 2017 09:47 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 16
   Basin Drainage Area: 4.06 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 4.06 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

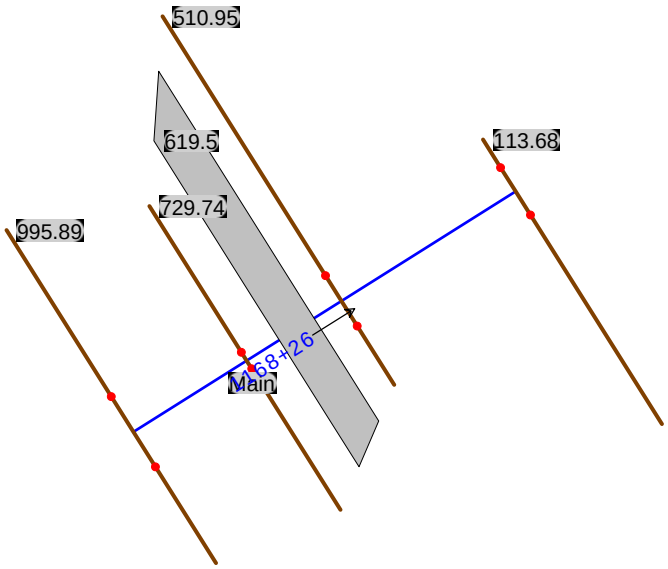
Results for: Site 16

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

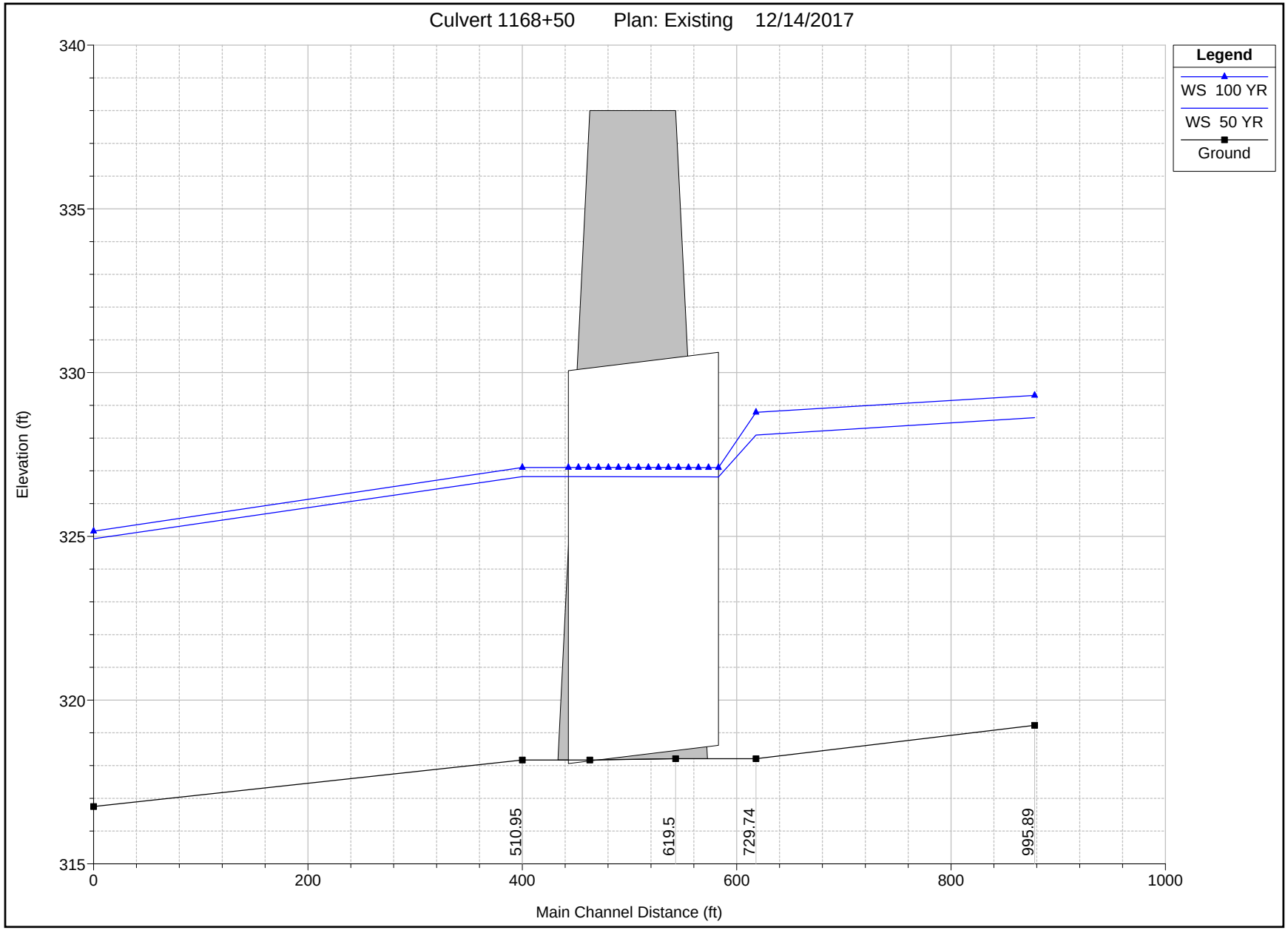
00149*PCTREG3)

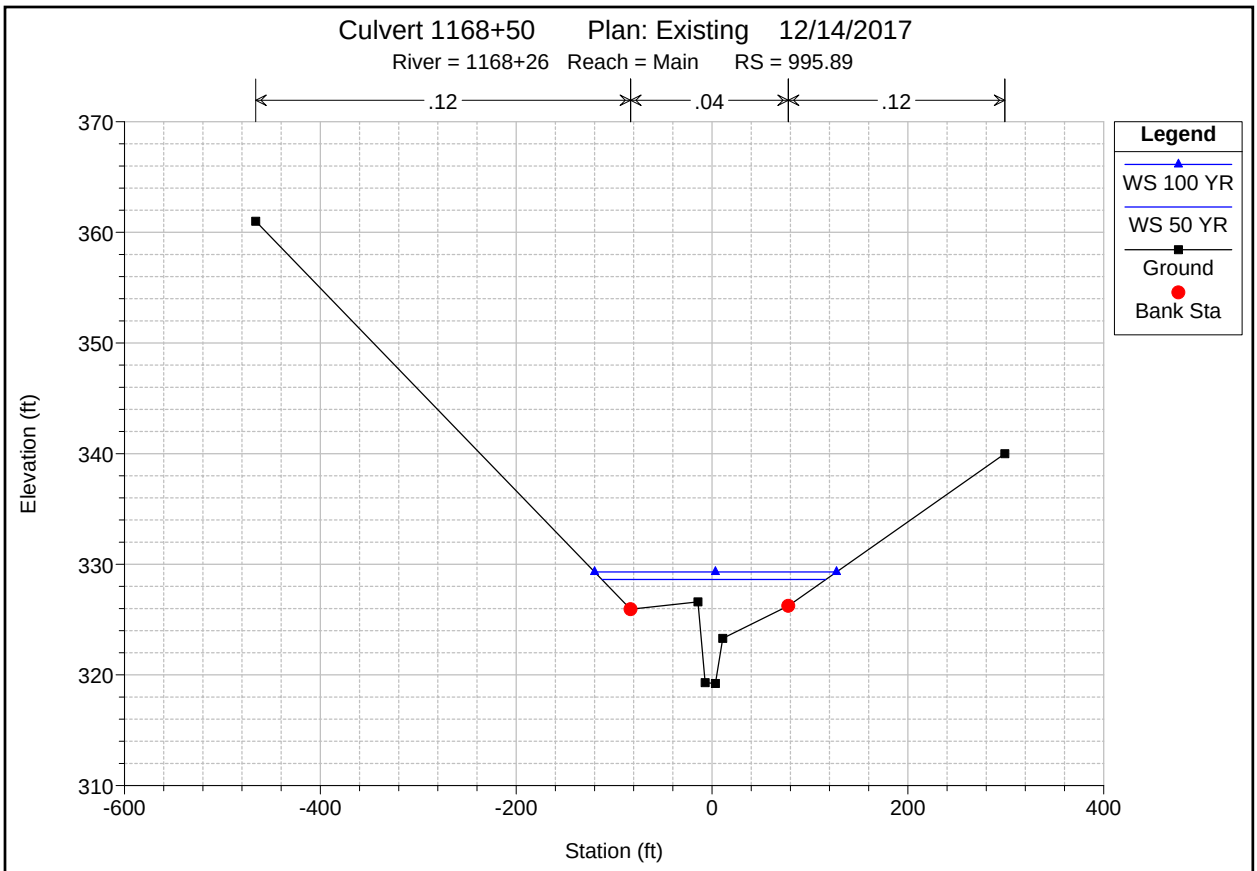
Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	393	226	684	35
PK5	710	412	1230	34
PK10	945	539	1660	35
PK25	1260	691	2280	38
PK50	1530	816	2870	40
PK100	1780	919	3460	42
PK200	2030	1010	4090	44
PK500	2430	1150	5120	48

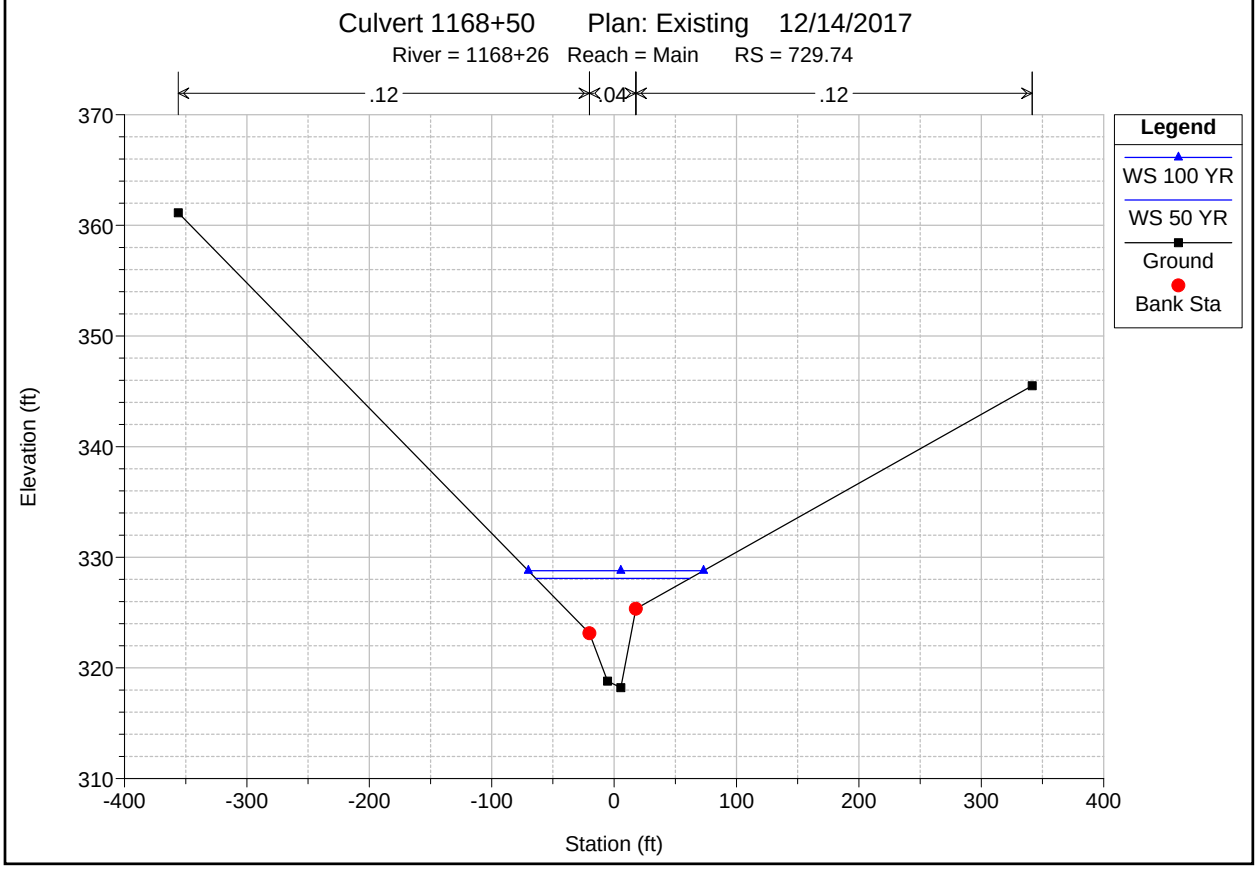
maximum: 14300 (for C&B region 2)

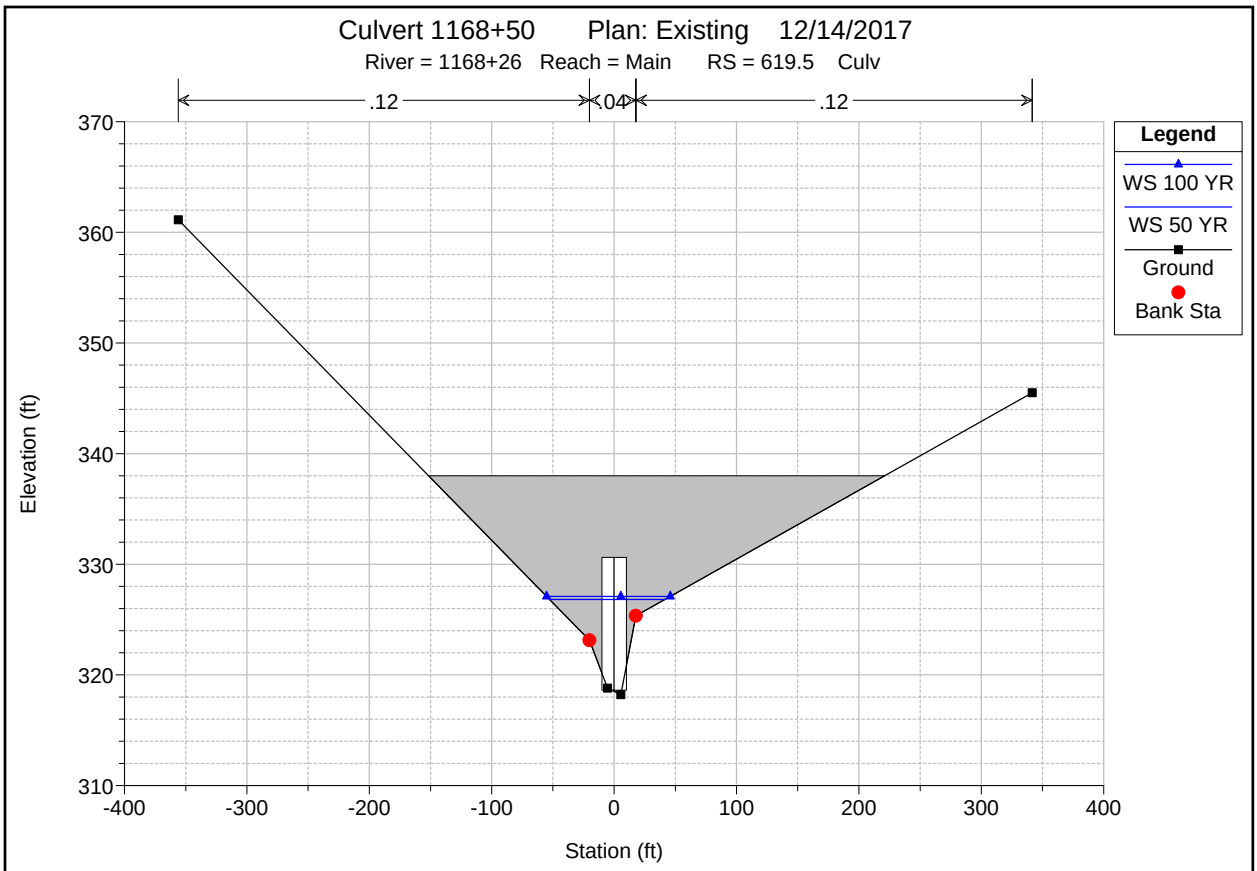


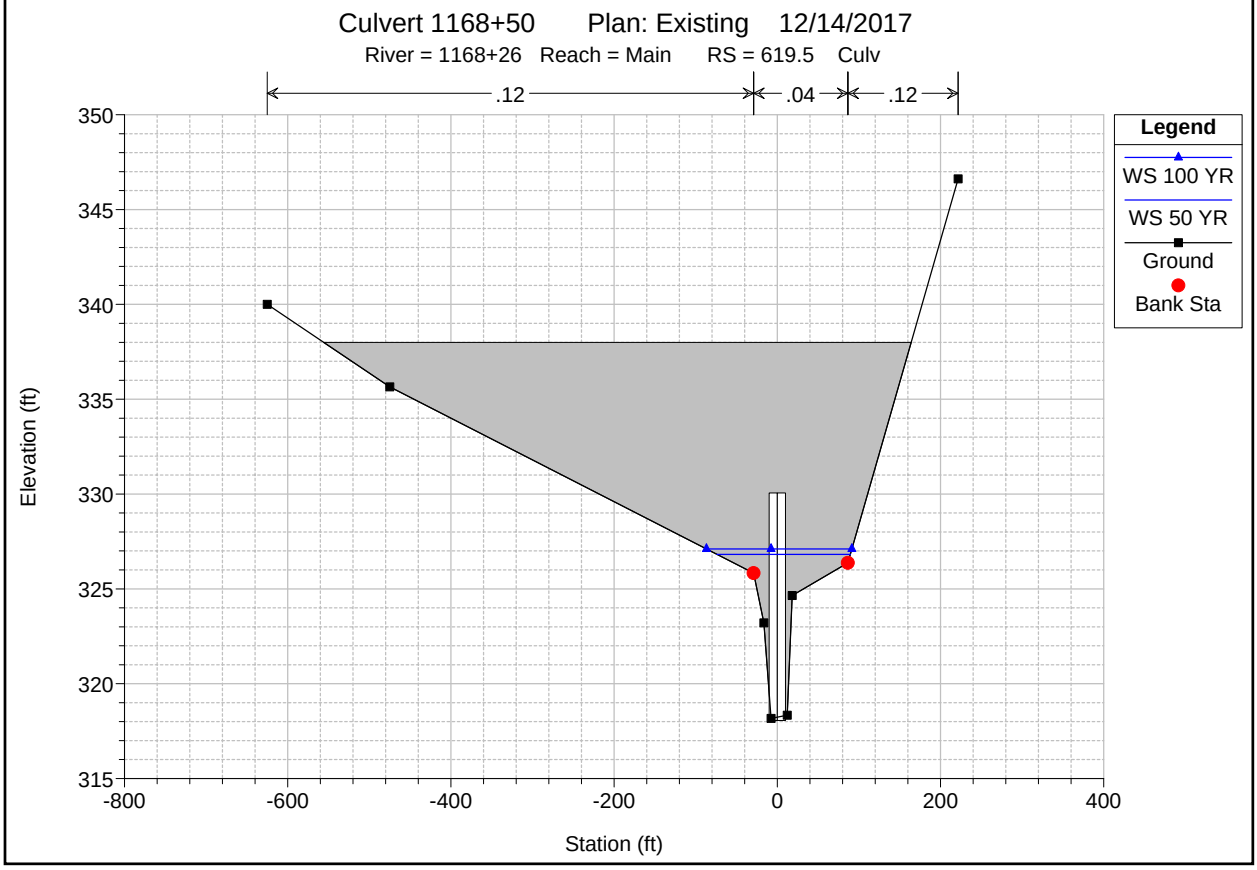
None of the XS's are Geo-Referenced (Geo-Ref user entered XS Geo-Ref interpolated XS Non Geo-Ref user entered XS Non Geo-Ref interpolated XS)

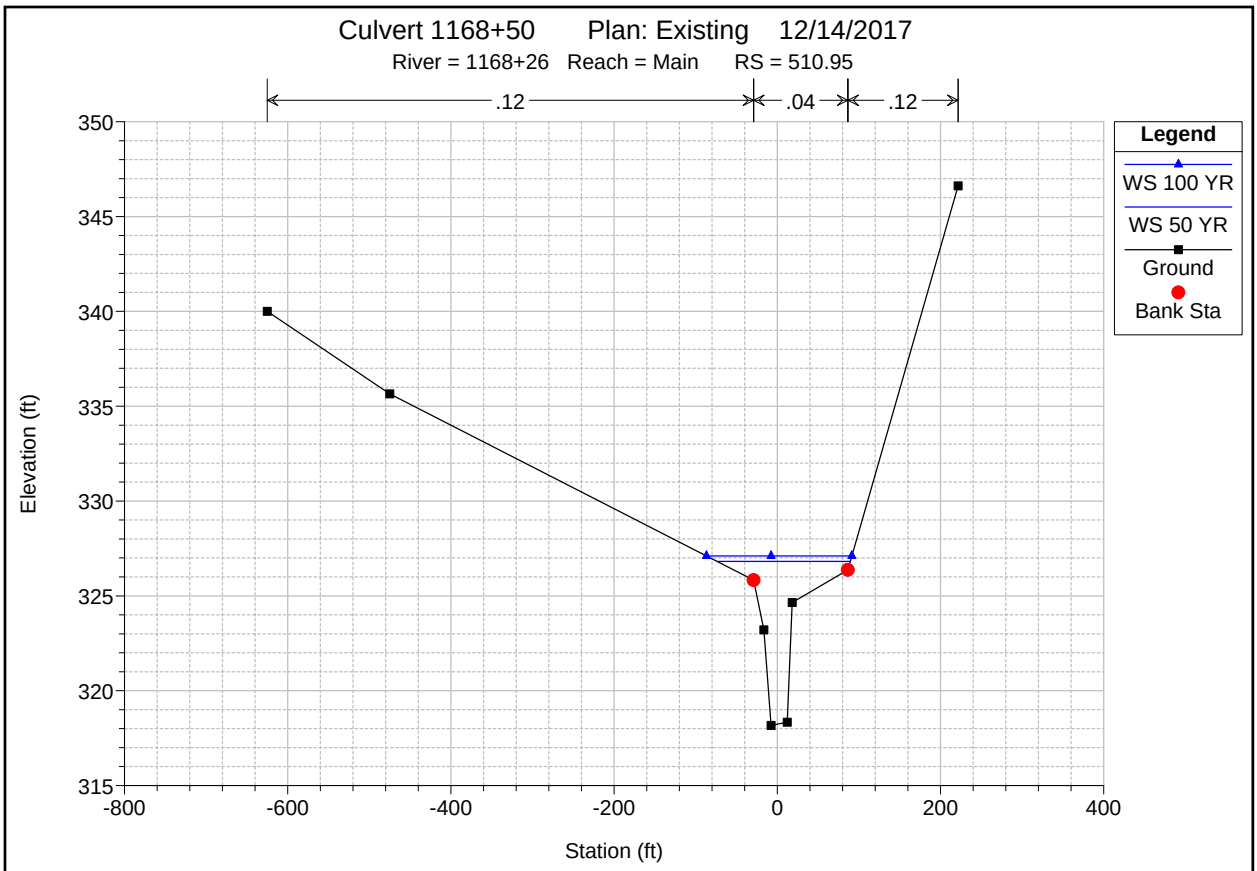

Culvert 1168+50 Plan: Existing 12/14/2017
Legend
WS 100 YR
WS 50 YR
Ground
Elevation (ft)
340
335
330
325
320
315
0
200
400
600
800
1000
Main Channel Distance (ft)
510.95
619.5
729.74
995.89

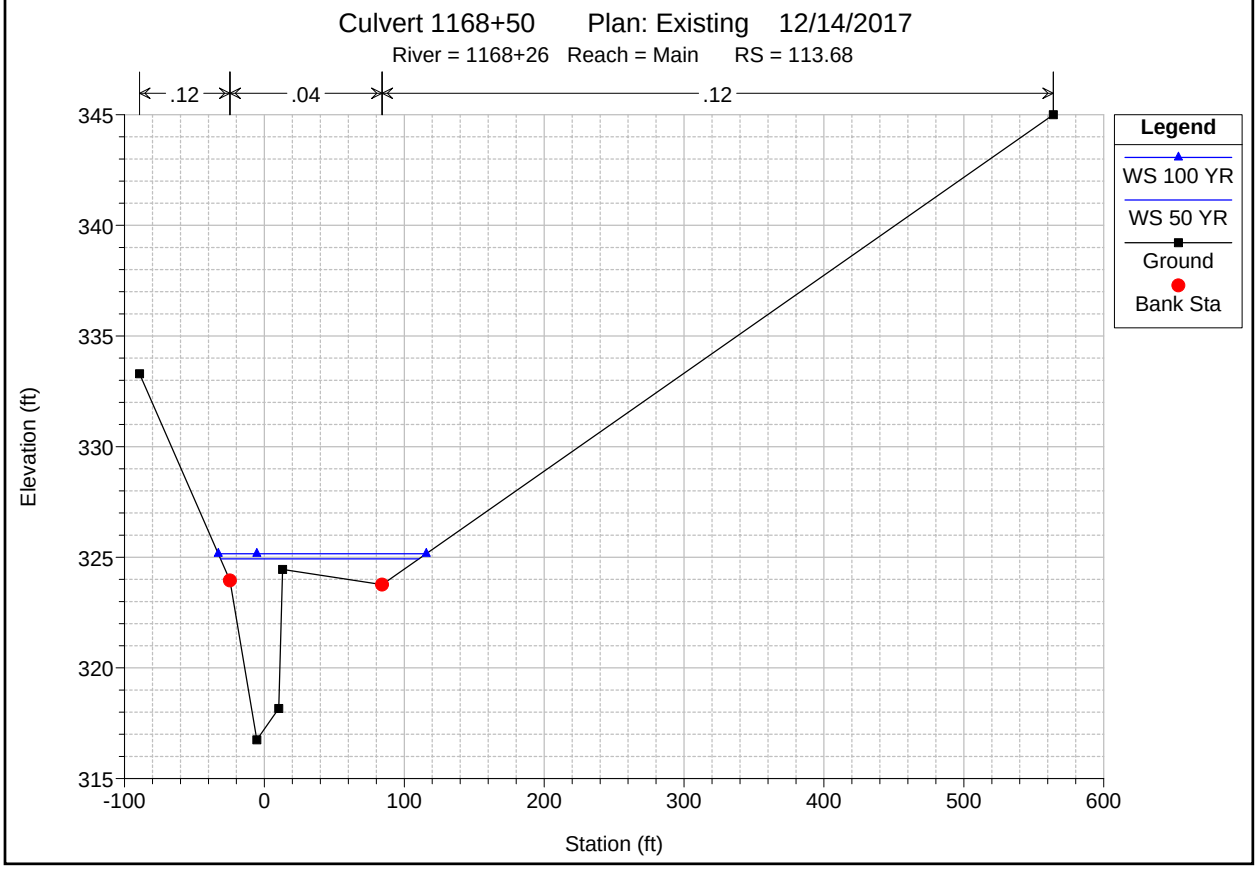

Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 995.89
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
370
360
350
340
330
320
310
-600
-400
-200
0
200
400
Station (ft)


Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 729.74
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
370
360
350
340
330
320
310
-400
-300
-200
-100
0
100
200
300
400
Station (ft)


Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 619.5 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
370
360
350
340
330
320
310
-400
-300
-200
-100
0
100
200
300
400


Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 619.5 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
350
345
340
335
330
325
320
315
-800
-600
-400
-200
0
200
400


Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 510.95
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
350
345
340
335
330
325
320
315
-800
-600
-400
-200
0
200
400


Culvert 1168+50 Plan: Existing 12/14/2017
River = 1168+26 Reach = Main RS = 113.68
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
345
340
335
330
325
320
315
-100
0
100
200
300
400
500
600

HEC-RAS Plan: Existing River: 1168+26 Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	995.89	50 YR	1530.00	319.23	328.62		328.71	0.000746	2.44	699.43	228.70	0.22
Main	995.89	100 YR	1780.00	319.23	329.30		329.39	0.000573	2.38	861.44	247.08	0.20
Main	729.74	50 YR	1530.00	318.21	328.09	324.14	328.44	0.001286	4.92	455.84	125.82	0.31
Main	729.74	100 YR	1780.00	318.21	328.79	324.61	329.15	0.001236	5.11	549.23	143.13	0.31
Main	619.5		Culvert									
Main	510.95	50 YR	1530.00	318.17	326.82		327.08	0.002607	4.06	397.97	163.63	0.40
Main	510.95	100 YR	1780.00	318.17	327.10		327.39	0.002652	4.32	446.06	178.28	0.41
Main	113.68	50 YR	1530.00	316.75	324.93	322.72	325.40	0.007002	5.56	291.65	141.86	0.62
Main	113.68	100 YR	1780.00	316.75	325.16	323.19	325.69	0.007005	5.89	325.39	148.71	0.63

HEC-RAS Plan: Existing River: 1168+26 Reach: Main

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Main	619.5 Culvert #1	50 YR	328.44	328.09	327.67	328.44	338.01	1530.00		1.27	9.34	8.73
Main	619.5 Culvert #1	100 YR	329.15	328.79	328.66	329.15	338.01	1780.00		1.68	10.50	9.84

CULVERT 98

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 98**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4334
Grass	0.25	1.05	0.2636
Woods	0.15	4.10	0.6157
	Σ	**5.64**	1.3127

$C_{ave} = \frac{1.3127}{5.64} = 0.23$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.57	0.5171
Grass	0.25	0.28	0.0688
Woods	0.15	4.10	0.6157
	Σ	**4.95**	1.2016

$C_{ave} = \frac{1.2016}{4.95} = 0.24$

T_c = 21.61 min.
I_{05} = 4.37 in / hr
I_{10} = 4.82 in / hr
I_{25} = 5.48 in / hr
I_{50} = 6.00 in / hr
I_{100} = 6.51 in / hr

Pre Construction Runoff:

Q_{05} =	0.23	x	4.37	x	5.64	x	1	=	**5.74**	cfs
Q_{10} =	0.23	x	4.82	x	5.64	x	1	=	**6.33**	cfs
Q_{25} =	0.23	x	5.48	x	5.64	x	1.1	=	**7.92**	cfs
Q_{50} =	0.23	x	6.00	x	5.64	x	1.2	=	**9.46**	cfs
Q_{100} =	0.23	x	6.51	x	5.64	x	1.25	=	**10.69**	cfs

Post Construction Runoff:

Q_{05} =	0.24	x	4.37	x	4.95	x	1	=	**5.25**	cfs
Q_{10} =	0.24	x	4.82	x	4.95	x	1	=	**5.79**	cfs
Q_{25} =	0.24	x	5.48	x	4.95	x	1.1	=	**7.25**	cfs
Q_{50} =	0.24	x	6.00	x	4.95	x	1.2	=	**8.66**	cfs
Q_{100} =	0.24	x	6.51	x	4.95	x	1.25	=	**9.78**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 98	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0800**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.338**	+		=	**0.338**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**400**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.022**	+		=	**0.022**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.360**
						min		**21.61**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.92 cfs

Design Flow: 9.46 cfs

Maximum Flow: 10.69 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1175+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
335.06	7.92	7.92	0.00	1
335.09	8.20	8.20	0.00	1
335.12	8.47	8.47	0.00	1
335.15	8.75	8.75	0.00	1
335.18	9.03	9.03	0.00	1
335.21	9.30	9.30	0.00	1
335.23	9.46	9.46	0.00	1
335.27	9.86	9.86	0.00	1
335.30	10.14	10.14	0.00	1
335.33	10.41	10.41	0.00	1
335.36	10.69	10.69	0.00	1
336.09	16.98	16.98	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.92	7.92	335.06	1.440	0.0*	1-S2n	0.536	1.001	0.536	0.798	11.304	2.758
8.20	8.20	335.09	1.472	0.0*	1-S2n	0.545	1.019	0.545	0.812	11.423	2.784
8.47	8.47	335.12	1.503	0.0*	1-S2n	0.555	1.037	0.555	0.826	11.536	2.809
8.75	8.75	335.15	1.533	0.0*	1-S2n	0.564	1.054	0.564	0.840	11.599	2.833
9.03	9.03	335.18	1.564	0.0*	1-S2n	0.573	1.070	0.607	0.853	10.842	2.857
9.30	9.30	335.21	1.594	0.0*	1-S2n	0.582	1.087	0.595	0.866	11.466	2.880
9.46	9.46	335.23	1.610	0.0*	1-S2n	0.587	1.096	0.587	0.873	11.883	2.893
9.86	9.86	335.27	1.653	0.0*	1-S2n	0.600	1.118	0.600	0.891	12.030	2.925
10.14	10.14	335.30	1.683	0.0*	1-S2n	0.609	1.134	0.609	0.903	12.127	2.947
10.41	10.41	335.33	1.712	0.0*	1-S2n	0.617	1.153	0.617	0.916	12.186	2.968
10.69	10.69	335.36	1.742	0.0*	1-S2n	0.626	1.169	0.626	0.928	12.284	2.989

* Full Flow Headwater elevation is below inlet invert.

****

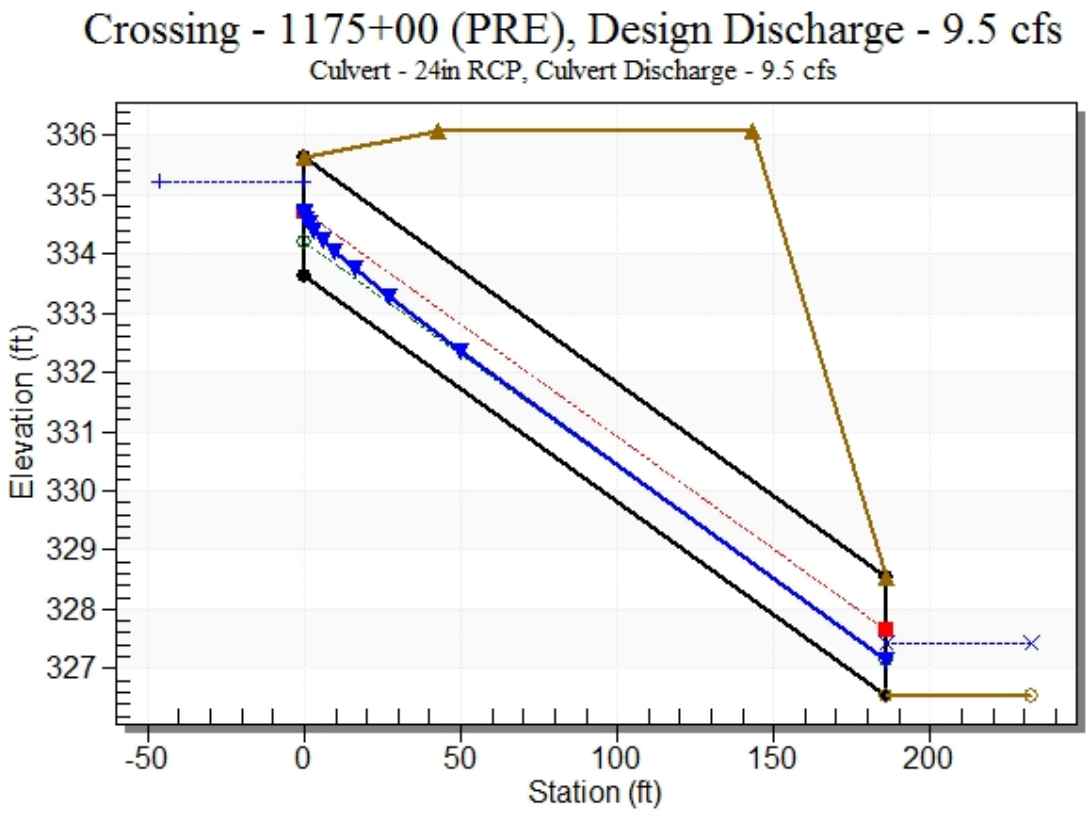
Straight Culvert

Inlet Elevation (invert): 333.62 ft, Outlet Elevation (invert): 326.55 ft

Culvert Length: 186.13 ft, Culvert Slope: 0.0380

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 333.62 ft

Outlet Station: 186.00 ft

Outlet Elevation: 326.55 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1175+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.92	327.35	0.80	2.76	1.49	0.65
8.20	327.36	0.81	2.78	1.52	0.66
8.47	327.38	0.83	2.81	1.55	0.66
8.75	327.39	0.84	2.83	1.57	0.66
9.03	327.40	0.85	2.86	1.60	0.66
9.30	327.42	0.87	2.88	1.62	0.66
9.46	327.42	0.87	2.89	1.63	0.66
9.86	327.44	0.89	2.93	1.67	0.66
10.14	327.45	0.90	2.95	1.69	0.66
10.41	327.47	0.92	2.97	1.71	0.66
10.69	327.48	0.93	2.99	1.74	0.67

Tailwater Channel Data - 1175+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 326.55 ft

Roadway Data for Crossing: 1175+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.09 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.25 cfs

Design Flow: 8.66 cfs

Maximum Flow: 9.78 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1175+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
334.98	7.25	7.25	0.00	1
335.01	7.50	7.50	0.00	1
335.04	7.76	7.76	0.00	1
335.07	8.01	8.01	0.00	1
335.10	8.26	8.26	0.00	1
335.13	8.52	8.52	0.00	1
335.14	8.66	8.66	0.00	1
335.18	9.02	9.02	0.00	1
335.21	9.27	9.27	0.00	1
335.24	9.53	9.53	0.00	1
335.26	9.78	9.78	0.00	1
336.09	16.98	16.98	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.25	7.25	334.98	1.363	0.0*	1-S2n	0.513	0.956	0.548	0.763	10.039	2.693
7.50	7.50	335.01	1.392	0.0*	1-S2n	0.521	0.974	0.527	0.777	10.948	2.718
7.76	7.76	335.04	1.422	0.0*	1-S2n	0.530	0.991	0.530	0.790	11.231	2.742
8.01	8.01	335.07	1.451	0.0*	1-S2n	0.539	1.007	0.539	0.803	11.343	2.766
8.26	8.26	335.10	1.479	0.0*	1-S2n	0.547	1.023	0.547	0.816	11.450	2.790
8.52	8.52	335.13	1.507	0.0*	1-S2n	0.556	1.039	0.556	0.828	11.553	2.812
8.66	8.66	335.14	1.523	0.0*	1-S2n	0.561	1.048	0.561	0.835	11.610	2.825
9.02	9.02	335.18	1.563	0.0*	1-S2n	0.573	1.070	0.607	0.852	10.827	2.857
9.27	9.27	335.21	1.590	0.0*	1-S2n	0.581	1.085	0.597	0.864	11.393	2.878
9.53	9.53	335.24	1.618	0.0*	1-S2n	0.589	1.100	0.589	0.876	11.908	2.899
9.78	9.78	335.26	1.645	0.0*	1-S2n	0.597	1.114	0.597	0.888	12.002	2.919

* Full Flow Headwater elevation is below inlet invert.

****

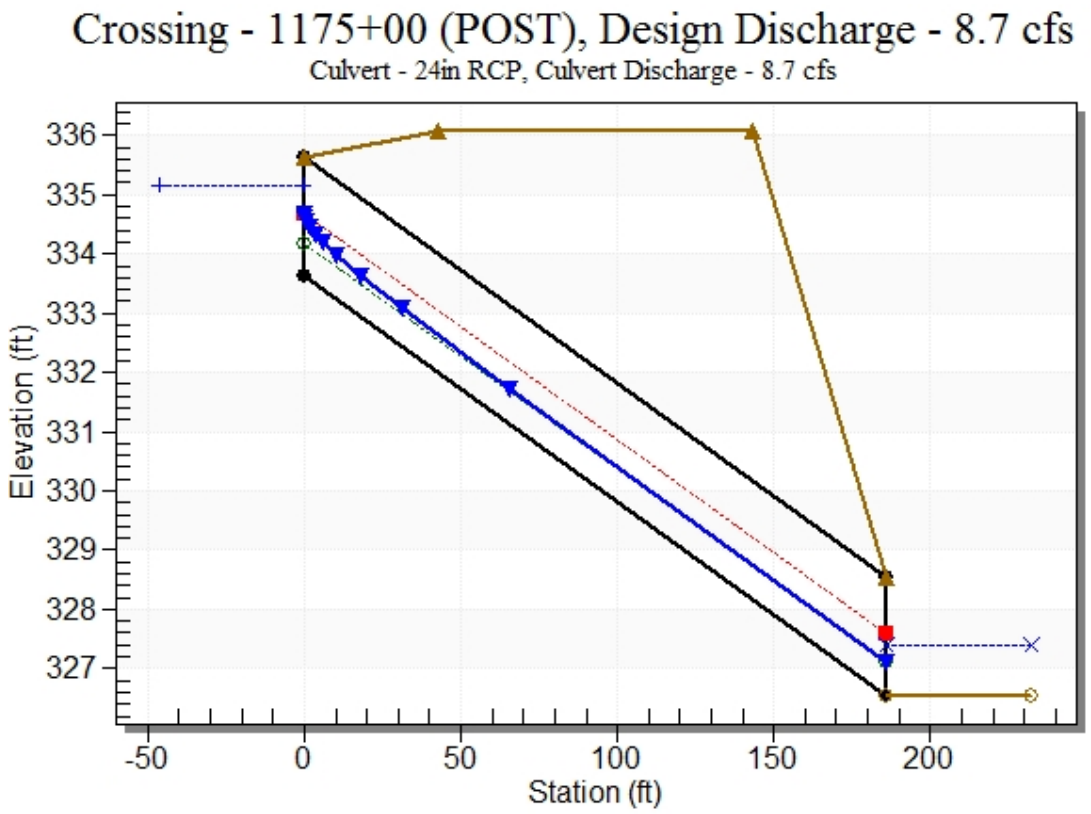
Straight Culvert

Inlet Elevation (invert): 333.62 ft, Outlet Elevation (invert): 326.55 ft

Culvert Length: 186.13 ft, Culvert Slope: 0.0380

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 333.62 ft

Outlet Station: 186.00 ft

Outlet Elevation: 326.55 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1175+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.25	327.31	0.76	2.69	1.43	0.65
7.50	327.33	0.78	2.72	1.45	0.65
7.76	327.34	0.79	2.74	1.48	0.65
8.01	327.35	0.80	2.77	1.50	0.65
8.26	327.37	0.82	2.79	1.53	0.66
8.52	327.38	0.83	2.81	1.55	0.66
8.66	327.39	0.84	2.82	1.56	0.66
9.02	327.40	0.85	2.86	1.60	0.66
9.27	327.41	0.86	2.88	1.62	0.66
9.53	327.43	0.88	2.90	1.64	0.66
9.78	327.44	0.89	2.92	1.66	0.66

Tailwater Channel Data - 1175+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 326.55 ft

Roadway Data for Crossing: 1175+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 336.09 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 17

Hydrograph Report

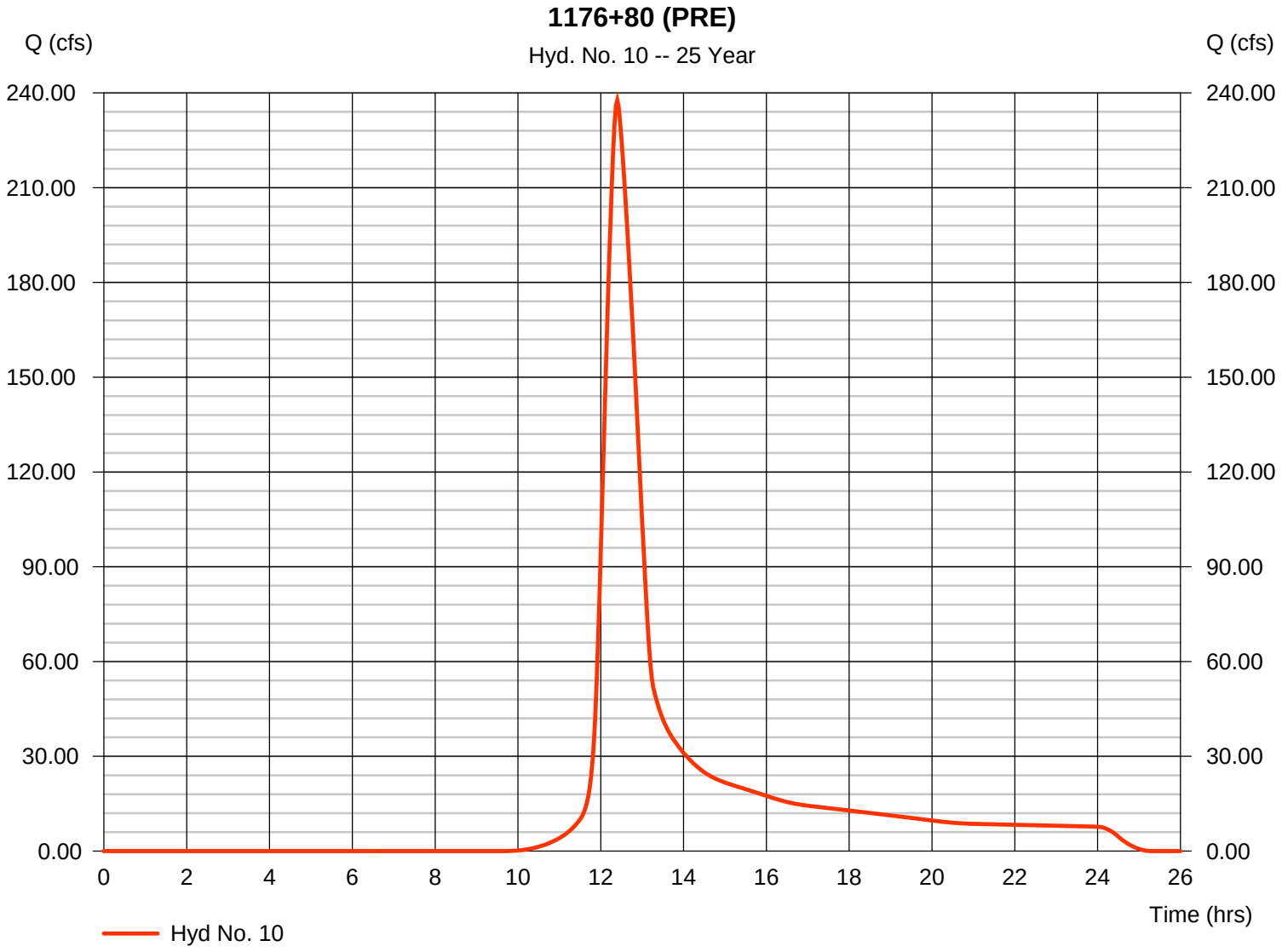
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 10

1176+80 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	237.67 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	1,382,330 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



Hydrograph Report

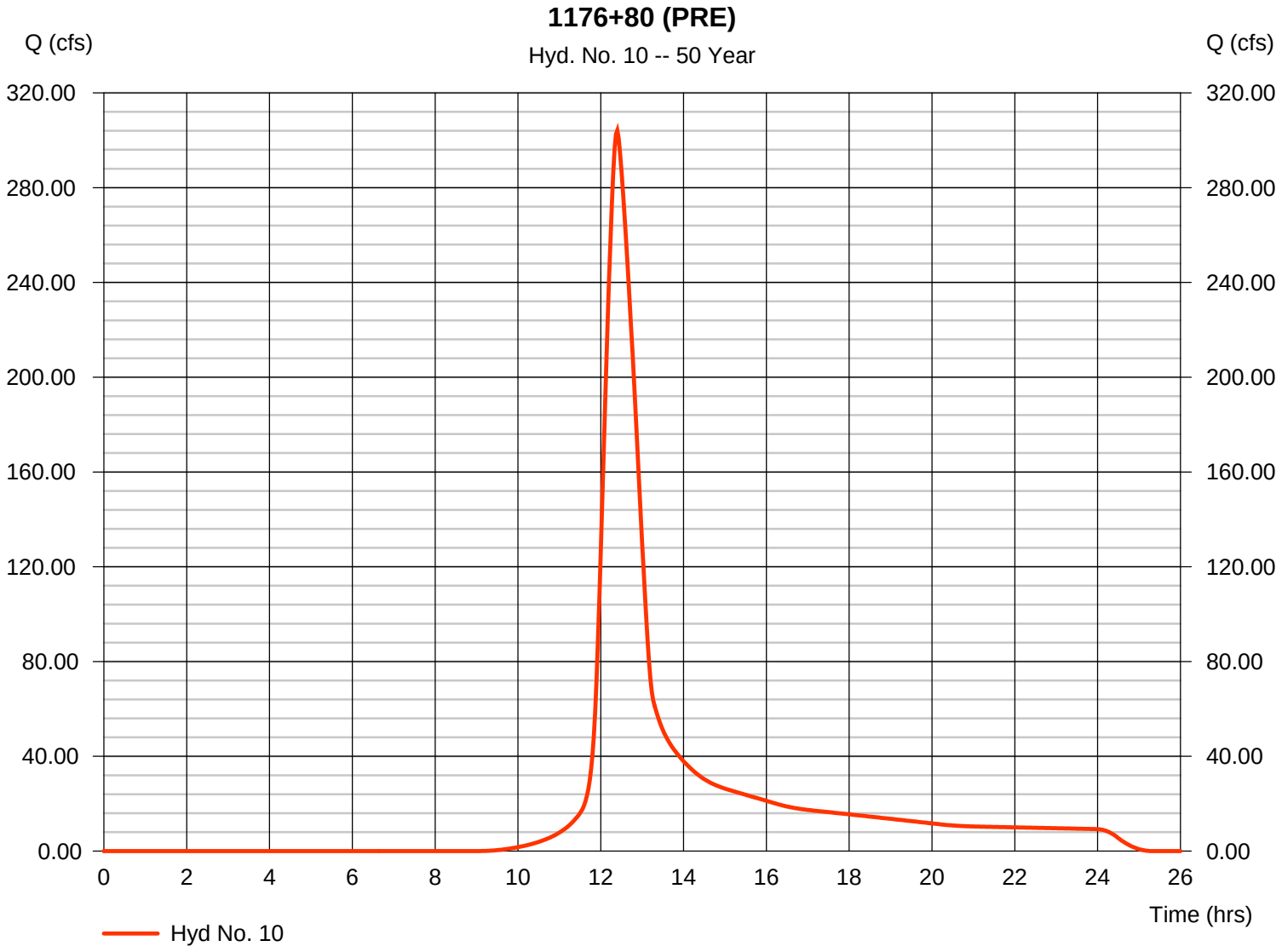
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 10

1176+80 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	304.11 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	1,746,624 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



Hydrograph Report

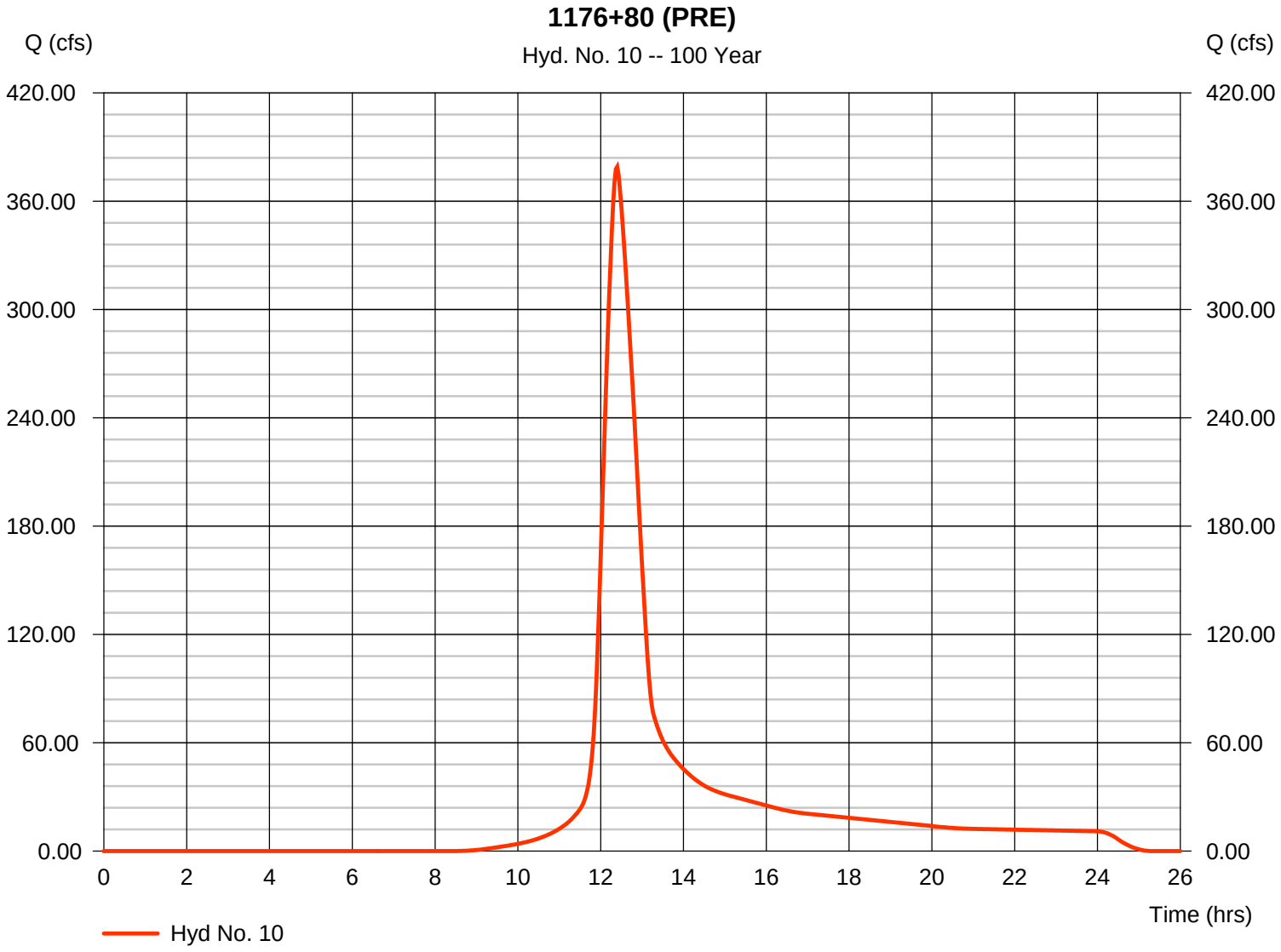
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 10

1176+80 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	379.10 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	2,160,550 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



Hydrograph Report

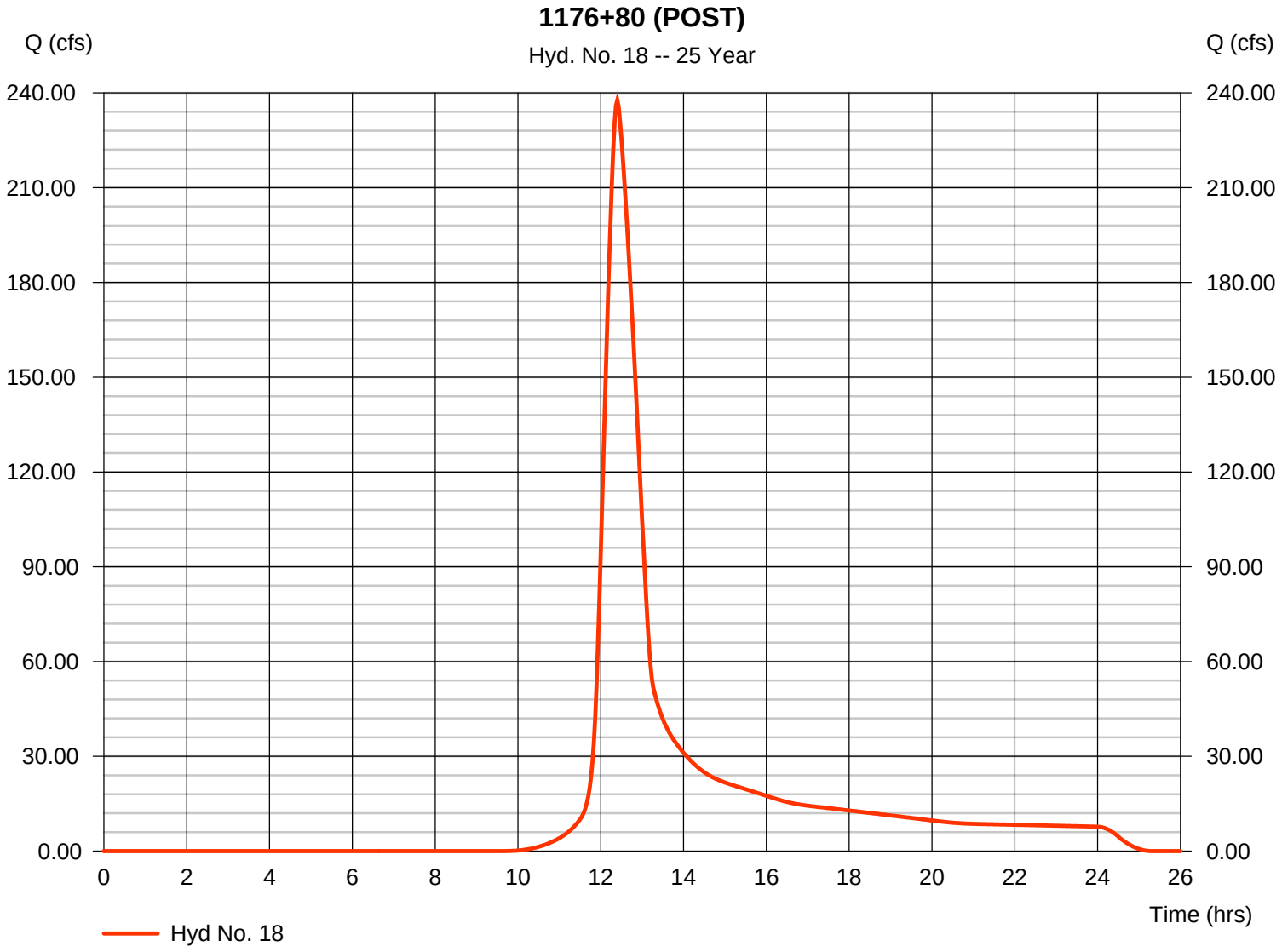
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 18

1176+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	237.67 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	1,382,330 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



Hydrograph Report

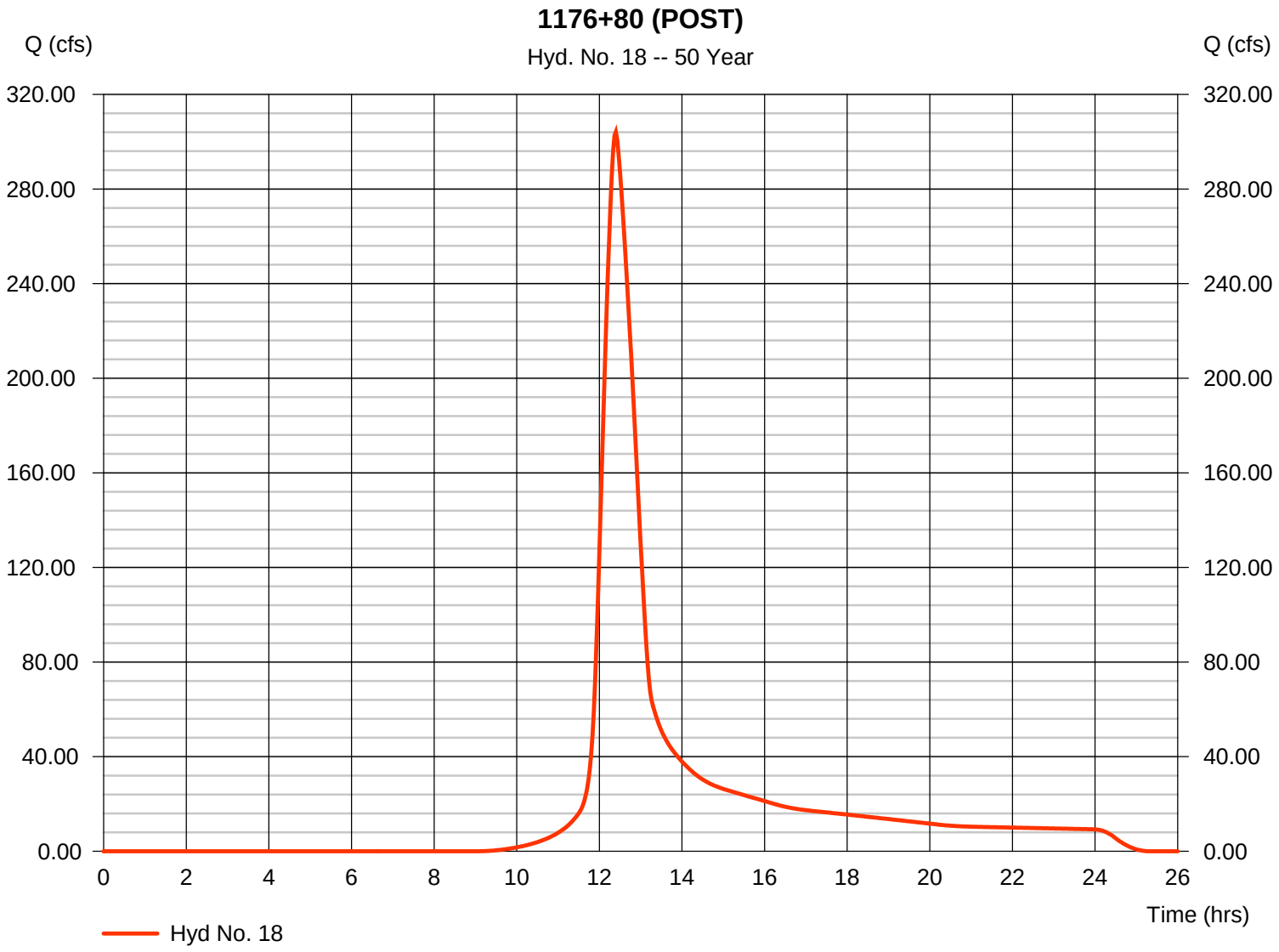
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 18

1176+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	304.11 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	1,746,624 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



Hydrograph Report

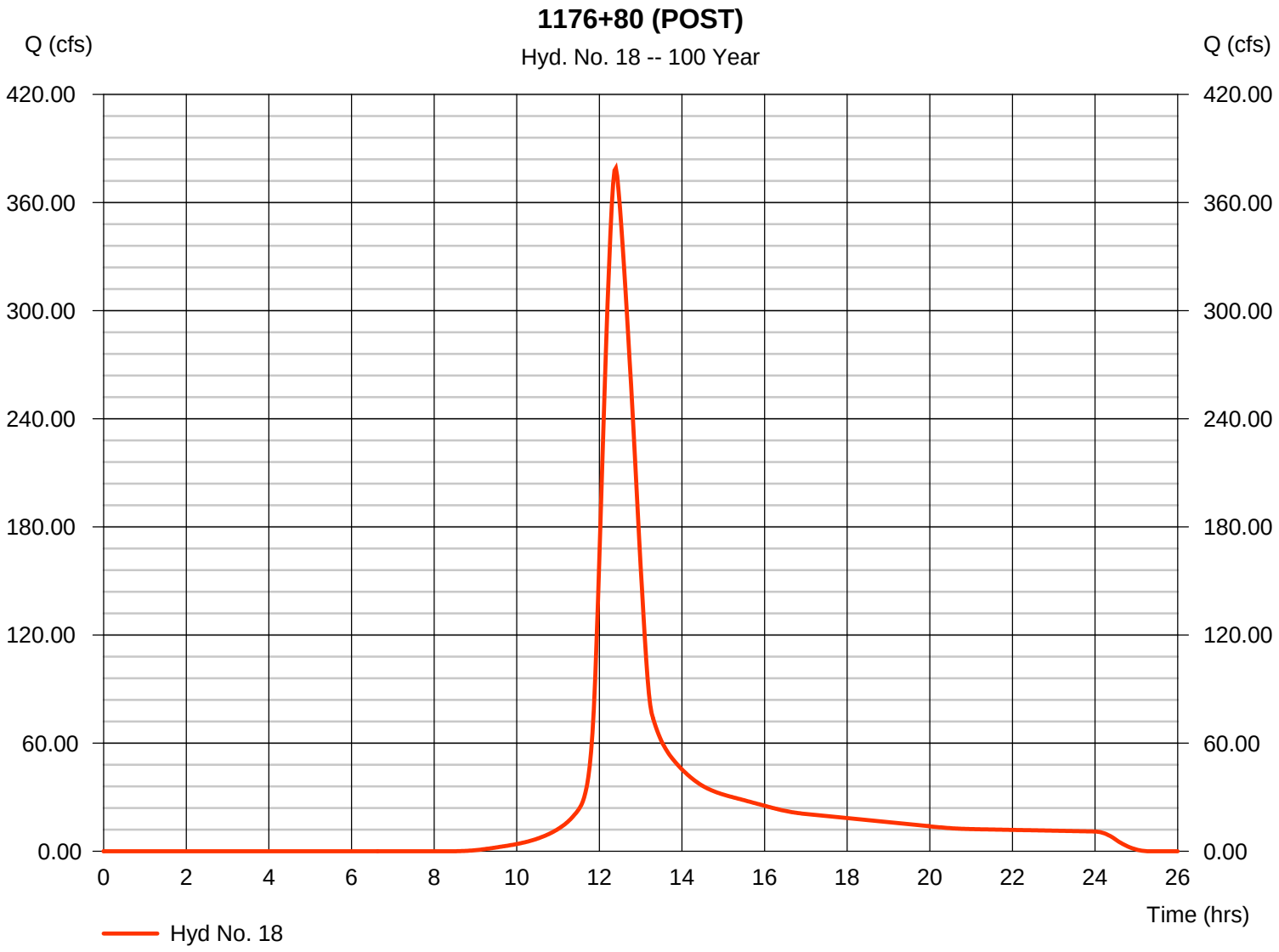
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 18

1176+80 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	379.10 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	2,160,550 cuft
Drainage area	=	142.100 ac	Curve number	=	66*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(65.240 x 70) + (8.630 x 74) + (7.920 x 98) + (49.130 x 55) + (11.180 x 61)] / 142.100



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 237.67 cfs

Design Flow: 304.11 cfs

Maximum Flow: 379.1 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1176+80 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
336.08	237.67	237.67	0.00	1
336.31	251.81	251.81	0.00	1
336.53	265.96	265.96	0.00	1
336.75	280.10	280.10	0.00	1
336.96	294.24	294.24	0.00	1
337.12	304.11	304.11	0.00	1
337.40	322.53	322.53	0.00	1
337.62	336.67	336.67	0.00	1
337.85	350.81	350.81	0.00	1
338.07	364.96	364.96	0.00	1
338.30	379.10	379.10	0.00	1
340.00	476.26	476.26	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
237.67	237.67	336.08	5.654	3.425	1-S2n	2.492	3.653	2.750	3.945	14.402	4.338
251.81	251.81	336.31	5.876	3.666	1-S2n	2.601	3.796	2.875	4.054	14.596	4.403
265.96	265.96	336.53	6.097	3.910	5-S2n	2.708	3.937	2.996	4.160	14.793	4.465
280.10	280.10	336.75	6.316	4.159	5-S2n	2.815	4.075	3.117	4.262	14.977	4.526
294.24	294.24	336.96	6.534	4.412	5-S2n	2.921	4.211	3.237	4.361	15.151	4.583
304.11	304.11	337.12	6.687	4.591	5-S2n	2.994	4.305	3.319	4.428	15.272	4.622
322.53	322.53	337.40	6.973	4.933	5-S2n	3.130	4.477	3.471	4.551	15.488	4.693
336.67	336.67	337.62	7.194	5.201	5-S2n	3.233	4.607	3.587	4.642	15.642	4.745
350.81	350.81	337.85	7.417	6.110	5-S2n	3.336	4.735	3.702	4.731	15.795	4.795
364.96	364.96	338.07	7.643	6.365	5-S2n	3.439	4.862	3.814	4.818	15.946	4.844
379.10	379.10	338.30	7.872	6.627	5-S2n	3.540	4.986	3.928	4.903	16.086	4.891

****

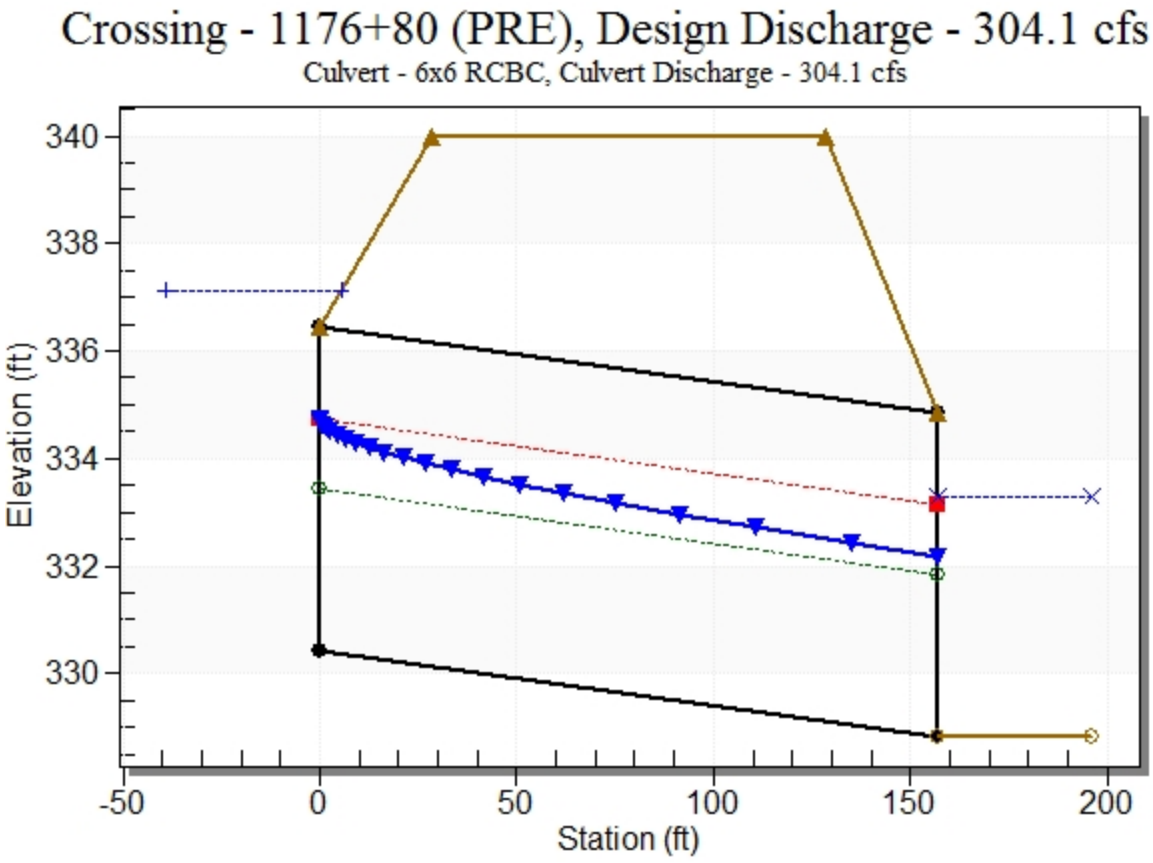
Straight Culvert

Inlet Elevation (invert): 330.43 ft, Outlet Elevation (invert): 328.84 ft

Culvert Length: 157.01 ft, Culvert Slope: 0.0101

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 330.43 ft

Outlet Station: 157.00 ft

Outlet Elevation: 328.84 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1176+80 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
237.67	332.78	3.94	4.34	2.46	0.48
251.81	332.89	4.05	4.40	2.53	0.48
265.96	333.00	4.16	4.47	2.60	0.49
280.10	333.10	4.26	4.53	2.66	0.49
294.24	333.20	4.36	4.58	2.72	0.49
304.11	333.27	4.43	4.62	2.76	0.49
322.53	333.39	4.55	4.69	2.84	0.49
336.67	333.48	4.64	4.74	2.90	0.49
350.81	333.57	4.73	4.79	2.95	0.49
364.96	333.66	4.82	4.84	3.01	0.49
379.10	333.74	4.90	4.89	3.06	0.50

Tailwater Channel Data - 1176+80 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 328.84 ft

Roadway Data for Crossing: 1176+80 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 340.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 237.67 cfs

Design Flow: 304.11 cfs

Maximum Flow: 379.1 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1176+80 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
336.08	237.67	237.67	0.00	1
336.31	251.81	251.81	0.00	1
336.53	265.96	265.96	0.00	1
336.75	280.10	280.10	0.00	1
336.96	294.24	294.24	0.00	1
337.12	304.11	304.11	0.00	1
337.40	322.53	322.53	0.00	1
337.62	336.67	336.67	0.00	1
337.85	350.81	350.81	0.00	1
338.07	364.96	364.96	0.00	1
338.30	379.10	379.10	0.00	1
340.00	476.26	476.26	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
237.67	237.67	336.08	5.654	3.425	1-S2n	2.492	3.653	2.750	3.945	14.402	4.338
251.81	251.81	336.31	5.876	3.666	1-S2n	2.601	3.796	2.875	4.054	14.596	4.403
265.96	265.96	336.53	6.097	3.910	5-S2n	2.708	3.937	2.996	4.160	14.793	4.465
280.10	280.10	336.75	6.316	4.159	5-S2n	2.815	4.075	3.117	4.262	14.977	4.526
294.24	294.24	336.96	6.534	4.412	5-S2n	2.921	4.211	3.237	4.361	15.151	4.583
304.11	304.11	337.12	6.687	4.591	5-S2n	2.994	4.305	3.319	4.428	15.272	4.622
322.53	322.53	337.40	6.973	4.933	5-S2n	3.130	4.477	3.471	4.551	15.488	4.693
336.67	336.67	337.62	7.194	5.201	5-S2n	3.233	4.607	3.587	4.642	15.642	4.745
350.81	350.81	337.85	7.417	6.110	5-S2n	3.336	4.735	3.702	4.731	15.795	4.795
364.96	364.96	338.07	7.643	6.365	5-S2n	3.439	4.862	3.814	4.818	15.946	4.844
379.10	379.10	338.30	7.872	6.627	5-S2n	3.540	4.986	3.928	4.903	16.086	4.891

****

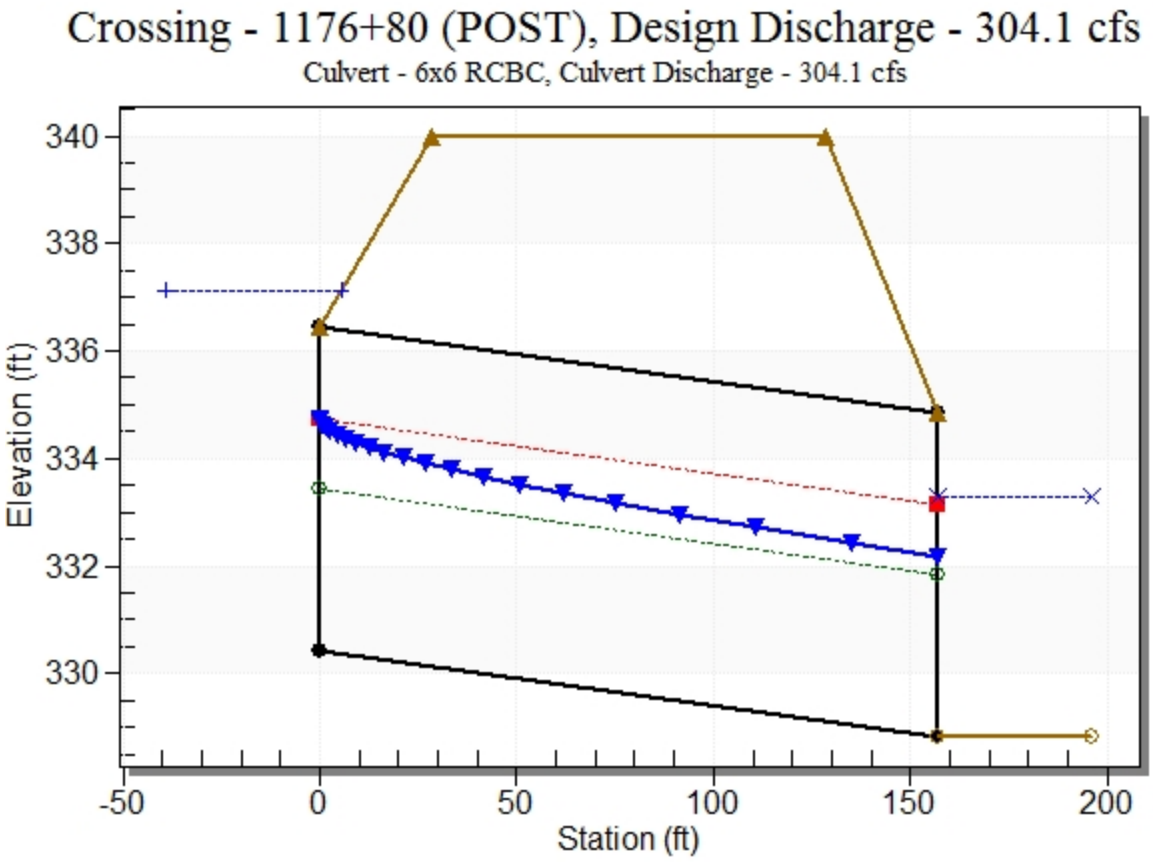
Straight Culvert

Inlet Elevation (invert): 330.43 ft, Outlet Elevation (invert): 328.84 ft

Culvert Length: 157.01 ft, Culvert Slope: 0.0101

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 330.43 ft

Outlet Station: 157.00 ft

Outlet Elevation: 328.84 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1176+80 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
237.67	332.78	3.94	4.34	2.46	0.48
251.81	332.89	4.05	4.40	2.53	0.48
265.96	333.00	4.16	4.47	2.60	0.49
280.10	333.10	4.26	4.53	2.66	0.49
294.24	333.20	4.36	4.58	2.72	0.49
304.11	333.27	4.43	4.62	2.76	0.49
322.53	333.39	4.55	4.69	2.84	0.49
336.67	333.48	4.64	4.74	2.90	0.49
350.81	333.57	4.73	4.79	2.95	0.49
364.96	333.66	4.82	4.84	3.01	0.49
379.10	333.74	4.90	4.89	3.06	0.50

Tailwater Channel Data - 1176+80 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 328.84 ft

Roadway Data for Crossing: 1176+80 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 340.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 99

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700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 99**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.41	0.3724
Grass	0.25	0.30	0.0752
Woods	0.15	0.00	0.0000
	Σ	**0.71**	0.4476

$C_{ave} = \frac{0.4476}{0.71} = 0.63$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.71	0.6390
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.71**	0.6390

$C_{ave} = \frac{0.6390}{0.71} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.63	**x**	6.32	**x**	0.71	**x**	1	=	**2.83**	cfs
Q_{10} =	0.63	**x**	7.04	**x**	0.71	**x**	1	=	**3.15**	cfs
Q_{25} =	0.63	**x**	8.10	**x**	0.71	**x**	1.1	=	**3.99**	cfs
Q_{50} =	0.63	**x**	8.95	**x**	0.71	**x**	1.2	=	**4.81**	cfs
Q_{100} =	0.63	**x**	9.80	**x**	0.71	**x**	1.25	=	**5.48**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.32	**x**	0.71	**x**	1	=	**4.04**	cfs
Q_{10} =	0.90	**x**	7.04	**x**	0.71	**x**	1	=	**4.50**	cfs
Q_{25} =	0.90	**x**	8.10	**x**	0.71	**x**	1.1	=	**5.70**	cfs
Q_{50} =	0.90	**x**	8.95	**x**	0.71	**x**	1.2	=	**6.87**	cfs
Q_{100} =	0.90	**x**	9.80	**x**	0.71	**x**	1.25	=	**7.83**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.99 cfs

Design Flow: 4.81 cfs

Maximum Flow: 5.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1180+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
339.23	3.99	3.99	0.00	1
339.26	4.14	4.14	0.00	1
339.30	4.29	4.29	0.00	1
339.33	4.44	4.44	0.00	1
339.37	4.59	4.59	0.00	1
339.40	4.74	4.74	0.00	1
339.42	4.81	4.81	0.00	1
339.48	5.03	5.03	0.00	1
339.52	5.18	5.18	0.00	1
339.56	5.33	5.33	0.00	1
339.60	5.48	5.48	0.00	1
341.65	10.39	10.39	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.99	3.99	339.23	1.249	0.0*	1-S2n	0.525	0.804	0.525	0.623	7.895	1.972
4.14	4.14	339.26	1.283	0.0*	5-S2n	0.536	0.818	0.536	0.635	7.963	1.993
4.29	4.29	339.30	1.317	0.0*	5-S2n	0.547	0.837	0.547	0.647	8.038	2.012
4.44	4.44	339.33	1.352	0.0*	5-S2n	0.557	0.851	0.578	0.658	7.730	2.032
4.59	4.59	339.37	1.387	0.0*	5-S2n	0.568	0.865	0.568	0.670	8.177	2.050
4.74	4.74	339.40	1.423	0.0*	5-S2n	0.579	0.879	0.601	0.681	7.845	2.068
4.81	4.81	339.42	1.442	0.0*	5-S2n	0.584	0.886	0.584	0.687	8.279	2.077
5.03	5.03	339.48	1.498	0.0*	5-S2n	0.599	0.907	0.622	0.703	7.982	2.103
5.18	5.18	339.52	1.538	0.0*	5-S2n	0.610	0.920	0.610	0.713	8.432	2.120
5.33	5.33	339.56	1.578	0.0*	5-S2n	0.620	0.932	0.620	0.724	8.493	2.137
5.48	5.48	339.60	1.619	0.0*	5-S2n	0.630	0.945	0.630	0.734	8.549	2.153

* Full Flow Headwater elevation is below inlet invert.

****

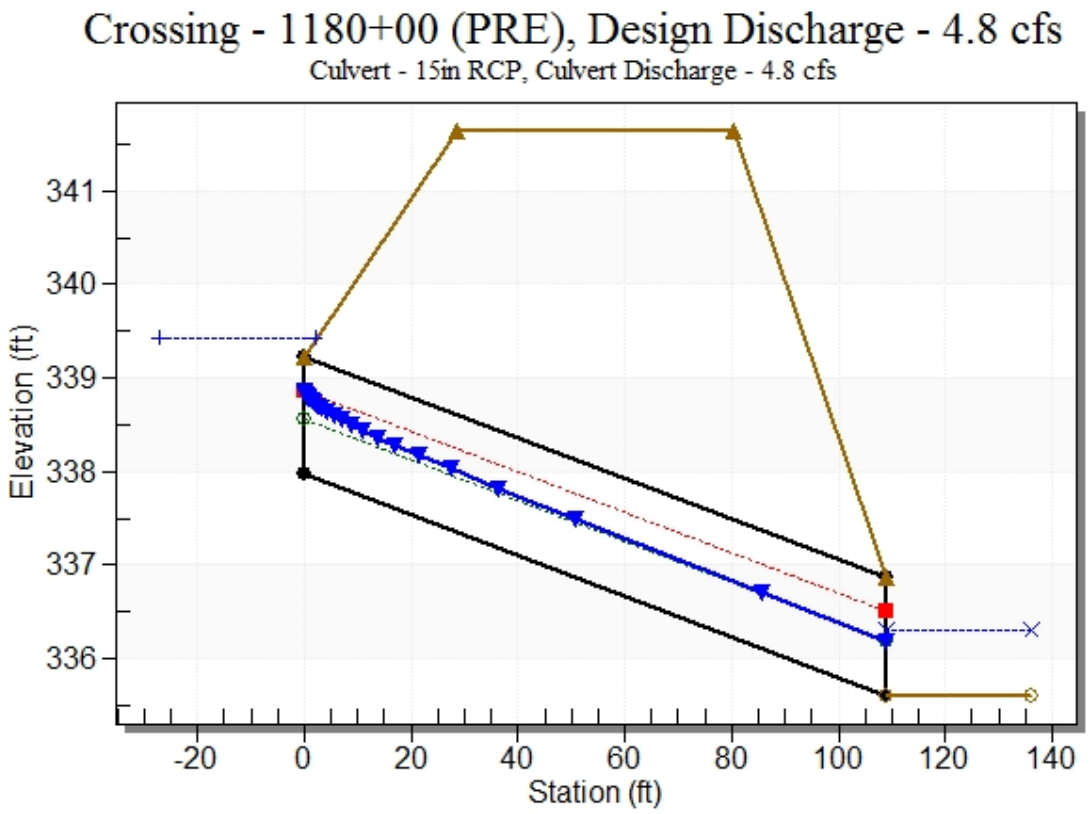
Straight Culvert

Inlet Elevation (invert): 337.98 ft, Outlet Elevation (invert): 335.61 ft

Culvert Length: 109.03 ft, Culvert Slope: 0.0217

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 337.98 ft

Outlet Station: 109.00 ft

Outlet Elevation: 335.61 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1180+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.99	336.23	0.62	1.97	0.78	0.52
4.14	336.25	0.64	1.99	0.79	0.52
4.29	336.26	0.65	2.01	0.81	0.52
4.44	336.27	0.66	2.03	0.82	0.52
4.59	336.28	0.67	2.05	0.84	0.52
4.74	336.29	0.68	2.07	0.85	0.52
4.81	336.30	0.69	2.08	0.86	0.52
5.03	336.31	0.70	2.10	0.88	0.53
5.18	336.32	0.71	2.12	0.89	0.53
5.33	336.33	0.72	2.14	0.90	0.53
5.48	336.34	0.73	2.15	0.92	0.53

Tailwater Channel Data - 1180+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 335.61 ft

Roadway Data for Crossing: 1180+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 341.65 ft

Roadway Surface: Paved

Roadway Top Width: 52.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.7 cfs

Design Flow: 6.87 cfs

Maximum Flow: 7.83 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1180+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
339.66	5.70	5.70	0.00	1
339.72	5.91	5.91	0.00	1
339.79	6.13	6.13	0.00	1
339.86	6.34	6.34	0.00	1
339.93	6.55	6.55	0.00	1
340.00	6.77	6.77	0.00	1
340.04	6.87	6.87	0.00	1
340.16	7.19	7.19	0.00	1
340.24	7.40	7.40	0.00	1
340.32	7.62	7.62	0.00	1
340.41	7.83	7.83	0.00	1
341.65	10.38	10.38	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.70	5.70	339.66	1.681	0.0*	5-S2n	0.645	0.963	0.645	0.749	8.631	2.176
5.91	5.91	339.72	1.745	0.060	5-S2n	0.660	0.980	0.660	0.763	8.707	2.198
6.13	6.13	339.79	1.810	0.164	5-S2n	0.675	0.996	0.675	0.777	8.779	2.219
6.34	6.34	339.86	1.878	0.272	5-S2n	0.689	1.012	0.689	0.790	8.848	2.240
6.55	6.55	339.93	1.949	0.383	5-S2n	0.704	1.027	0.704	0.804	8.916	2.260
6.77	6.77	340.00	2.023	0.497	5-S2n	0.718	1.042	0.718	0.817	8.978	2.279
6.87	6.87	340.04	2.060	0.554	5-S2n	0.726	1.049	0.726	0.823	9.011	2.289
7.19	7.19	340.16	2.178	0.734	5-S2n	0.748	1.069	0.772	0.842	8.757	2.317
7.40	7.40	340.24	2.259	0.857	5-S2n	0.762	1.082	0.789	0.855	8.806	2.336
7.62	7.62	340.32	2.343	0.984	5-S2n	0.777	1.094	0.807	0.867	8.819	2.353
7.83	7.83	340.41	2.430	1.113	5-S2n	0.792	1.106	0.819	0.879	8.912	2.371

* Full Flow Headwater elevation is below inlet invert.

****

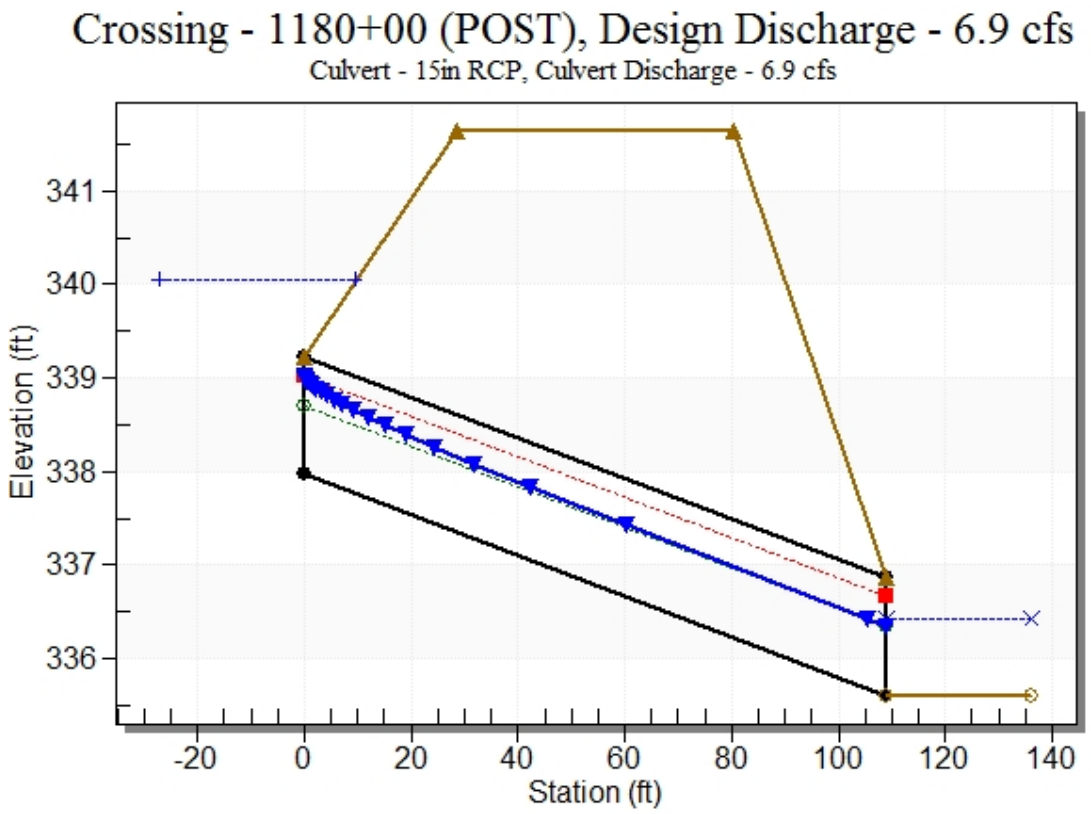
Straight Culvert

Inlet Elevation (invert): 337.98 ft, Outlet Elevation (invert): 335.61 ft

Culvert Length: 109.03 ft, Culvert Slope: 0.0217

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 337.98 ft

Outlet Station: 109.00 ft

Outlet Elevation: 335.61 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1180+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.70	336.36	0.75	2.18	0.93	0.53
5.91	336.37	0.76	2.20	0.95	0.53
6.13	336.39	0.78	2.22	0.97	0.53
6.34	336.40	0.79	2.24	0.99	0.53
6.55	336.41	0.80	2.26	1.00	0.53
6.77	336.43	0.82	2.28	1.02	0.54
6.87	336.43	0.82	2.29	1.03	0.54
7.19	336.45	0.84	2.32	1.05	0.54
7.40	336.46	0.85	2.34	1.07	0.54
7.62	336.48	0.87	2.35	1.08	0.54
7.83	336.49	0.88	2.37	1.10	0.54

Tailwater Channel Data - 1180+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 335.61 ft

Roadway Data for Crossing: 1180+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 341.65 ft

Roadway Surface: Paved

Roadway Top Width: 52.00 ft

CULVERT 100

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 100a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	1.01	0.2523
Woods	0.15	6.70	1.0045
	Σ	**7.71**	1.2567

$C_{ave} = \frac{1.2567}{7.71} = 0.16$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	1.01	0.2523
Woods	0.15	6.70	1.0045
	Σ	**7.71**	1.2567

$C_{ave} = \frac{1.2567}{7.71} = 0.16$

T_c =	38.83	min.
I_{05} =	3.30	in / hr
I_{10} =	3.63	in / hr
I_{25} =	4.11	in / hr
I_{50} =	4.48	in / hr
I_{100} =	4.84	in / hr

Pre Construction Runoff:

Q_{05} =	0.16	x	3.30	x	7.71	x	1	=	**4.15**	cfs
Q_{10} =	0.16	x	3.63	x	7.71	x	1	=	**4.56**	cfs
Q_{25} =	0.16	x	4.11	x	7.71	x	1.1	=	**5.68**	cfs
Q_{50} =	0.16	x	4.48	x	7.71	x	1.2	=	**6.76**	cfs
Q_{100} =	0.16	x	4.84	x	7.71	x	1.25	=	**7.60**	cfs

Post Construction Runoff:

Q_{05} =	0.16	x	3.30	x	7.71	x	1	=	**4.15**	cfs
Q_{10} =	0.16	x	3.63	x	7.71	x	1	=	**4.56**	cfs
Q_{25} =	0.16	x	4.11	x	7.71	x	1.1	=	**5.68**	cfs
Q_{50} =	0.16	x	4.48	x	7.71	x	1.2	=	**6.76**	cfs
Q_{100} =	0.16	x	4.84	x	7.71	x	1.25	=	**7.60**	cfs

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700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 100b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.21	0.1888
Grass	0.25	0.45	0.1124
Woods	0.15	0.60	0.0904
	Σ	**1.26**	0.3917

$C_{ave} = \frac{0.3917}{1.26} = 0.31$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.41	0.3659
Grass	0.25	0.45	0.1124
Woods	0.15	0.60	0.0904
	Σ	**1.46**	0.5688

$C_{ave} = \frac{0.5688}{1.46} = 0.39$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.31	**x**	6.32	**x**	1.26	**x**	1	=	**2.48**	cfs
Q_{10} =	0.31	**x**	7.04	**x**	1.26	**x**	1	=	**2.76**	cfs
Q_{25} =	0.31	**x**	8.10	**x**	1.26	**x**	1.1	=	**3.49**	cfs
Q_{50} =	0.31	**x**	8.95	**x**	1.26	**x**	1.2	=	**4.21**	cfs
Q_{100} =	0.31	**x**	9.80	**x**	1.26	**x**	1.25	=	**4.80**	cfs

Post Construction Runoff:

Q_{05} =	0.39	**x**	6.32	**x**	1.46	**x**	1	=	**3.60**	cfs
Q_{10} =	0.39	**x**	7.04	**x**	1.46	**x**	1	=	**4.00**	cfs
Q_{25} =	0.39	**x**	8.10	**x**	1.46	**x**	1.1	=	**5.07**	cfs
Q_{50} =	0.39	**x**	8.95	**x**	1.46	**x**	1.2	=	**6.11**	cfs
Q_{100} =	0.39	**x**	9.80	**x**	1.46	**x**	1.25	=	**6.97**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 100c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7853
Grass	0.25	0.58	0.1454
Woods	0.15	0.00	0.0000
	Σ	**1.45**	0.9306

$C_{ave} = \frac{0.9306}{1.45} = 0.64$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.92	0.8244
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.92**	0.8244

$C_{ave} = \frac{0.8244}{0.92} = 0.90$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.64	x	6.32	x	1.45	x	1	=	**5.89**	cfs
Q_{10} =	0.64	x	7.04	x	1.45	x	1	=	**6.55**	cfs
Q_{25} =	0.64	x	8.10	x	1.45	x	1.1	=	**8.30**	cfs
Q_{50} =	0.64	x	8.95	x	1.45	x	1.2	=	**10.00**	cfs
Q_{100} =	0.64	x	9.80	x	1.45	x	1.25	=	**11.40**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.92	x	1	=	**5.21**	cfs
Q_{10} =	0.90	x	7.04	x	0.92	x	1	=	**5.80**	cfs
Q_{25} =	0.90	x	8.10	x	0.92	x	1.1	=	**7.35**	cfs
Q_{50} =	0.90	x	8.95	x	0.92	x	1.2	=	**8.86**	cfs
Q_{100} =	0.90	x	9.80	x	0.92	x	1.25	=	**10.10**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 100a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**850**				
9	Watercourse slope, s	----------	ft/ft	**0.0635**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.07**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.058**	+		=	**0.058**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.647**
						min		**38.83**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-100		Outlet	OP	348.04	348.04	0.00	0.77	0.00	39.26	0.00	10.42	0.25	0.00
CB-100c		Other	C.B. TYPE 112	352.45	352.45	3.48	0.04	39.06	39.06	13.90	10.42	0.25	4.50
CB-100b		Other	C.B. TYPE 112	352.66	352.66	3.32	0.02	38.87	38.87	8.92	8.97	0.18	4.51
DN-100a		Other	DUMMY JOINT	351.66	351.66	0.00	0.00	38.83	38.83	6.81	7.71	0.16	4.51

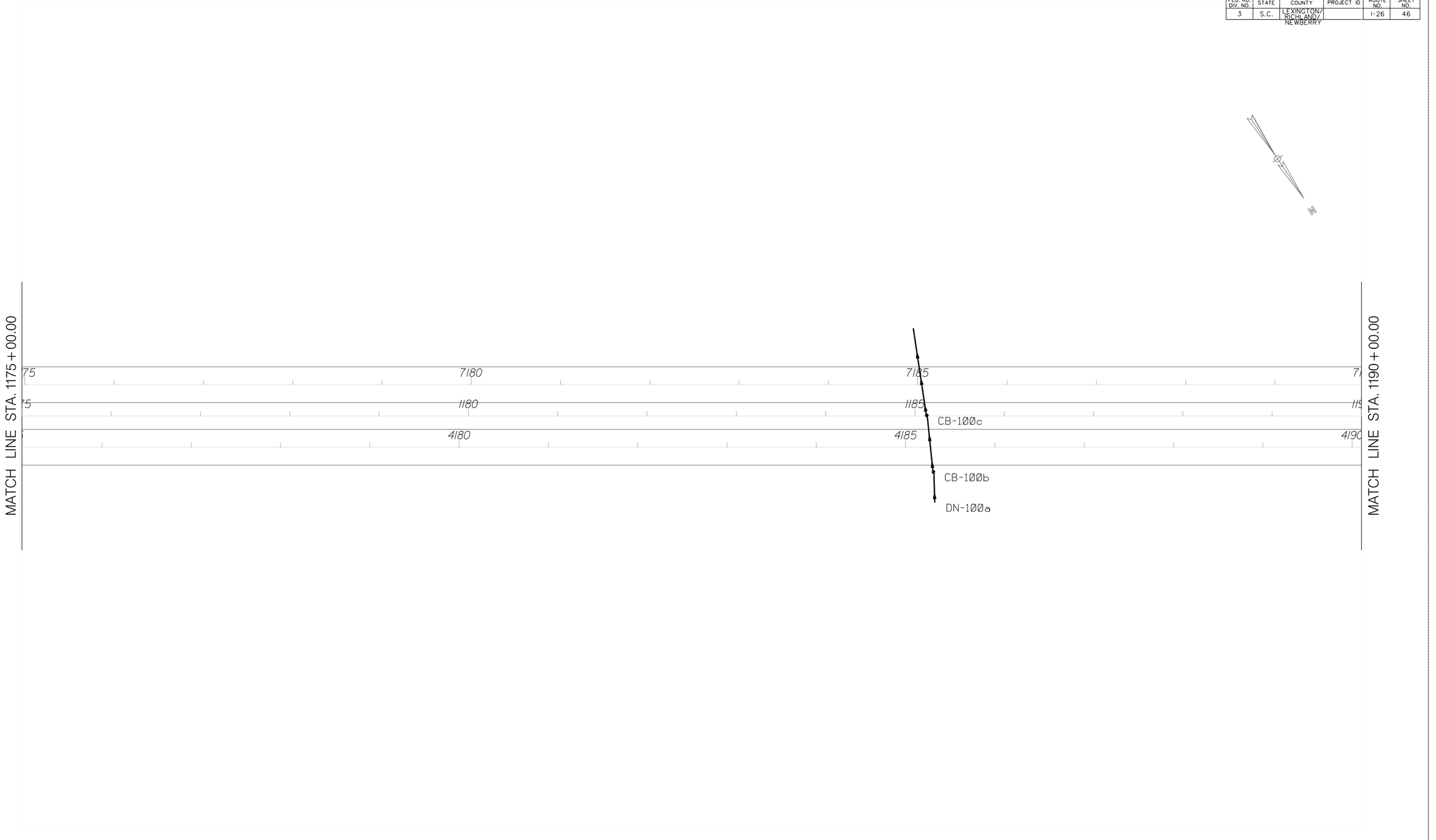
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-53	CB-100c	OF-100	Circular	Concrete	1	1.50	98	0.95	13.90	11.93	1.50	8.07	350.47	351.00	349.54	349.42	348.97	348.04	7.87	8.18	1.50	1.38
NP-52	CB-100b	CB-100c	Circular	Concrete	1	1.50	62	0.60	8.92	9.47	1.25	5.65	350.84	351.42	350.47	351.00	349.34	348.97	5.05	5.05	1.50	1.50
NP-51	DN-100a	CB-100b	Circular	Concrete	1	1.50	33	6.97	6.81	32.32	0.49	13.75	353.16	353.26	350.84	349.88	351.66	349.34	3.85	12.01	1.50	0.54

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-100c	5.00	10.05	9.03	0.64	1.45	0.64	1.45	0.00	0.00
CB-100b	5.00	4.24	9.03	0.31	1.26	0.31	1.26	0.00	0.00
DN-100a	38.83	6.81	4.51	0.16	7.71	0.16	7.71	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	46



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

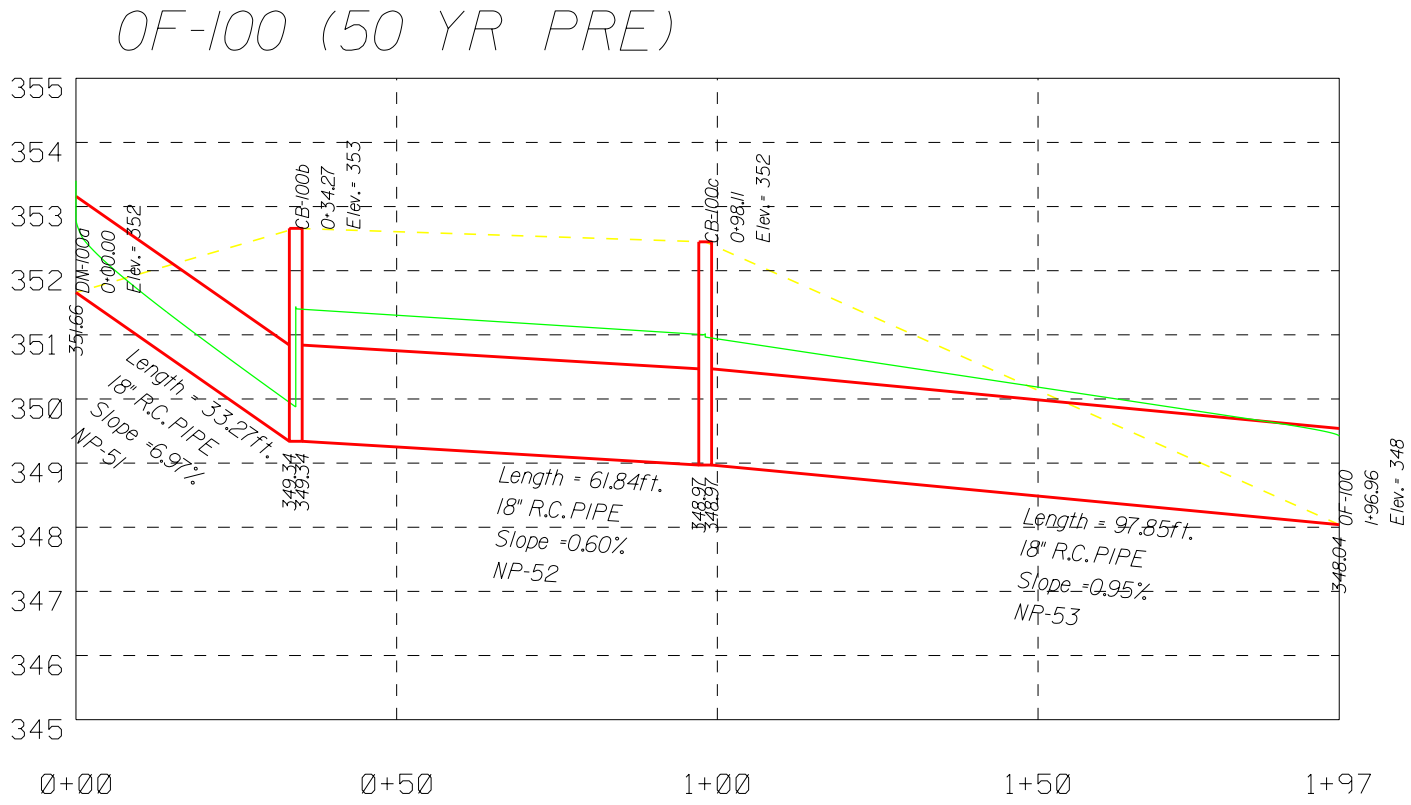
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1175+00.00 TO STA. 1190+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-100 (50 YR PRE)
355
354
353
352
351
350
349
348
347
346
345
0+00
0+50
1+00
1+50
1+97
DM-100a
0-00.00
Elev. = 352
351.66
CB-100b
0-34.27
Elev. = 353
CB-100c
0-98.11
Elev. = 352
OF-100
1-96.96
Elev. = 348
348.04
Length = 33.27ft.
18" R.C. PIPE
Slope =6.97%
NP-51
349.34
348.34
Length = 61.84ft.
18" R.C. PIPE
Slope =0.60%
NP-52
348.97
348.37
Length = 97.85ft.
18" R.C. PIPE
Slope =0.95%
NR-53

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

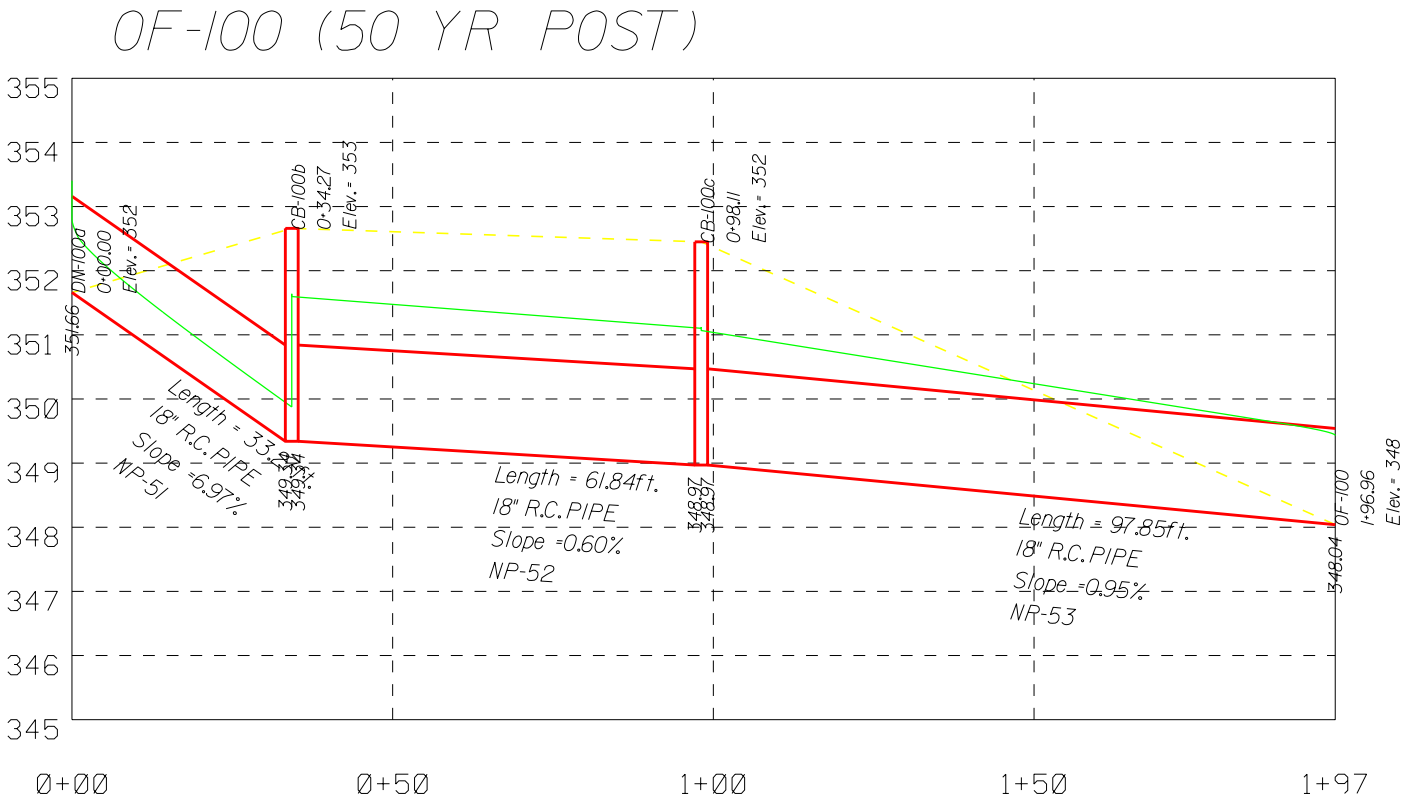
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-100	Outlet	OP	348.04	348.04	0.00	0.77	0.00	39.25	0.00	10.09	0.26	0.00
CB-100c	Other	C.B. TYPE 112	352.45	352.45	3.48	0.04	39.06	39.06	14.33	10.09	0.26	4.50
CB-100b	Other	C.B. TYPE 112	352.66	352.66	3.32	0.03	38.87	38.87	9.89	9.17	0.20	4.51
DN-100a	Other	DUMMY JOINT	351.66	351.66	0.00	0.00	38.83	38.83	6.81	7.71	0.16	4.51

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-53	CB-100c	OF-100	Circular	Concrete	1	1.50	98	0.95	14.33	11.93	1.50	8.32	350.47	351.10	349.54	349.43	348.97	348.04	8.11	8.39	1.50	1.39
NP-52	CB-100b	CB-100c	Circular	Concrete	1	1.50	62	0.60	9.89	9.47	1.50	5.74	350.84	351.62	350.47	351.10	349.34	348.97	5.60	5.60	1.50	1.50
NP-51	DN-100a	CB-100b	Circular	Concrete	1	1.50	33	6.97	6.81	32.32	0.49	13.75	353.16	353.26	350.84	349.88	351.66	349.34	3.85	12.01	1.50	0.54

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-100c	5.00	8.97	9.03	0.90	0.92	0.90	0.92	0.00	0.00
CB-100b	5.00	6.19	9.03	0.39	1.46	0.39	1.46	0.00	0.00
DN-100a	38.83	6.81	4.51	0.16	7.71	0.16	7.71	0.00	0.00


OF-100 (50 YR POST)
355
354
353
352
351
350
349
348
347
346
345
0+00
0+50
1+00
1+50
1+97
DM-100a
0-00.00
Elev. = 352
351.66
CB-100b
0-34.27
Elev. = 353
CB-100c
0-98.11
Elev. = 352
OF-100
1-96.96
Elev. = 348
348.04
Length = 33.44ft.
18" R.C. PIPE
Slope =6.97%
NP-51
349.34
348.97
Length = 61.84ft.
18" R.C. PIPE
Slope =0.60%
NP-52
Length = 97.85ft.
18" R.C. PIPE
Slope =0.95%
NP-53

CULVERT 18

MICHAEL BAKER INTERNATIONAL
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 18**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.29	3.8582
Grass	0.25	7.87	1.9681
Woods	0.15	44.53	6.6788
	Σ	**56.68**	12.5051

$C_{ave} = \frac{12.5051}{56.68} = 0.22$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.26	4.7349
Grass	0.25	6.90	1.7246
Woods	0.15	44.53	6.6788
	Σ	**56.68**	13.1383

$C_{ave} = \frac{13.1383}{56.68} = 0.23$

T_c =	49.12	min.
I_{05} =	2.88	in / hr
I_{10} =	3.16	in / hr
I_{25} =	3.57	in / hr
I_{50} =	3.89	in / hr
I_{100} =	4.20	in / hr

Pre Construction Runoff:

Q_{05} =	0.22	x	2.88	x	56.68	x	1	=	**36.04**	cfs
Q_{10} =	0.22	x	3.16	x	56.68	x	1	=	**39.56**	cfs
Q_{25} =	0.22	x	3.57	x	56.68	x	1.1	=	**49.14**	cfs
Q_{50} =	0.22	x	3.89	x	56.68	x	1.2	=	**58.38**	cfs
Q_{100} =	0.22	x	4.20	x	56.68	x	1.25	=	**65.63**	cfs

Post Construction Runoff:

Q_{05} =	0.23	x	2.88	x	56.68	x	1	=	**37.87**	cfs
Q_{10} =	0.23	x	3.16	x	56.68	x	1	=	**41.57**	cfs
Q_{25} =	0.23	x	3.57	x	56.68	x	1.1	=	**51.63**	cfs
Q_{50} =	0.23	x	3.89	x	56.68	x	1.2	=	**61.33**	cfs
Q_{100} =	0.23	x	4.20	x	56.68	x	1.25	=	**68.95**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 18	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**2678**				
9	Watercourse slope, s	----------	ft/ft	**0.0403**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.24**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.230**	+		=	**0.230**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.819**
						min		**49.12**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 49.14 cfs

Design Flow: 58.38 cfs

Maximum Flow: 65.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1190+17 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	4x4 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
357.00	49.14	49.14	0.00	1
357.05	50.79	50.79	0.00	1
357.11	52.44	52.44	0.00	1
357.17	54.09	54.09	0.00	1
357.22	55.74	55.74	0.00	1
357.28	57.38	57.38	0.00	1
357.31	58.38	58.38	0.00	1
357.39	60.68	60.68	0.00	1
357.44	62.33	62.33	0.00	1
357.49	63.98	63.98	0.00	1
357.55	65.63	65.63	0.00	1
369.00	317.63	317.63	0.00	Overtopping

Table 2 - Culvert Summary Table: 4x4 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
49.14	49.14	357.00	2.606	1.167	1-S2n	1.442	1.674	1.484	1.748	8.279	3.752
50.79	50.79	357.05	2.664	1.214	1-S2n	1.476	1.711	1.521	1.777	8.350	3.785
52.44	52.44	357.11	2.721	1.262	1-S2n	1.511	1.748	1.557	1.805	8.420	3.818
54.09	54.09	357.17	2.778	1.309	1-S2n	1.546	1.784	1.593	1.833	8.489	3.849
55.74	55.74	357.22	2.833	1.357	1-S2n	1.580	1.820	1.629	1.860	8.555	3.880
57.38	57.38	357.28	2.889	1.405	1-S2n	1.614	1.856	1.664	1.888	8.620	3.910
58.38	58.38	357.31	2.922	1.434	1-S2n	1.635	1.877	1.686	1.904	8.659	3.928
60.68	60.68	357.39	2.997	1.501	1-S2n	1.682	1.926	1.734	1.940	8.747	3.969
62.33	62.33	357.44	3.051	1.549	1-S2n	1.715	1.961	1.769	1.966	8.808	3.997
63.98	63.98	357.49	3.103	1.602	1-S2n	1.749	1.995	1.749	1.991	9.147	4.025
65.63	65.63	357.55	3.156	1.660	1-S2n	1.782	2.030	1.782	2.016	9.208	4.052

****

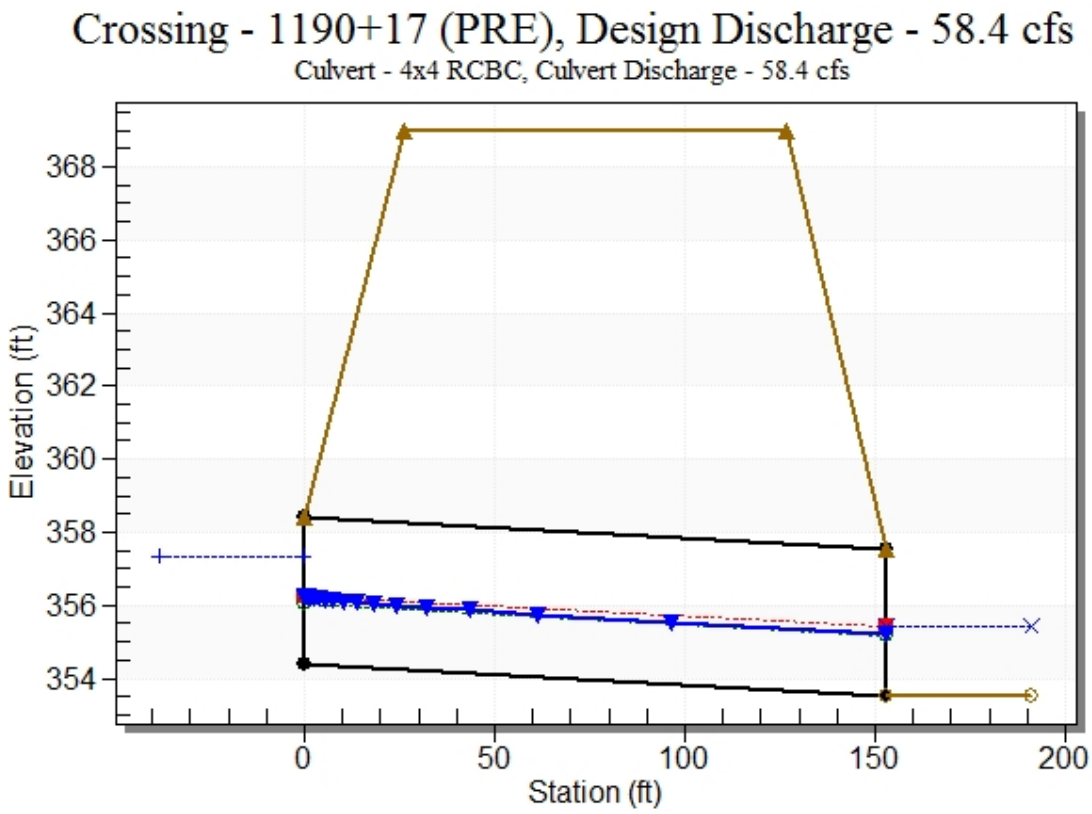
Straight Culvert

Inlet Elevation (invert): 354.39 ft, Outlet Elevation (invert): 353.54 ft

Culvert Length: 153.00 ft, Culvert Slope: 0.0056

****

Water Surface Profile Plot for Culvert: 4x4 RCBC



Site Data - 4x4 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 354.39 ft

Outlet Station: 153.00 ft

Outlet Elevation: 353.54 ft

Number of Barrels: 1

Culvert Data Summary - 4x4 RCBC

Barrel Shape: Concrete Box

Barrel Span: 4.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1190+17 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
49.14	355.29	1.75	3.75	2.18	0.61
50.79	355.32	1.78	3.78	2.22	0.61
52.44	355.34	1.80	3.82	2.25	0.61
54.09	355.37	1.83	3.85	2.29	0.61
55.74	355.40	1.86	3.88	2.32	0.61
57.38	355.43	1.89	3.91	2.36	0.61
58.38	355.44	1.90	3.93	2.38	0.61
60.68	355.48	1.94	3.97	2.42	0.61
62.33	355.51	1.97	4.00	2.45	0.61
63.98	355.53	1.99	4.02	2.49	0.62
65.63	355.56	2.02	4.05	2.52	0.62

Tailwater Channel Data - 1190+17 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 353.54 ft

Roadway Data for Crossing: 1190+17 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 51.63 cfs

Design Flow: 61.33 cfs

Maximum Flow: 68.95 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1190+17 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	4x4 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
357.08	51.63	51.63	0.00	1
357.14	53.36	53.36	0.00	1
357.20	55.09	55.09	0.00	1
357.26	56.83	56.83	0.00	1
357.32	58.56	58.56	0.00	1
357.37	60.29	60.29	0.00	1
357.41	61.33	61.33	0.00	1
357.49	63.75	63.75	0.00	1
357.54	65.49	65.49	0.00	1
357.60	67.22	67.22	0.00	1
357.65	68.95	68.95	0.00	1
369.00	317.63	317.63	0.00	Overtopping

Table 2 - Culvert Summary Table: 4x4 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
51.63	51.63	357.08	2.693	1.239	1-S2n	1.494	1.730	1.539	1.791	8.386	3.802
53.36	53.36	357.14	2.753	1.288	1-S2n	1.531	1.768	1.577	1.821	8.459	3.835
55.09	55.09	357.20	2.812	1.338	1-S2n	1.567	1.806	1.615	1.850	8.529	3.868
56.83	56.83	357.26	2.870	1.389	1-S2n	1.602	1.844	1.652	1.878	8.598	3.900
58.56	58.56	357.32	2.927	1.439	1-S2n	1.638	1.881	1.689	1.906	8.666	3.931
60.29	60.29	357.37	2.984	1.490	1-S2n	1.674	1.918	1.726	1.934	8.732	3.962
61.33	61.33	357.41	3.018	1.520	1-S2n	1.695	1.940	1.748	1.950	8.771	3.980
63.75	63.75	357.49	3.096	1.594	1-S2n	1.744	1.991	1.744	1.988	9.138	4.021
65.49	65.49	357.54	3.151	1.655	1-S2n	1.779	2.027	1.779	2.014	9.203	4.049
67.22	67.22	357.60	3.206	1.716	1-S2n	1.814	2.062	1.814	2.040	9.265	4.077
68.95	68.95	357.65	3.260	1.778	1-S2n	1.849	2.097	1.849	2.066	9.325	4.105

****

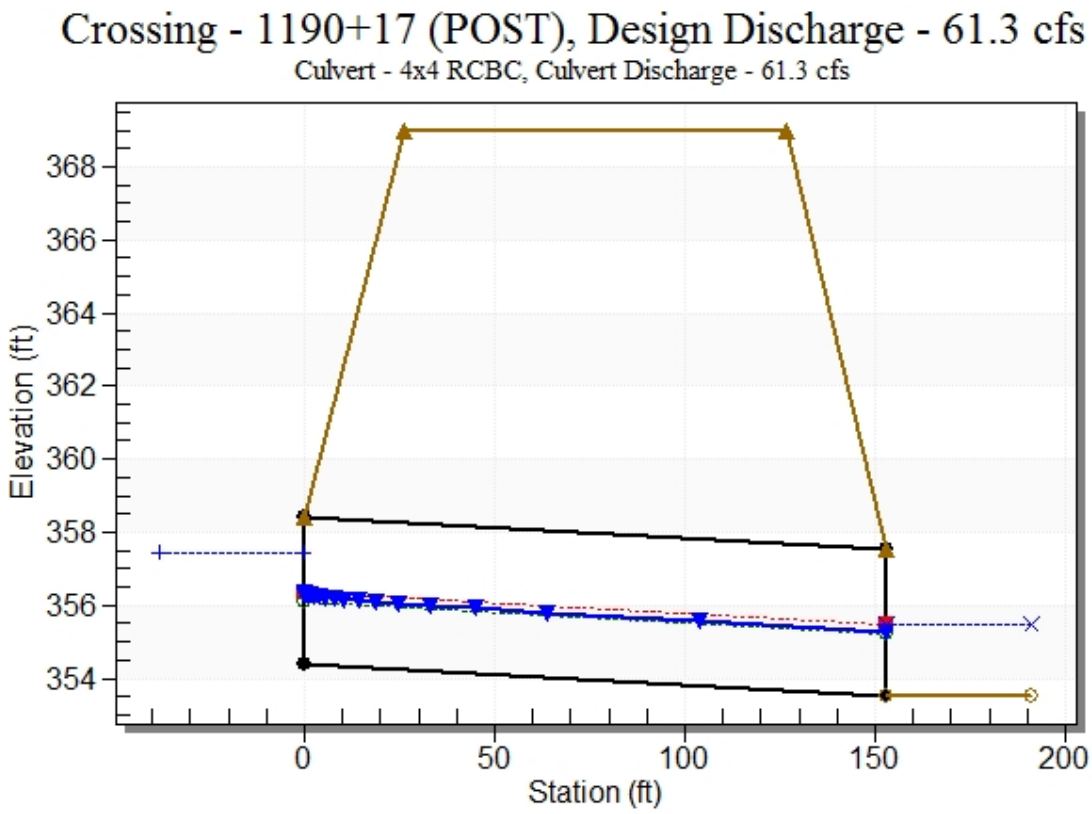
Straight Culvert

Inlet Elevation (invert): 354.39 ft, Outlet Elevation (invert): 353.54 ft

Culvert Length: 153.00 ft, Culvert Slope: 0.0056

****

Water Surface Profile Plot for Culvert: 4x4 RCBC



Site Data - 4x4 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 354.39 ft

Outlet Station: 153.00 ft

Outlet Elevation: 353.54 ft

Number of Barrels: 1

Culvert Data Summary - 4x4 RCBC

Barrel Shape: Concrete Box

Barrel Span: 4.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1190+17 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
51.63	355.33	1.79	3.80	2.24	0.61
53.36	355.36	1.82	3.84	2.27	0.61
55.09	355.39	1.85	3.87	2.31	0.61
56.83	355.42	1.88	3.90	2.34	0.61
58.56	355.45	1.91	3.93	2.38	0.61
60.29	355.47	1.93	3.96	2.41	0.61
61.33	355.49	1.95	3.98	2.43	0.61
63.75	355.53	1.99	4.02	2.48	0.62
65.49	355.55	2.01	4.05	2.51	0.62
67.22	355.58	2.04	4.08	2.55	0.62
68.95	355.61	2.07	4.11	2.58	0.62

Tailwater Channel Data - 1190+17 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 353.54 ft

Roadway Data for Crossing: 1190+17 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 101

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 101**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.69	0.6202
Grass	0.25	0.48	0.1198
Woods	0.15	0.27	0.0407
	Σ	**1.44**	0.7807

$C_{ave} = \frac{0.7807}{1.44} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.98	0.8803
Grass	0.25	0.19	0.0475
Woods	0.15	0.27	0.0407
	Σ	**1.44**	0.9685

$C_{ave} = \frac{0.9685}{1.44} = 0.67$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.54	x	6.32	x	1.44	x	1	=	**4.94**	cfs
Q_{10} =	0.54	x	7.04	x	1.44	x	1	=	**5.50**	cfs
Q_{25} =	0.54	x	8.10	x	1.44	x	1.1	=	**6.96**	cfs
Q_{50} =	0.54	x	8.95	x	1.44	x	1.2	=	**8.39**	cfs
Q_{100} =	0.54	x	9.80	x	1.44	x	1.25	=	**9.57**	cfs

Post Construction Runoff:

Q_{05} =	0.67	x	6.32	x	1.44	x	1	=	**6.13**	cfs
Q_{10} =	0.67	x	7.04	x	1.44	x	1	=	**6.82**	cfs
Q_{25} =	0.67	x	8.10	x	1.44	x	1.1	=	**8.63**	cfs
Q_{50} =	0.67	x	8.95	x	1.44	x	1.2	=	**10.41**	cfs
Q_{100} =	0.67	x	9.80	x	1.44	x	1.25	=	**11.87**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.96 cfs

Design Flow: 8.39 cfs

Maximum Flow: 9.57 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1196+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
387.60	6.96	6.96	0.00	1
387.65	7.22	7.22	0.00	1
387.70	7.48	7.48	0.00	1
387.75	7.74	7.74	0.00	1
387.80	8.00	8.00	0.00	1
387.85	8.27	8.27	0.00	1
387.88	8.39	8.39	0.00	1
387.96	8.79	8.79	0.00	1
388.02	9.05	9.05	0.00	1
388.08	9.31	9.31	0.00	1
388.14	9.57	9.57	0.00	1
389.00	12.66	12.66	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.96	6.96	387.60	1.602	0.0*	5-S2n	0.556	1.019	0.556	0.656	11.278	3.205
7.22	7.22	387.65	1.649	0.0*	5-S2n	0.567	1.038	0.567	0.668	11.395	3.238
7.48	7.48	387.70	1.697	0.0*	5-S2n	0.579	1.056	0.579	0.681	11.507	3.269
7.74	7.74	387.75	1.747	0.0*	5-S2n	0.589	1.074	0.589	0.693	11.604	3.301
8.00	8.00	387.80	1.798	0.0*	5-S2n	0.600	1.092	0.600	0.705	11.711	3.331
8.27	8.27	387.85	1.850	0.0*	5-S2n	0.611	1.110	0.646	0.716	10.975	3.360
8.39	8.39	387.88	1.876	0.0*	5-S2n	0.616	1.118	0.644	0.722	11.182	3.374
8.79	8.79	387.96	1.960	0.0*	5-S2n	0.632	1.143	0.632	0.739	12.001	3.417
9.05	9.05	388.02	2.017	0.0*	5-S2n	0.643	1.159	0.643	0.750	12.096	3.444
9.31	9.31	388.08	2.076	0.0*	5-S2n	0.653	1.178	0.653	0.761	12.186	3.471
9.57	9.57	388.14	2.137	0.0*	5-S2n	0.663	1.193	0.663	0.772	12.279	3.497

* Full Flow Headwater elevation is below inlet invert.

****

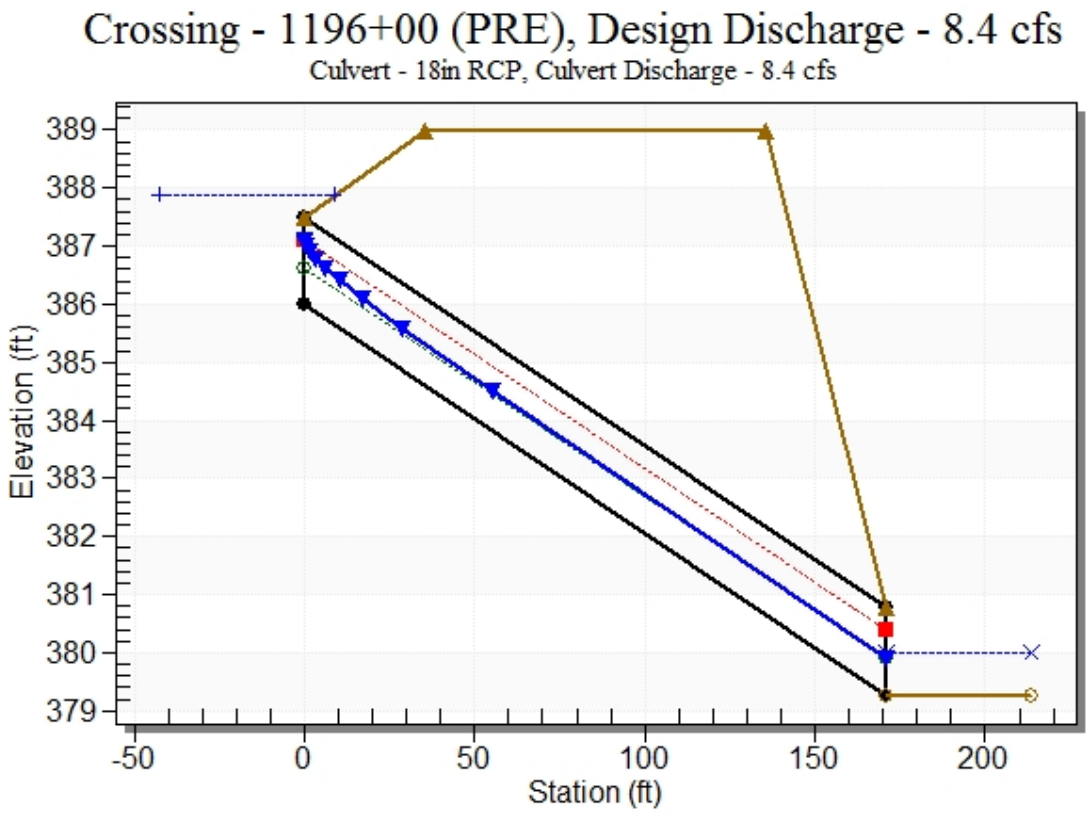
Straight Culvert

Inlet Elevation (invert): 386.00 ft, Outlet Elevation (invert): 379.27 ft

Culvert Length: 171.13 ft, Culvert Slope: 0.0394

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 386.00 ft

Outlet Station: 171.00 ft

Outlet Elevation: 379.27 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1196+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.96	379.93	0.66	3.21	2.05	0.82
7.22	379.94	0.67	3.24	2.09	0.83
7.48	379.95	0.68	3.27	2.12	0.83
7.74	379.96	0.69	3.30	2.16	0.83
8.00	379.97	0.70	3.33	2.20	0.83
8.27	379.99	0.72	3.36	2.24	0.83
8.39	379.99	0.72	3.37	2.25	0.83
8.79	380.01	0.74	3.42	2.31	0.84
9.05	380.02	0.75	3.44	2.34	0.84
9.31	380.03	0.76	3.47	2.38	0.84
9.57	380.04	0.77	3.50	2.41	0.84

Tailwater Channel Data - 1196+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 379.27 ft

Roadway Data for Crossing: 1196+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 389.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.63 cfs

Design Flow: 10.41 cfs

Maximum Flow: 11.87 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1196+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
387.93	8.63	8.63	0.00	1
388.00	8.95	8.95	0.00	1
388.07	9.28	9.28	0.00	1
388.14	9.60	9.60	0.00	1
388.22	9.93	9.93	0.00	1
388.30	10.25	10.25	0.00	1
388.35	10.41	10.41	0.00	1
388.48	10.90	10.90	0.00	1
388.57	11.22	11.22	0.00	1
388.66	11.55	11.55	0.00	1
388.75	11.87	11.87	0.00	1
389.00	12.65	12.65	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.63	8.63	387.93	1.926	0.0*	5-S2n	0.626	1.133	0.640	0.733	11.589	3.400
8.95	8.95	388.00	1.996	0.0*	5-S2n	0.639	1.153	0.639	0.746	12.062	3.435
9.28	9.28	388.07	2.069	0.0*	5-S2n	0.652	1.176	0.652	0.760	12.176	3.468
9.60	9.60	388.14	2.145	0.0*	5-S2n	0.665	1.195	0.665	0.773	12.290	3.500
9.93	9.93	388.22	2.223	0.0*	5-S2n	0.677	1.214	0.677	0.786	12.388	3.532
10.25	10.25	388.30	2.304	0.0*	5-S2n	0.690	1.231	0.690	0.799	12.491	3.563
10.41	10.41	388.35	2.345	0.0*	5-S2n	0.696	1.240	0.696	0.806	12.542	3.578
10.90	10.90	388.48	2.475	0.0*	5-S2n	0.715	1.264	0.758	0.825	11.774	3.622
11.22	11.22	388.57	2.565	0.0*	5-S2n	0.727	1.280	0.767	0.837	11.949	3.651
11.55	11.55	388.66	2.658	0.0*	5-S2n	0.740	1.295	0.777	0.849	12.100	3.679
11.87	11.87	388.75	2.754	0.0*	5-S2n	0.752	1.309	0.788	0.861	12.223	3.706

* Full Flow Headwater elevation is below inlet invert.

****

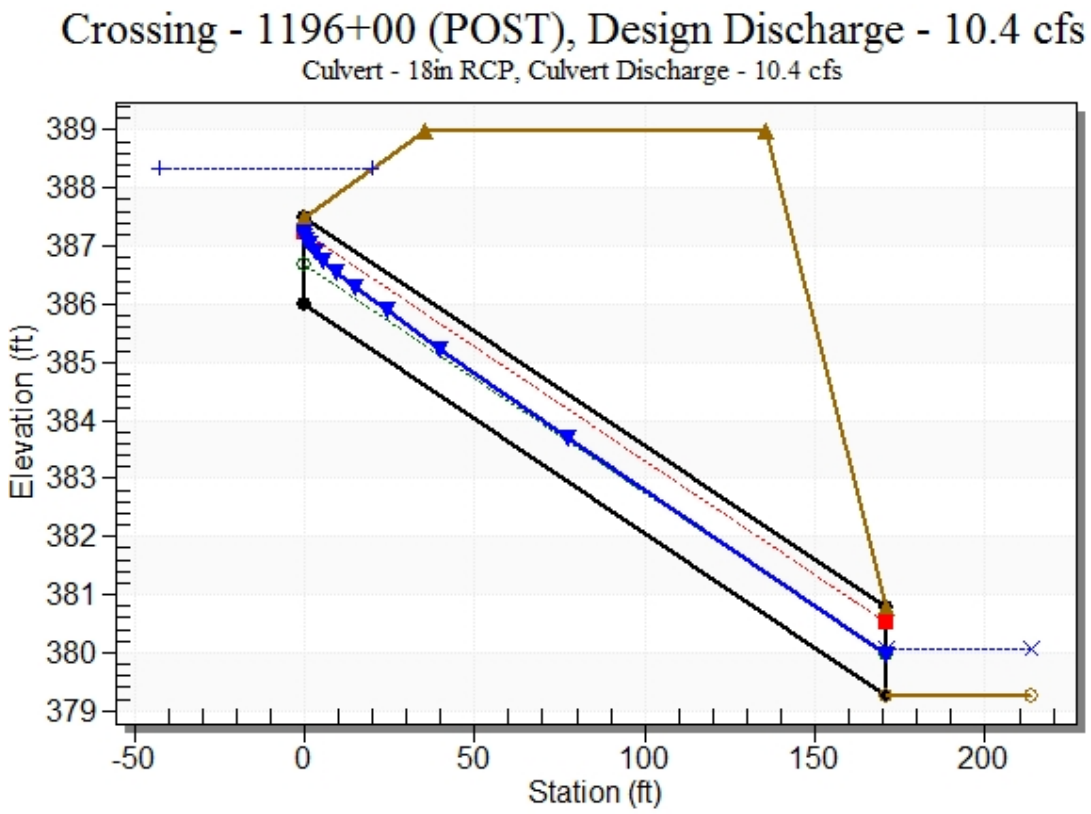
Straight Culvert

Inlet Elevation (invert): 386.00 ft, Outlet Elevation (invert): 379.27 ft

Culvert Length: 171.13 ft, Culvert Slope: 0.0394

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 386.00 ft

Outlet Station: 171.00 ft

Outlet Elevation: 379.27 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1196+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
8.63	380.00	0.73	3.40	2.29	0.84
8.95	380.02	0.75	3.43	2.33	0.84
9.28	380.03	0.76	3.47	2.37	0.84
9.60	380.04	0.77	3.50	2.41	0.84
9.93	380.06	0.79	3.53	2.45	0.84
10.25	380.07	0.80	3.56	2.49	0.84
10.41	380.08	0.81	3.58	2.51	0.84
10.90	380.09	0.82	3.62	2.57	0.85
11.22	380.11	0.84	3.65	2.61	0.85
11.55	380.12	0.85	3.68	2.65	0.85
11.87	380.13	0.86	3.71	2.69	0.85

Tailwater Channel Data - 1196+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 379.27 ft

Roadway Data for Crossing: 1196+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 389.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 102

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 102a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.29	0.2641
Grass	0.25	0.18	0.0442
Woods	0.15	0.59	0.0888
	Σ	**1.06**	0.3971

$C_{ave} = \frac{0.3971}{1.06} = 0.37$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3874
Grass	0.25	0.18	0.0442
Woods	0.15	0.59	0.0888
	Σ	**1.20**	0.5204

$C_{ave} = \frac{0.5204}{1.20} = 0.43$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.37	x	6.32	x	1.06	x	1	=	**2.51**	cfs
Q_{10} =	0.37	x	7.04	x	1.06	x	1	=	**2.80**	cfs
Q_{25} =	0.37	x	8.10	x	1.06	x	1.1	=	**3.54**	cfs
Q_{50} =	0.37	x	8.95	x	1.06	x	1.2	=	**4.27**	cfs
Q_{100} =	0.37	x	9.80	x	1.06	x	1.25	=	**4.87**	cfs

Post Construction Runoff:

Q_{05} =	0.43	x	6.32	x	1.20	x	1	=	**3.29**	cfs
Q_{10} =	0.43	x	7.04	x	1.20	x	1	=	**3.66**	cfs
Q_{25} =	0.43	x	8.10	x	1.20	x	1.1	=	**4.64**	cfs
Q_{50} =	0.43	x	8.95	x	1.20	x	1.2	=	**5.59**	cfs
Q_{100} =	0.43	x	9.80	x	1.20	x	1.25	=	**6.38**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 102b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.36	0.3195
Grass	0.25	0.31	0.0764
Woods	0.15	0.00	0.0000
	Σ	**0.66**	0.3959

$C_{ave} = \frac{0.3959}{0.66} = 0.60$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.39	0.3465
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.39**	0.3465

$C_{ave} = \frac{0.3465}{0.39} = 0.90$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.60	x	6.32	x	0.66	x	1	=	**2.50**	cfs
Q_{10} =	0.60	x	7.04	x	0.66	x	1	=	**2.79**	cfs
Q_{25} =	0.60	x	8.10	x	0.66	x	1.1	=	**3.53**	cfs
Q_{50} =	0.60	x	8.95	x	0.66	x	1.2	=	**4.25**	cfs
Q_{100} =	0.60	x	9.80	x	0.66	x	1.25	=	**4.85**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.39	x	1	=	**2.19**	cfs
Q_{10} =	0.90	x	7.04	x	0.39	x	1	=	**2.44**	cfs
Q_{25} =	0.90	x	8.10	x	0.39	x	1.1	=	**3.09**	cfs
Q_{50} =	0.90	x	8.95	x	0.39	x	1.2	=	**3.72**	cfs
Q_{100} =	0.90	x	9.80	x	0.39	x	1.25	=	**4.25**	cfs

MICHAEL BAKER INTERNATIONAL
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Columbia, South Carolina 29201
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 102c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.26	0.2296
Grass	0.25	0.15	0.0374
Woods	0.15	0.13	0.0192
	Σ	**0.53**	0.2861

$C_{ave} = \frac{0.2861}{0.53} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.39	0.3538
Grass	0.25	0.15	0.0374
Woods	0.15	0.13	0.0192
	Σ	**0.67**	0.4103

$C_{ave} = \frac{0.4103}{0.67} = 0.61$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.54	**x**	6.32	**x**	0.53	**x**	1	=	**1.81**	cfs
Q_{10} =	0.54	**x**	7.04	**x**	0.53	**x**	1	=	**2.01**	cfs
Q_{25} =	0.54	**x**	8.10	**x**	0.53	**x**	1.1	=	**2.55**	cfs
Q_{50} =	0.54	**x**	8.95	**x**	0.53	**x**	1.2	=	**3.07**	cfs
Q_{100} =	0.54	**x**	9.80	**x**	0.53	**x**	1.25	=	**3.51**	cfs

Post Construction Runoff:

Q_{05} =	0.61	**x**	6.32	**x**	0.67	**x**	1	=	**2.59**	cfs
Q_{10} =	0.61	**x**	7.04	**x**	0.67	**x**	1	=	**2.89**	cfs
Q_{25} =	0.61	**x**	8.10	**x**	0.67	**x**	1.1	=	**3.66**	cfs
Q_{50} =	0.61	**x**	8.95	**x**	0.67	**x**	1.2	=	**4.41**	cfs
Q_{100} =	0.61	**x**	9.80	**x**	0.67	**x**	1.25	=	**5.03**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-102		Outlet	OP	404.20	404.20	0.00	0.77	0.00	5.44	0.00	2.25	0.48	0.00
CB-102c		Other	C.B. TYPE 112	409.31	409.31	4.59	0.04	5.37	5.37	11.45	2.25	0.48	8.93
CB-102b		Other	C.B. TYPE 112	408.80	408.80	2.76	0.04	5.25	5.25	8.46	1.72	0.46	8.96
CB-102a		Other	C.B. TYPE 112	409.37	409.37	3.10	0.00	5.00	5.00	4.27	1.06	0.37	9.03

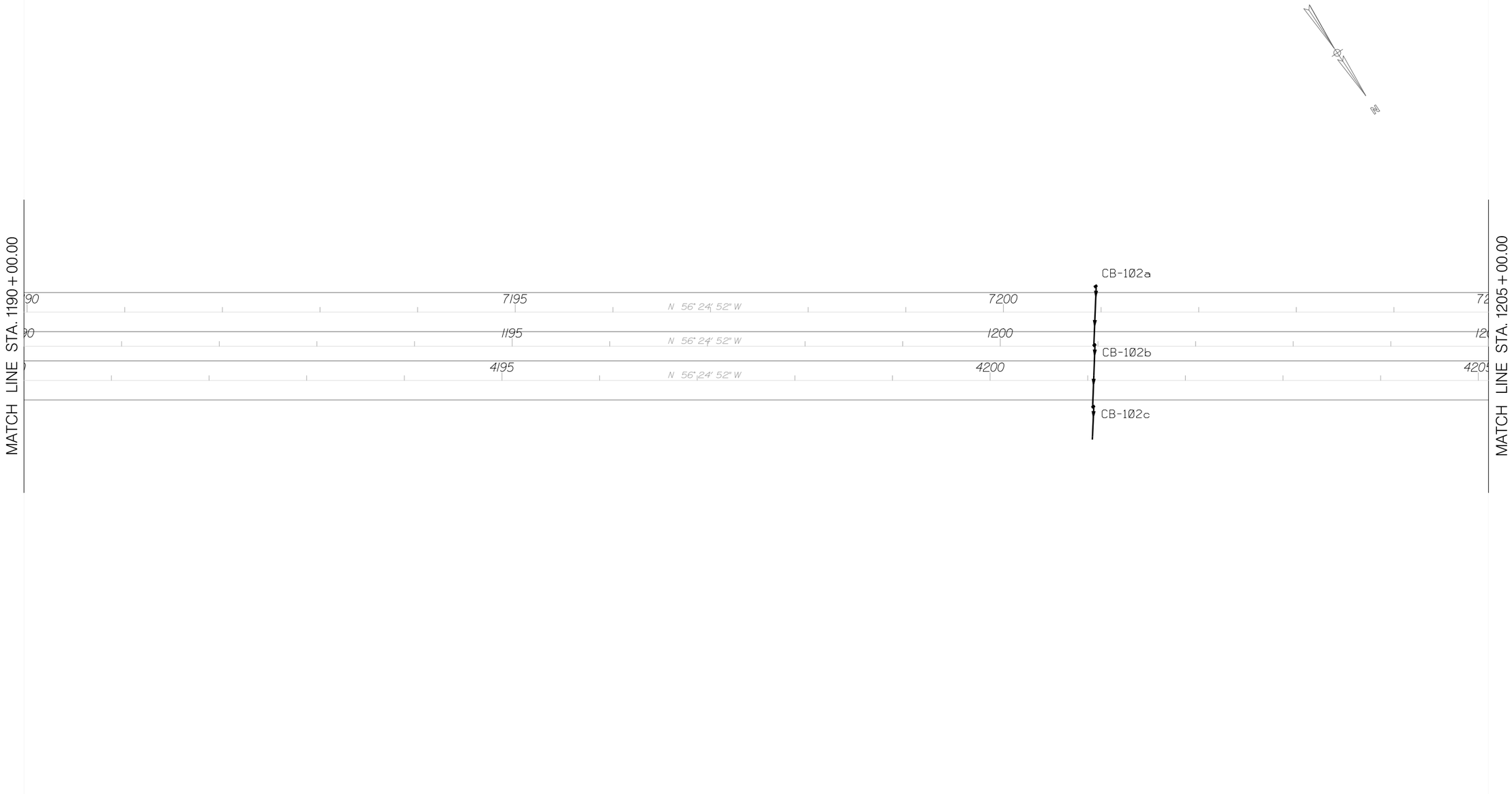
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-56	CB-102c	OF-102	Circular	Concrete	1	1.50	33	1.58	11.45	15.39	1.02	8.97	406.22	406.06	405.70	405.27	404.72	404.20	6.86	8.48	1.34	1.07
NP-55	CB-102b	CB-102c	Circular	Concrete	1	1.50	62	1.51	8.46	15.05	0.84	8.29	407.54	407.24	406.61	405.97	406.04	405.11	5.60	8.06	1.20	0.86
NP-54	CB-102a	CB-102b	Circular	Concrete	1	1.50	59	0.36	4.27	7.33	0.86	4.09	407.77	407.45	407.56	407.24	406.27	406.06	2.87	2.87	1.18	1.18

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-102c	5.00	3.05	9.03	0.53	0.53	0.53	0.53	0.00	0.00
CB-102b	5.00	4.25	9.03	0.59	0.66	0.59	0.66	0.00	0.00
CB-102a	5.00	4.27	9.03	0.37	1.06	0.37	1.06	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	47



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

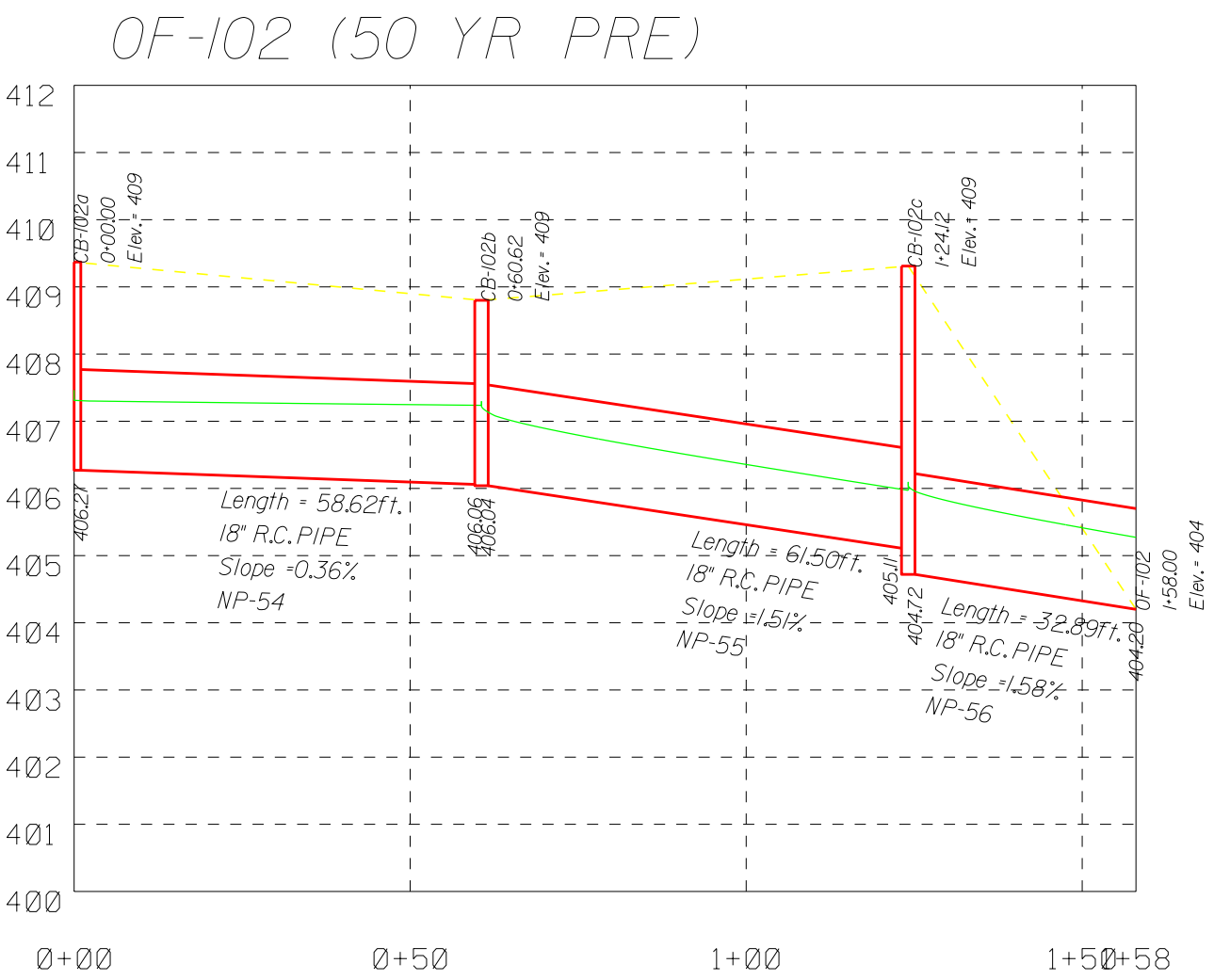
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1190+00.00 TO STA. 1205+00.00

$$$$$$$$$$filename$$$$$$$$$$
$$$$date$$$$


OF-102 (50 YR PRE)
412
411
410
409
408
407
406
405
404
403
402
401
400
0+00
0+50
1+00
1+50
1+58
CB-102a
0+00.00
Elev.= 409
CB-102b
0+60.62
Elev.= 409
CB-102c
1+24.12
Elev.= 409
406.21
406.06
406.04
405.11
404.72
404.20
OF-102
1+58.00
Elev.= 404
Length = 58.62ft.
18" R.C. PIPE
Slope =0.36%
NP-54
Length = 61.50ft.
18" R.C. PIPE
Slope =1.51%
NP-55
Length = 32.89ft.
18" R.C. PIPE
Slope =1.58%
NP-56

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

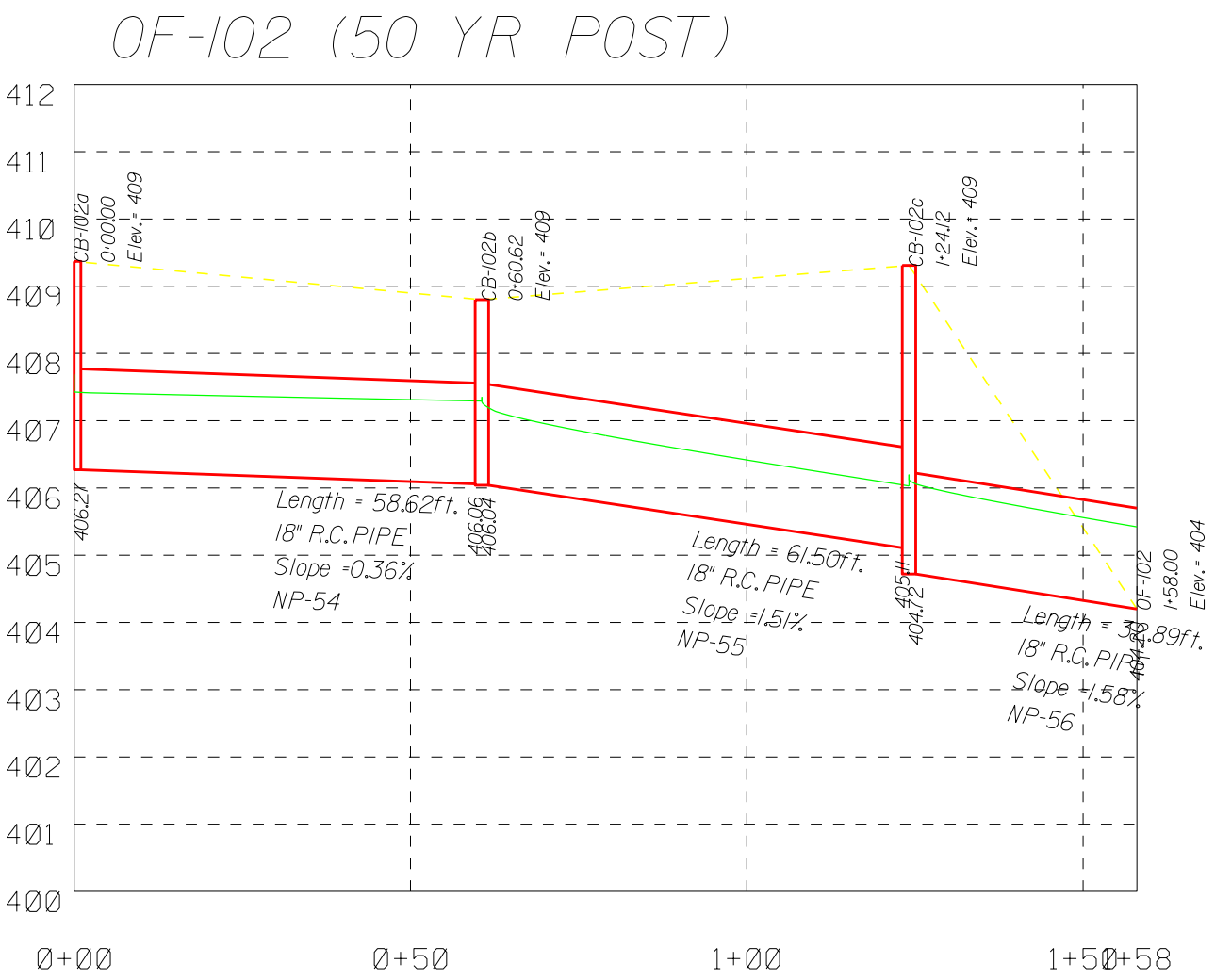
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-102	Outlet	OP	404.20	404.20	0.00	0.77	0.00	5.42	0.00	2.26	0.57	0.00
CB-102c	Other	C.B. TYPE 112	409.31	409.31	4.59	0.06	5.36	5.36	13.72	2.26	0.57	8.93
CB-102b	Other	C.B. TYPE 112	408.80	408.80	2.76	0.04	5.23	5.23	9.38	1.59	0.55	8.97
CB-102a	Other	C.B. TYPE 112	409.37	409.37	3.10	0.00	5.00	5.00	5.64	1.20	0.43	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-56	CB-102c	OF-102	Circular	Concrete	1	1.50	33	1.58	13.72	15.39	1.18	9.22	406.22	406.17	405.70	405.42	404.72	404.20	7.85	8.90	1.45	1.22
NP-55	CB-102b	CB-102c	Circular	Concrete	1	1.50	62	1.51	9.38	15.05	0.90	8.51	407.54	407.29	406.61	406.03	406.04	405.11	5.95	8.26	1.25	0.92
NP-54	CB-102a	CB-102b	Circular	Concrete	1	1.50	59	0.36	5.64	7.33	1.03	4.34	407.77	407.68	407.56	407.29	406.27	406.06	3.28	3.63	1.41	1.23

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-102c	5.00	4.42	9.03	0.61	0.67	0.61	0.67	0.00	0.00
CB-102b	5.00	3.80	9.03	0.90	0.39	0.90	0.39	0.00	0.00
CB-102a	5.00	5.64	9.03	0.43	1.20	0.43	1.20	0.00	0.00


OF-102 (50 YR POST)
412
411
410
409
408
407
406
405
404
403
402
401
400
0+00
0+50
1+00
1+50
1+58
CB-102a
0+00.00
Elev.= 409
CB-102b
0+60.62
Elev.= 409
CB-102c
1+24.12
Elev.= 409
OF-102
1+58.00
Elev.= 404
406.21
406.06
406.04
405.41
404.72
404.29
Length = 58.62ft.
18" R.C. PIPE
Slope =0.36%
NP-54
Length = 61.50ft.
18" R.C. PIPE
Slope =1.51%
NP-55
Length = 34.89ft.
18" R.C. PIPE
Slope =1.58%
NP-56

CULVERT 103

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 103**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.92	0.8302
Grass	0.25	0.94	0.2338
Woods	0.15	0.99	0.1484
	Σ	**2.85**	1.2124

$C_{ave} = \frac{1.2124}{2.85} = 0.43$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.11	1.0030
Grass	0.25	0.57	0.1435
Woods	0.15	0.99	0.1484
	Σ	**2.68**	1.2949

$C_{ave} = \frac{1.2949}{2.68} = 0.48$

T_c =	30.48	min.
I_{05} =	3.75	in / hr
I_{10} =	4.13	in / hr
I_{25} =	4.68	in / hr
I_{50} =	5.11	in / hr
I_{100} =	5.53	in / hr

Pre Construction Runoff:

Q_{05} =	0.43	x	3.75	x	2.85	x	1	=	**4.54**	cfs
Q_{10} =	0.43	x	4.13	x	2.85	x	1	=	**5.00**	cfs
Q_{25} =	0.43	x	4.68	x	2.85	x	1.1	=	**6.24**	cfs
Q_{50} =	0.43	x	5.11	x	2.85	x	1.2	=	**7.43**	cfs
Q_{100} =	0.43	x	5.53	x	2.85	x	1.25	=	**8.38**	cfs

Post Construction Runoff:

Q_{05} =	0.48	x	3.75	x	2.68	x	1	=	**4.85**	cfs
Q_{10} =	0.48	x	4.13	x	2.68	x	1	=	**5.34**	cfs
Q_{25} =	0.48	x	4.68	x	2.68	x	1.1	=	**6.66**	cfs
Q_{50} =	0.48	x	5.11	x	2.68	x	1.2	=	**7.94**	cfs
Q_{100} =	0.48	x	5.53	x	2.68	x	1.25	=	**8.95**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 103	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**100**				
9	Watercourse slope, s	----------	ft/ft	**0.0600**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.95**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.007**	+		=	**0.007**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.508**
						min		**30.48**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.24 cfs

Design Flow: 7.43 cfs

Maximum Flow: 8.38 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1206+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
427.84	6.24	6.24	0.00	1
427.88	6.45	6.45	0.00	1
427.91	6.67	6.67	0.00	1
427.95	6.88	6.88	0.00	1
427.99	7.10	7.10	0.00	1
428.03	7.31	7.31	0.00	1
428.05	7.43	7.43	0.00	1
428.11	7.74	7.74	0.00	1
428.15	7.95	7.95	0.00	1
428.19	8.17	8.17	0.00	1
428.24	8.38	8.38	0.00	1
428.42	9.23	9.23	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.24	6.24	427.84	1.459	0.0*	1-S2n	0.464	0.960	0.487	0.784	12.114	2.230
6.45	6.45	427.88	1.495	0.0*	1-S2n	0.472	0.980	0.472	0.798	13.141	2.251
6.67	6.67	427.91	1.532	0.0*	5-S2n	0.480	0.997	0.480	0.811	13.221	2.271
6.88	6.88	427.95	1.570	0.0*	5-S2n	0.488	1.013	0.488	0.824	13.343	2.290
7.10	7.10	427.99	1.608	0.0*	5-S2n	0.496	1.029	0.496	0.837	13.460	2.309
7.31	7.31	428.03	1.647	0.0*	5-S2n	0.504	1.044	0.504	0.849	13.580	2.328
7.43	7.43	428.05	1.670	0.0*	5-S2n	0.508	1.053	0.544	0.856	12.418	2.338
7.74	7.74	428.11	1.728	0.0*	5-S2n	0.519	1.074	0.530	0.874	13.409	2.363
7.95	7.95	428.15	1.770	0.0*	5-S2n	0.527	1.089	0.527	0.886	13.882	2.381
8.17	8.17	428.19	1.812	0.0*	5-S2n	0.534	1.103	0.534	0.897	13.986	2.398
8.38	8.38	428.24	1.856	0.0*	5-S2n	0.542	1.117	0.542	0.909	14.091	2.414

* Full Flow Headwater elevation is below inlet invert.

****

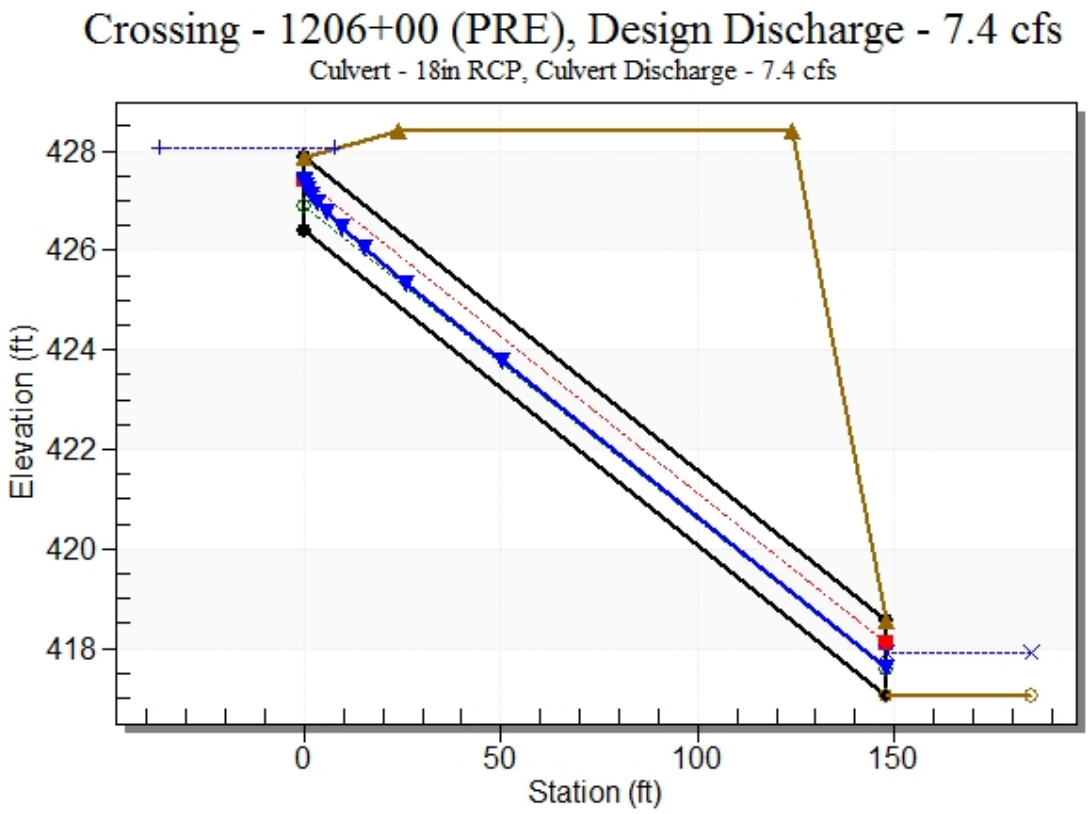
Straight Culvert

Inlet Elevation (invert): 426.38 ft, Outlet Elevation (invert): 417.06 ft

Culvert Length: 148.29 ft, Culvert Slope: 0.0630

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 426.38 ft

Outlet Station: 148.00 ft

Outlet Elevation: 417.06 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1206+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.24	417.84	0.78	2.23	0.98	0.53
6.45	417.86	0.80	2.25	1.00	0.53
6.67	417.87	0.81	2.27	1.01	0.53
6.88	417.88	0.82	2.29	1.03	0.54
7.10	417.90	0.84	2.31	1.04	0.54
7.31	417.91	0.85	2.33	1.06	0.54
7.43	417.92	0.86	2.34	1.07	0.54
7.74	417.93	0.87	2.36	1.09	0.54
7.95	417.95	0.89	2.38	1.11	0.54
8.17	417.96	0.90	2.40	1.12	0.54
8.38	417.97	0.91	2.41	1.13	0.54

Tailwater Channel Data - 1206+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 417.06 ft

Roadway Data for Crossing: 1206+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.42 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.66 cfs

Design Flow: 7.94 cfs

Maximum Flow: 8.95 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1206+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
427.91	6.66	6.66	0.00	1
427.95	6.89	6.89	0.00	1
427.99	7.12	7.12	0.00	1
428.03	7.35	7.35	0.00	1
428.08	7.58	7.58	0.00	1
428.12	7.80	7.80	0.00	1
428.15	7.94	7.94	0.00	1
428.21	8.26	8.26	0.00	1
428.26	8.49	8.49	0.00	1
428.31	8.72	8.72	0.00	1
428.36	8.95	8.95	0.00	1
428.42	9.23	9.23	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.66	6.66	427.91	1.531	0.0*	5-S2n	0.479	0.996	0.479	0.810	13.216	2.270
6.89	6.89	427.95	1.571	0.0*	5-S2n	0.488	1.013	0.488	0.824	13.347	2.291
7.12	7.12	427.99	1.612	0.0*	5-S2n	0.497	1.030	0.497	0.838	13.472	2.311
7.35	7.35	428.03	1.654	0.0*	5-S2n	0.505	1.047	0.505	0.851	13.601	2.331
7.58	7.58	428.08	1.697	0.0*	5-S2n	0.513	1.063	0.538	0.864	12.867	2.350
7.80	7.80	428.12	1.741	0.0*	5-S2n	0.521	1.079	0.521	0.878	13.809	2.369
7.94	7.94	428.15	1.767	0.0*	5-S2n	0.526	1.088	0.526	0.885	13.876	2.379
8.26	8.26	428.21	1.832	0.0*	5-S2n	0.538	1.109	0.538	0.903	14.032	2.405
8.49	8.49	428.26	1.879	0.0*	5-S2n	0.546	1.124	0.546	0.915	14.148	2.423
8.72	8.72	428.31	1.928	0.0*	5-S2n	0.553	1.139	0.553	0.927	14.228	2.440
8.95	8.95	428.36	1.978	0.0*	5-S2n	0.561	1.153	0.561	0.939	14.332	2.457

* Full Flow Headwater elevation is below inlet invert.

****

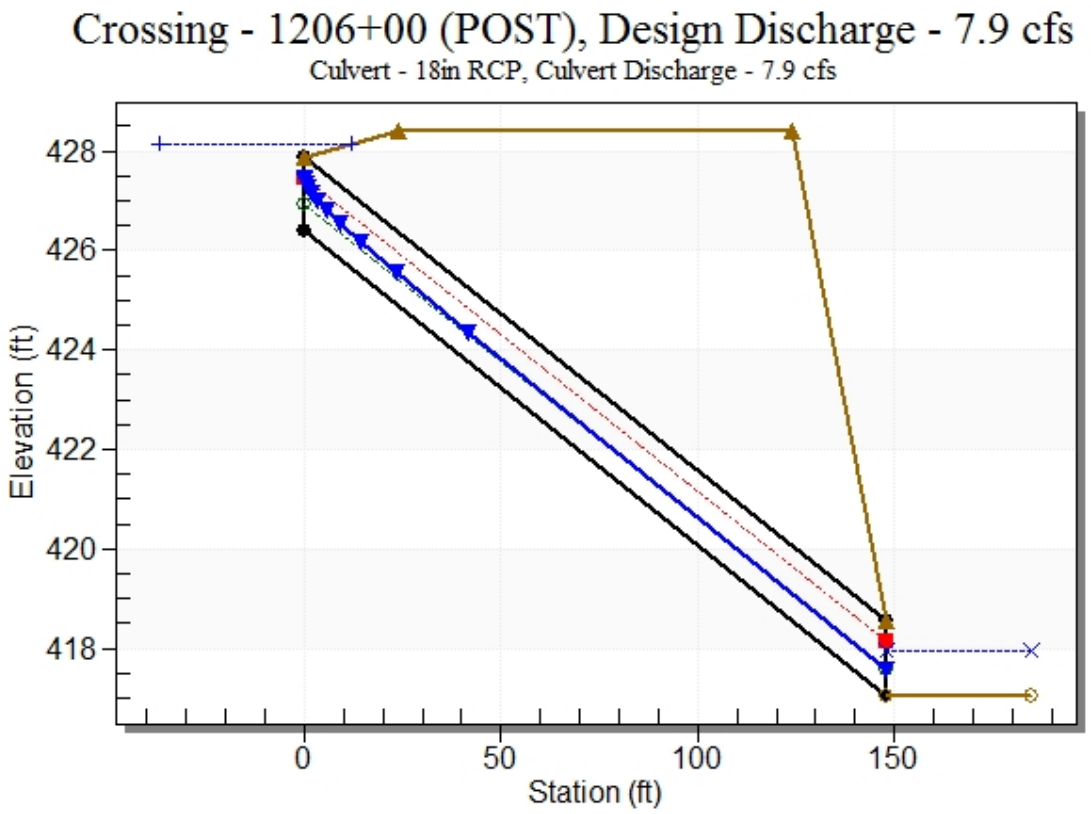
Straight Culvert

Inlet Elevation (invert): 426.38 ft, Outlet Elevation (invert): 417.06 ft

Culvert Length: 148.29 ft, Culvert Slope: 0.0630

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 426.38 ft

Outlet Station: 148.00 ft

Outlet Elevation: 417.06 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1206+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.66	417.87	0.81	2.27	1.01	0.53
6.89	417.88	0.82	2.29	1.03	0.54
7.12	417.90	0.84	2.31	1.05	0.54
7.35	417.91	0.85	2.33	1.06	0.54
7.58	417.92	0.86	2.35	1.08	0.54
7.80	417.94	0.88	2.37	1.10	0.54
7.94	417.95	0.89	2.38	1.10	0.54
8.26	417.96	0.90	2.41	1.13	0.54
8.49	417.98	0.92	2.42	1.14	0.54
8.72	417.99	0.93	2.44	1.16	0.54
8.95	418.00	0.94	2.46	1.17	0.54

Tailwater Channel Data - 1206+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 417.06 ft

Roadway Data for Crossing: 1206+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.42 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 104

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 104**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7811
Grass	0.25	0.73	0.1815
Woods	0.15	1.38	0.2077
	Σ	**2.98**	1.1702

$C_{ave} = \frac{1.1702}{2.98} = 0.39$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.10	0.9859
Grass	0.25	0.33	0.0820
Woods	0.15	1.38	0.2077
	Σ	**2.81**	1.2756

$C_{ave} = \frac{1.2756}{2.81} = 0.45$

T_c =	23.51	min.
I_{05} =	4.22	in / hr
I_{10} =	4.65	in / hr
I_{25} =	5.29	in / hr
I_{50} =	5.79	in / hr
I_{100} =	6.27	in / hr

Pre Construction Runoff:

Q_{05} =	0.39	x	4.22	x	2.98	x	1	=	**4.94**	cfs
Q_{10} =	0.39	x	4.65	x	2.98	x	1	=	**5.45**	cfs
Q_{25} =	0.39	x	5.29	x	2.98	x	1.1	=	**6.81**	cfs
Q_{50} =	0.39	x	5.79	x	2.98	x	1.2	=	**8.13**	cfs
Q_{100} =	0.39	x	6.27	x	2.98	x	1.25	=	**9.18**	cfs

Post Construction Runoff:

Q_{05} =	0.45	x	4.22	x	2.81	x	1	=	**5.38**	cfs
Q_{10} =	0.45	x	4.65	x	2.81	x	1	=	**5.94**	cfs
Q_{25} =	0.45	x	5.29	x	2.81	x	1.1	=	**7.42**	cfs
Q_{50} =	0.45	x	5.79	x	2.81	x	1.2	=	**8.86**	cfs
Q_{100} =	0.45	x	6.27	x	2.81	x	1.25	=	**10.00**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 104	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0600**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.380**	+		=	**0.380**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**225**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.392**
							min	**23.51**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.81 cfs

Design Flow: 8.13 cfs

Maximum Flow: 9.18 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1218+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
430.46	6.81	6.81	0.00	1
430.50	7.05	7.05	0.00	1
430.54	7.28	7.28	0.00	1
430.59	7.52	7.52	0.00	1
430.63	7.76	7.76	0.00	1
430.68	7.99	7.99	0.00	1
430.70	8.13	8.13	0.00	1
430.77	8.47	8.47	0.00	1
430.82	8.71	8.71	0.00	1
430.87	8.94	8.94	0.00	1
430.93	9.18	9.18	0.00	1
431.28	10.61	10.61	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.81	6.81	430.46	1.586	0.0*	5-S2n	0.625	1.007	0.650	0.648	8.968	3.186
7.05	7.05	430.50	1.628	0.0*	5-S2n	0.637	1.025	0.663	0.660	9.050	3.216
7.28	7.28	430.54	1.671	0.0*	5-S2n	0.649	1.042	0.675	0.671	9.124	3.246
7.52	7.52	430.59	1.715	0.0*	5-S2n	0.660	1.059	0.684	0.683	9.269	3.274
7.76	7.76	430.63	1.761	0.0*	5-S2n	0.672	1.075	0.672	0.694	9.780	3.303
7.99	7.99	430.68	1.807	0.0*	5-S2n	0.684	1.092	0.709	0.704	9.403	3.330
8.13	8.13	430.70	1.834	0.0*	5-S2n	0.690	1.101	0.690	0.710	9.899	3.345
8.47	8.47	430.77	1.903	0.0*	5-S2n	0.707	1.123	0.737	0.726	9.489	3.382
8.71	8.71	430.82	1.953	0.0*	5-S2n	0.718	1.138	0.749	0.736	9.555	3.409
8.94	8.94	430.87	2.005	0.0*	5-S2n	0.730	1.153	0.761	0.746	9.622	3.433
9.18	9.18	430.93	2.058	0.0*	5-S2n	0.741	1.167	0.741	0.756	10.207	3.458

* Full Flow Headwater elevation is below inlet invert.

****

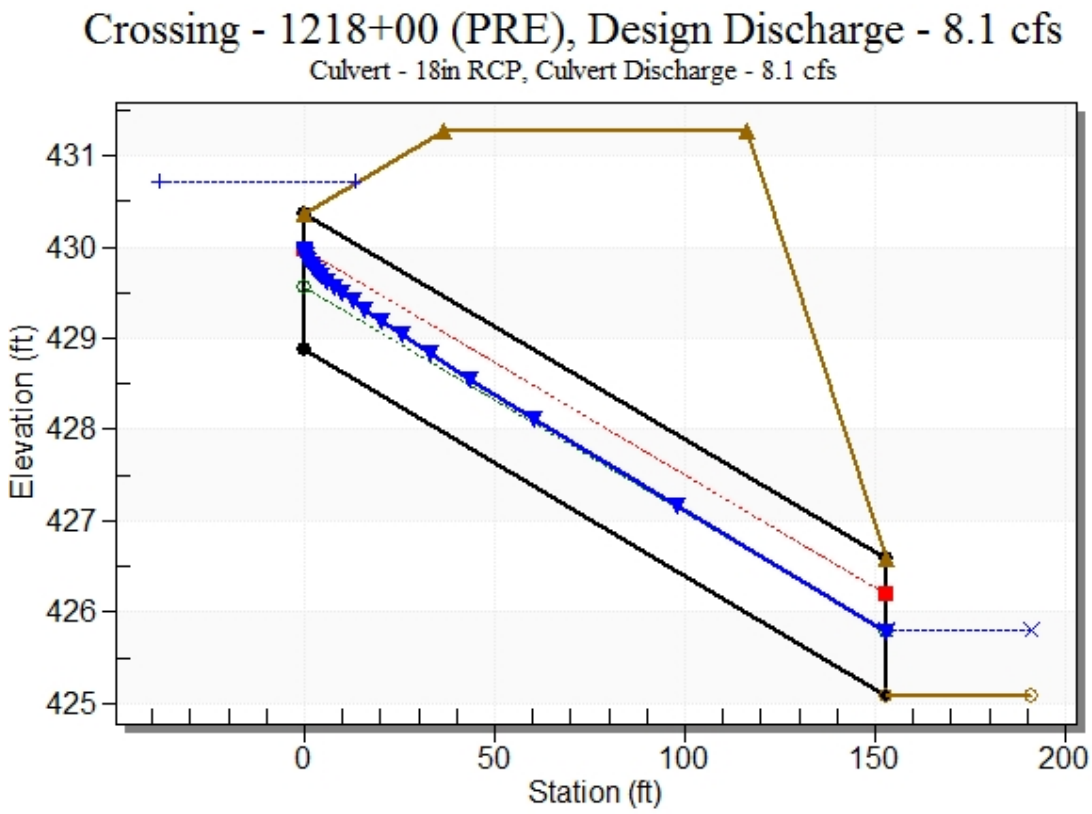
Straight Culvert

Inlet Elevation (invert): 428.87 ft, Outlet Elevation (invert): 425.09 ft

Culvert Length: 153.05 ft, Culvert Slope: 0.0247

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 428.87 ft

Outlet Station: 153.00 ft

Outlet Elevation: 425.09 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1218+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.81	425.74	0.65	3.19	2.02	0.82
7.05	425.75	0.66	3.22	2.06	0.82
7.28	425.76	0.67	3.25	2.09	0.83
7.52	425.77	0.68	3.27	2.13	0.83
7.76	425.78	0.69	3.30	2.16	0.83
7.99	425.79	0.70	3.33	2.20	0.83
8.13	425.80	0.71	3.34	2.22	0.83
8.47	425.82	0.73	3.38	2.26	0.83
8.71	425.83	0.74	3.41	2.30	0.84
8.94	425.84	0.75	3.43	2.33	0.84
9.18	425.85	0.76	3.46	2.36	0.84

Tailwater Channel Data - 1218+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 425.09 ft

Roadway Data for Crossing: 1218+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 431.28 ft

Roadway Surface: Paved

Roadway Top Width: 80.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.42 cfs

Design Flow: 8.86 cfs

Maximum Flow: 10 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1218+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
430.57	7.42	7.42	0.00	1
430.62	7.68	7.68	0.00	1
430.67	7.94	7.94	0.00	1
430.72	8.19	8.19	0.00	1
430.77	8.45	8.45	0.00	1
430.82	8.71	8.71	0.00	1
430.86	8.86	8.86	0.00	1
430.94	9.23	9.23	0.00	1
431.00	9.48	9.48	0.00	1
431.06	9.74	9.74	0.00	1
431.12	10.00	10.00	0.00	1
431.28	10.61	10.61	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.42	7.42	430.57	1.697	0.0*	5-S2n	0.655	1.052	0.655	0.678	9.671	3.262
7.68	7.68	430.62	1.745	0.0*	5-S2n	0.668	1.070	0.668	0.690	9.754	3.293
7.94	7.94	430.67	1.795	0.0*	5-S2n	0.681	1.088	0.703	0.702	9.438	3.323
8.19	8.19	430.72	1.847	0.0*	5-S2n	0.694	1.105	0.694	0.713	9.919	3.353
8.45	8.45	430.77	1.900	0.0*	5-S2n	0.706	1.122	0.736	0.725	9.484	3.381
8.71	8.71	430.82	1.954	0.0*	5-S2n	0.719	1.138	0.749	0.736	9.556	3.409
8.86	8.86	430.86	1.987	0.0*	5-S2n	0.726	1.148	0.756	0.742	9.599	3.425
9.23	9.23	430.94	2.068	0.0*	5-S2n	0.743	1.173	0.743	0.758	10.217	3.462
9.48	9.48	431.00	2.128	0.0*	5-S2n	0.756	1.188	0.756	0.769	10.287	3.489
9.74	9.74	431.06	2.189	0.0*	5-S2n	0.768	1.203	0.768	0.779	10.354	3.514
10.00	10.00	431.12	2.252	0.0*	5-S2n	0.780	1.218	0.780	0.789	10.419	3.539

* Full Flow Headwater elevation is below inlet invert.

****

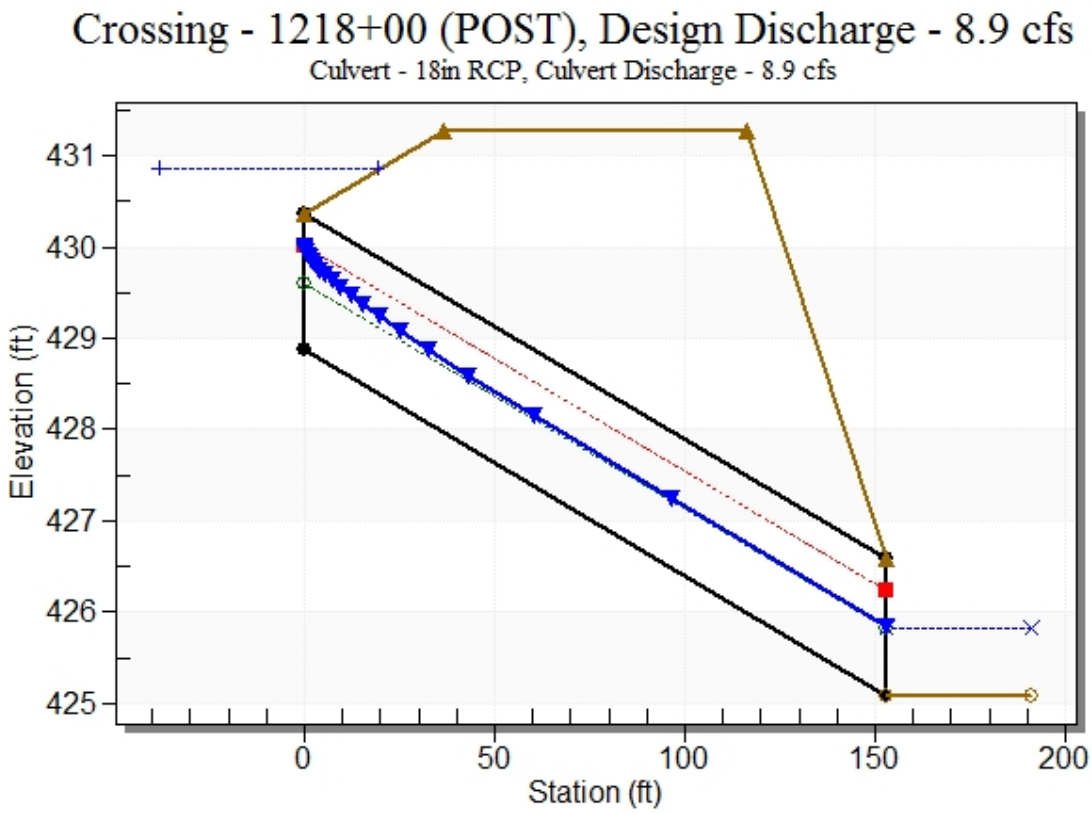
Straight Culvert

Inlet Elevation (invert): 428.87 ft, Outlet Elevation (invert): 425.09 ft

Culvert Length: 153.05 ft, Culvert Slope: 0.0247

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 428.87 ft

Outlet Station: 153.00 ft

Outlet Elevation: 425.09 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1218+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.42	425.77	0.68	3.26	2.11	0.83
7.68	425.78	0.69	3.29	2.15	0.83
7.94	425.79	0.70	3.32	2.19	0.83
8.19	425.80	0.71	3.35	2.23	0.83
8.45	425.81	0.72	3.38	2.26	0.83
8.71	425.83	0.74	3.41	2.30	0.84
8.86	425.83	0.74	3.42	2.32	0.84
9.23	425.85	0.76	3.46	2.36	0.84
9.48	425.86	0.77	3.49	2.40	0.84
9.74	425.87	0.78	3.51	2.43	0.84
10.00	425.88	0.79	3.54	2.46	0.84

Tailwater Channel Data - 1218+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 425.09 ft

Roadway Data for Crossing: 1218+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 431.28 ft

Roadway Surface: Paved

Roadway Top Width: 80.00 ft

CULVERT 105

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 105**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.65	0.5813
Grass	0.25	0.66	0.1639
Woods	0.15	0.00	0.0000
	Σ	**1.30**	0.7452

$C_{ave} = \frac{0.7452}{1.30} = 0.57$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.80	0.7200
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.80**	0.7200

$C_{ave} = \frac{0.7200}{0.80} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.32	in / hr								
I_{10} =	7.04	in / hr								
I_{25} =	8.10	in / hr								
I_{50} =	8.95	in / hr								
I_{100} =	9.80	in / hr								

Pre Construction Runoff:

Q_{05} =	0.57	**x**	6.32	**x**	1.30	**x**	1	=	**4.71**	cfs
Q_{10} =	0.57	**x**	7.04	**x**	1.30	**x**	1	=	**5.25**	cfs
Q_{25} =	0.57	**x**	8.10	**x**	1.30	**x**	1.1	=	**6.64**	cfs
Q_{50} =	0.57	**x**	8.95	**x**	1.30	**x**	1.2	=	**8.01**	cfs
Q_{100} =	0.57	**x**	9.80	**x**	1.30	**x**	1.25	=	**9.13**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.32	**x**	0.80	**x**	1	=	**4.55**	cfs
Q_{10} =	0.90	**x**	7.04	**x**	0.80	**x**	1	=	**5.07**	cfs
Q_{25} =	0.90	**x**	8.10	**x**	0.80	**x**	1.1	=	**6.42**	cfs
Q_{50} =	0.90	**x**	8.95	**x**	0.80	**x**	1.2	=	**7.74**	cfs
Q_{100} =	0.90	**x**	9.80	**x**	0.80	**x**	1.25	=	**8.82**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.64 cfs

Design Flow: 8.01 cfs

Maximum Flow: 9.13 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1223+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
422.18	6.64	6.64	0.00	1
422.26	6.89	6.89	0.00	1
422.36	7.14	7.14	0.00	1
422.45	7.39	7.39	0.00	1
422.55	7.64	7.64	0.00	1
422.65	7.88	7.88	0.00	1
422.70	8.01	8.01	0.00	1
422.87	8.38	8.38	0.00	1
422.98	8.63	8.63	0.00	1
423.09	8.88	8.88	0.00	1
423.21	9.13	9.13	0.00	1
423.23	9.16	9.16	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.64	6.64	422.18	1.927	0.0*	5-S2n	0.450	1.033	0.450	0.640	16.135	3.163
6.89	6.89	422.26	2.014	0.0*	5-S2n	0.459	1.050	0.500	0.652	14.520	3.196
7.14	7.14	422.36	2.105	0.0*	5-S2n	0.468	1.066	0.508	0.664	14.734	3.228
7.39	7.39	422.45	2.200	0.0*	5-S2n	0.477	1.081	0.515	0.676	14.983	3.258
7.64	7.64	422.55	2.298	0.0*	5-S2n	0.486	1.095	0.522	0.688	15.237	3.288
7.88	7.88	422.65	2.400	0.0*	5-S2n	0.494	1.109	0.528	0.699	15.476	3.317
8.01	8.01	422.70	2.453	0.0*	5-S2n	0.498	1.115	0.532	0.705	15.563	3.331
8.38	8.38	422.87	2.615	0.0*	5-S2n	0.511	1.132	0.544	0.722	15.833	3.373
8.63	8.63	422.98	2.728	0.0*	5-S2n	0.520	1.142	0.553	0.733	15.962	3.400
8.88	8.88	423.09	2.844	0.0*	5-S2n	0.528	1.151	0.562	0.743	16.050	3.427
9.13	9.13	423.21	2.964	0.0*	5-S2n	0.536	1.159	0.573	0.754	16.085	3.452

* Full Flow Headwater elevation is below inlet invert.

****

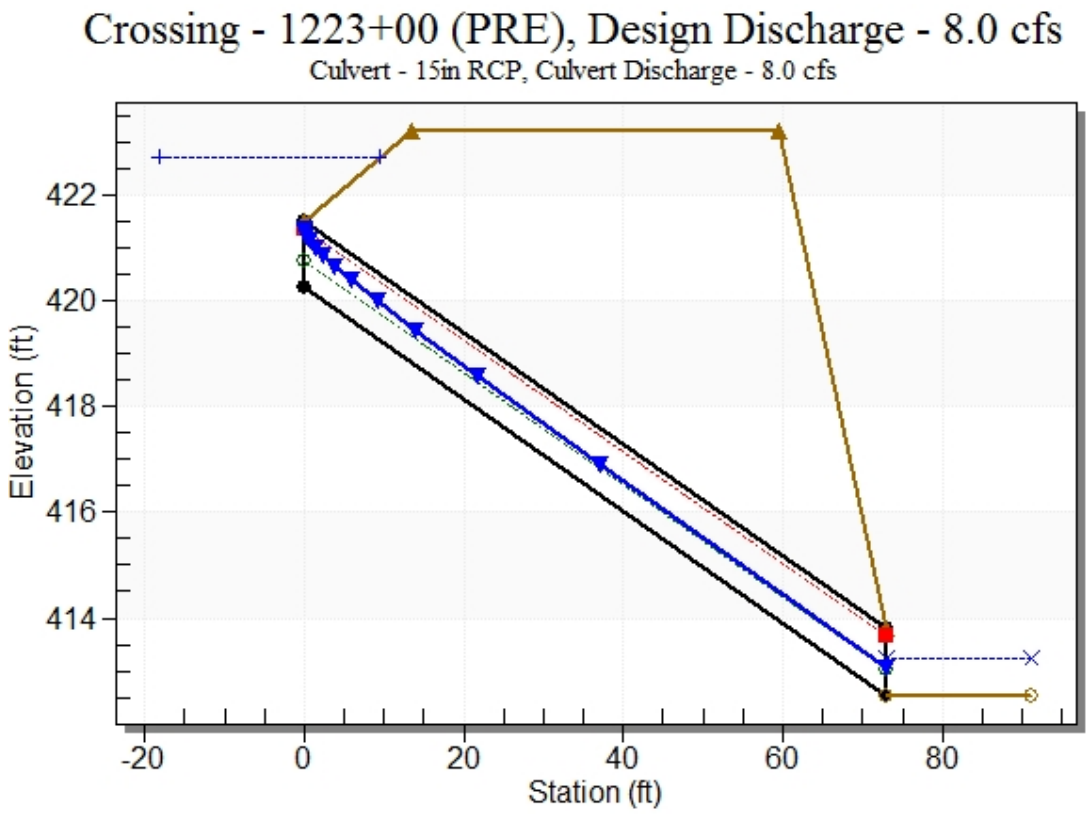
Straight Culvert

Inlet Elevation (invert): 420.25 ft, Outlet Elevation (invert): 412.54 ft

Culvert Length: 73.41 ft, Culvert Slope: 0.1056

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 420.25 ft

Outlet Station: 73.00 ft

Outlet Elevation: 412.54 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1223+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.64	413.18	0.64	3.16	2.00	0.82
6.89	413.19	0.65	3.20	2.04	0.82
7.14	413.20	0.66	3.23	2.07	0.83
7.39	413.22	0.68	3.26	2.11	0.83
7.64	413.23	0.69	3.29	2.15	0.83
7.88	413.24	0.70	3.32	2.18	0.83
8.01	413.25	0.71	3.33	2.20	0.83
8.38	413.26	0.72	3.37	2.25	0.83
8.63	413.27	0.73	3.40	2.29	0.84
8.88	413.28	0.74	3.43	2.32	0.84
9.13	413.29	0.75	3.45	2.35	0.84

Tailwater Channel Data - 1223+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 412.54 ft

Roadway Data for Crossing: 1223+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 423.23 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.42 cfs

Design Flow: 7.74 cfs

Maximum Flow: 8.82 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1223+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
422.10	6.42	6.42	0.00	1
422.18	6.66	6.66	0.00	1
422.27	6.90	6.90	0.00	1
422.36	7.14	7.14	0.00	1
422.45	7.38	7.38	0.00	1
422.54	7.62	7.62	0.00	1
422.59	7.74	7.74	0.00	1
422.74	8.10	8.10	0.00	1
422.85	8.34	8.34	0.00	1
422.95	8.58	8.58	0.00	1
423.07	8.82	8.82	0.00	1
423.23	9.16	9.16	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.42	6.42	422.10	1.853	0.0*	5-S2n	0.442	1.018	0.442	0.629	15.982	3.134
6.66	6.66	422.18	1.934	0.0*	5-S2n	0.451	1.035	0.451	0.641	16.150	3.166
6.90	6.90	422.27	2.018	0.0*	5-S2n	0.460	1.051	0.501	0.653	14.528	3.197
7.14	7.14	422.36	2.106	0.0*	5-S2n	0.468	1.066	0.508	0.664	14.736	3.228
7.38	7.38	422.45	2.197	0.0*	5-S2n	0.477	1.081	0.515	0.676	14.976	3.257
7.62	7.62	422.54	2.292	0.0*	5-S2n	0.485	1.095	0.521	0.687	15.221	3.286
7.74	7.74	422.59	2.341	0.0*	5-S2n	0.489	1.101	0.524	0.693	15.340	3.300
8.10	8.10	422.74	2.491	0.0*	5-S2n	0.502	1.119	0.534	0.709	15.636	3.342
8.34	8.34	422.85	2.596	0.0*	5-S2n	0.510	1.130	0.542	0.720	15.806	3.369
8.58	8.58	422.95	2.704	0.0*	5-S2n	0.518	1.140	0.551	0.730	15.938	3.395
8.82	8.82	423.07	2.816	0.0*	5-S2n	0.526	1.149	0.560	0.741	16.032	3.421

* Full Flow Headwater elevation is below inlet invert.

****

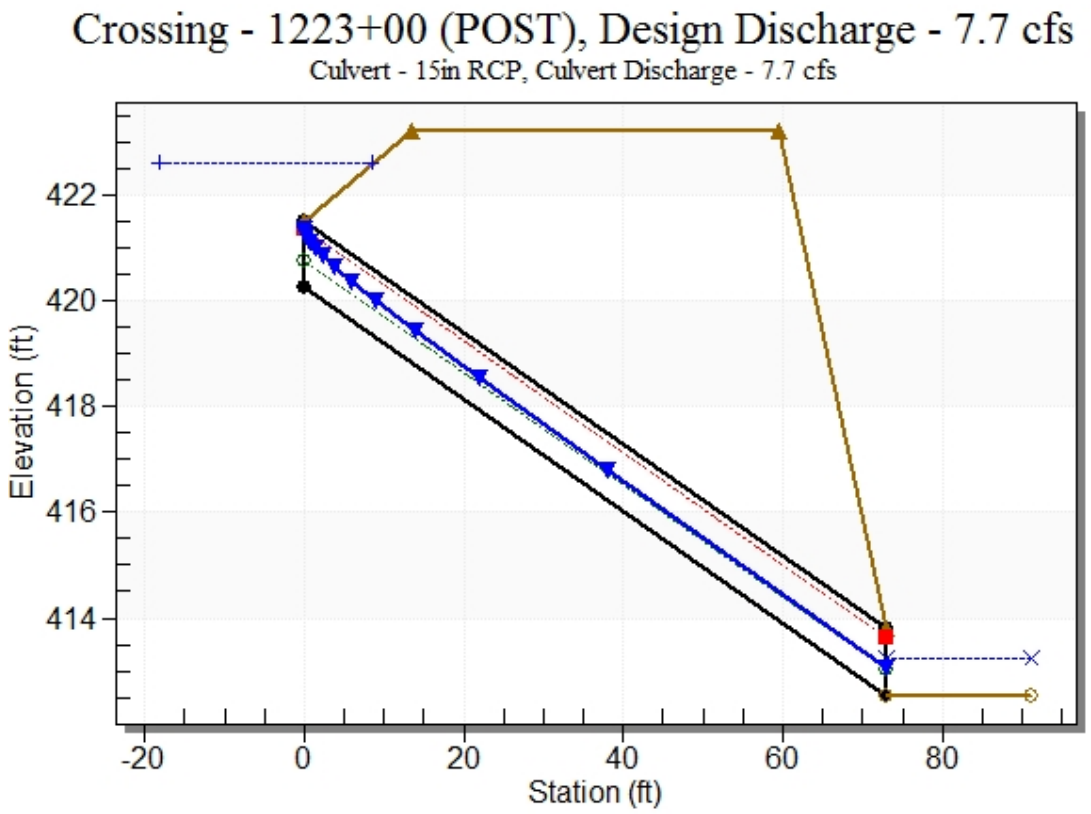
Straight Culvert

Inlet Elevation (invert): 420.25 ft, Outlet Elevation (invert): 412.54 ft

Culvert Length: 73.41 ft, Culvert Slope: 0.1056

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 420.25 ft

Outlet Station: 73.00 ft

Outlet Elevation: 412.54 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1223+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.42	413.17	0.63	3.13	1.96	0.82
6.66	413.18	0.64	3.17	2.00	0.82
6.90	413.19	0.65	3.20	2.04	0.82
7.14	413.20	0.66	3.23	2.07	0.83
7.38	413.22	0.68	3.26	2.11	0.83
7.62	413.23	0.69	3.29	2.14	0.83
7.74	413.23	0.69	3.30	2.16	0.83
8.10	413.25	0.71	3.34	2.21	0.83
8.34	413.26	0.72	3.37	2.25	0.83
8.58	413.27	0.73	3.39	2.28	0.83
8.82	413.28	0.74	3.42	2.31	0.84

Tailwater Channel Data - 1223+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 412.54 ft

Roadway Data for Crossing: 1223+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 423.23 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 19

Hydrograph Report

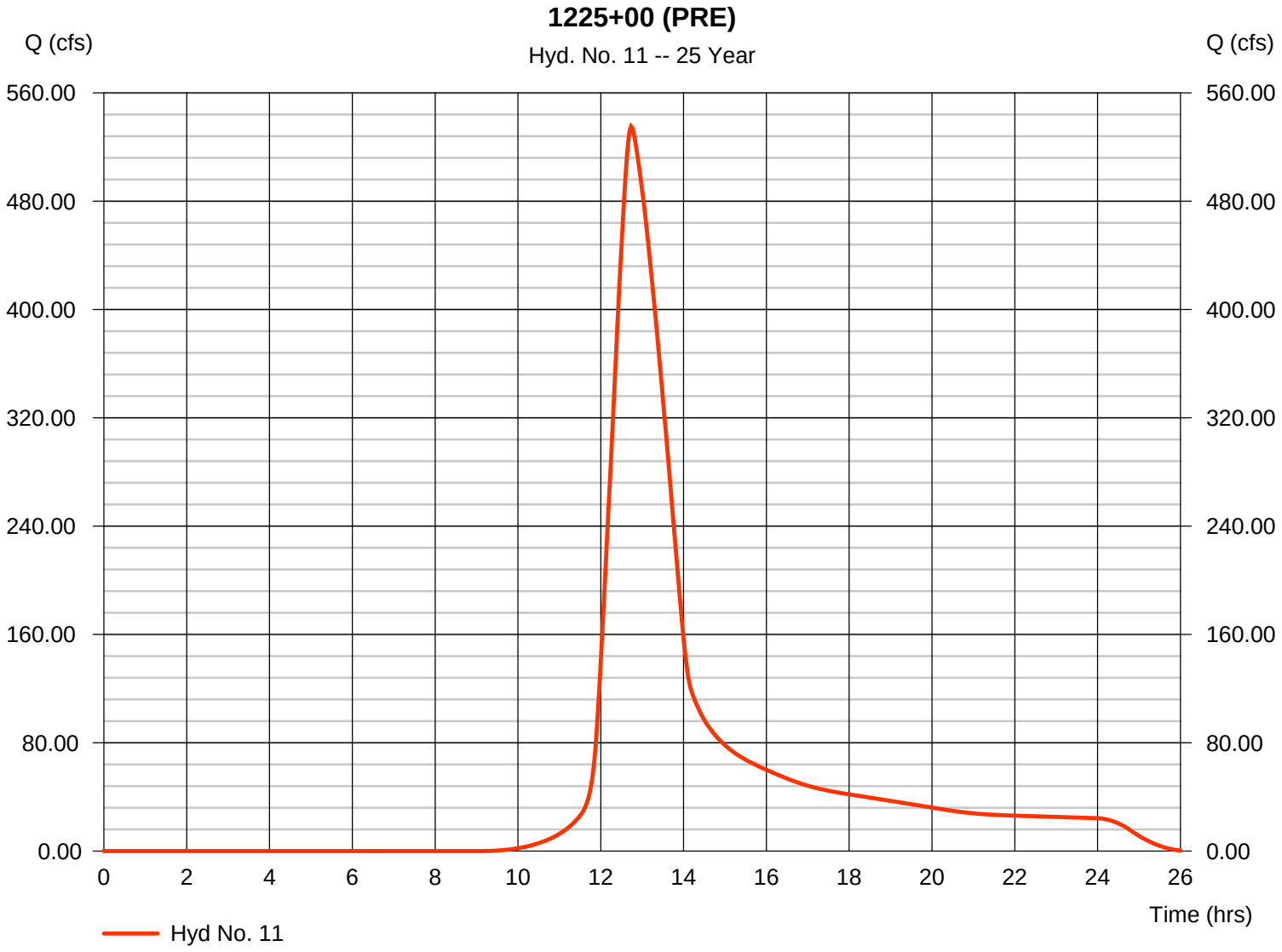
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 11

1225+00 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 535.25 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.73 hrs
Time interval	= 2 min	Hyd. volume	= 4,500,539 cuft
Drainage area	= 416.120 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 83.00 min
Total precip.	= 6.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



Hydrograph Report

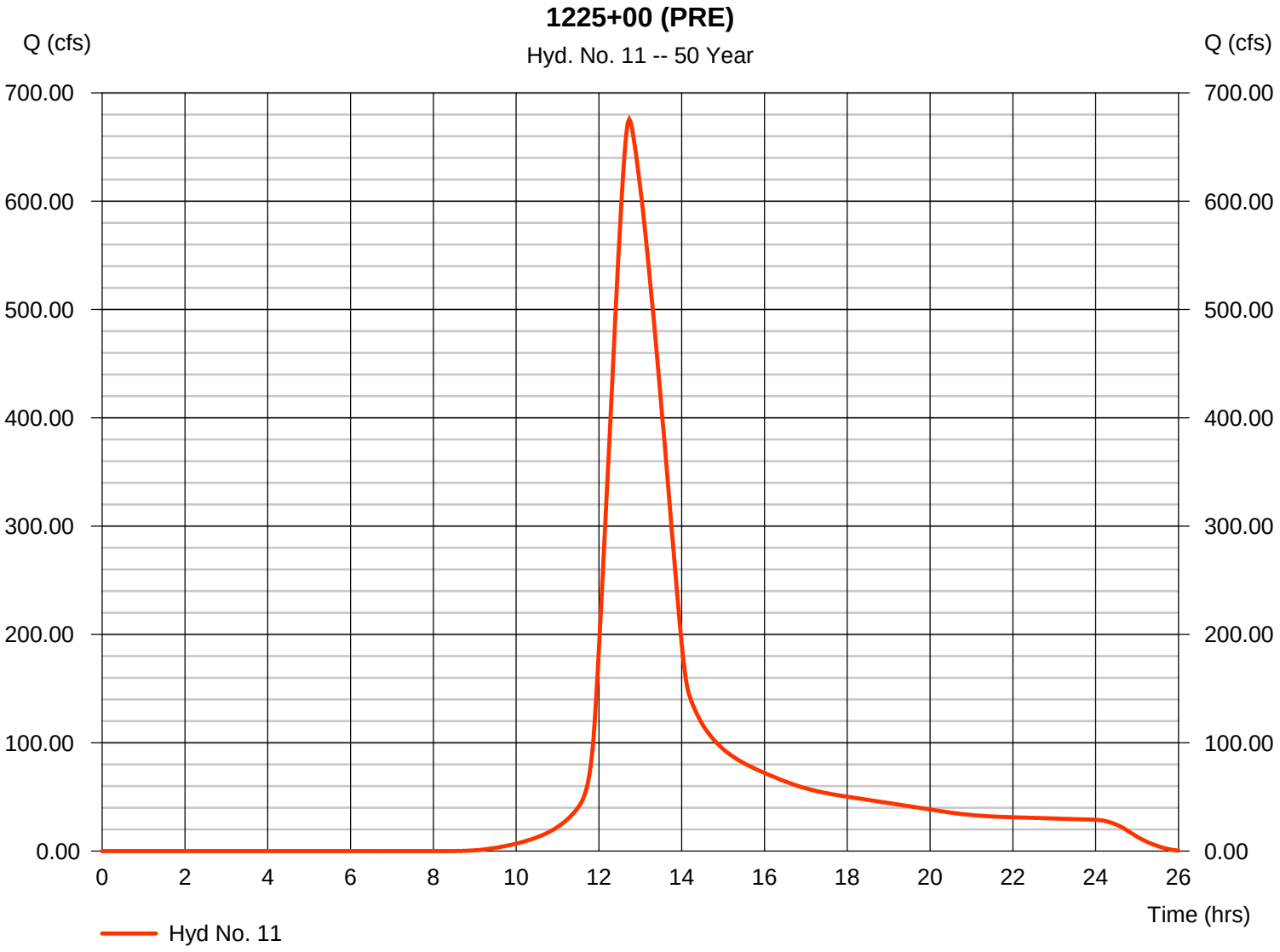
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 11

1225+00 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 675.55 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.73 hrs
Time interval	= 2 min	Hyd. volume	= 5,622,142 cuft
Drainage area	= 416.120 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 83.00 min
Total precip.	= 7.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



Hydrograph Report

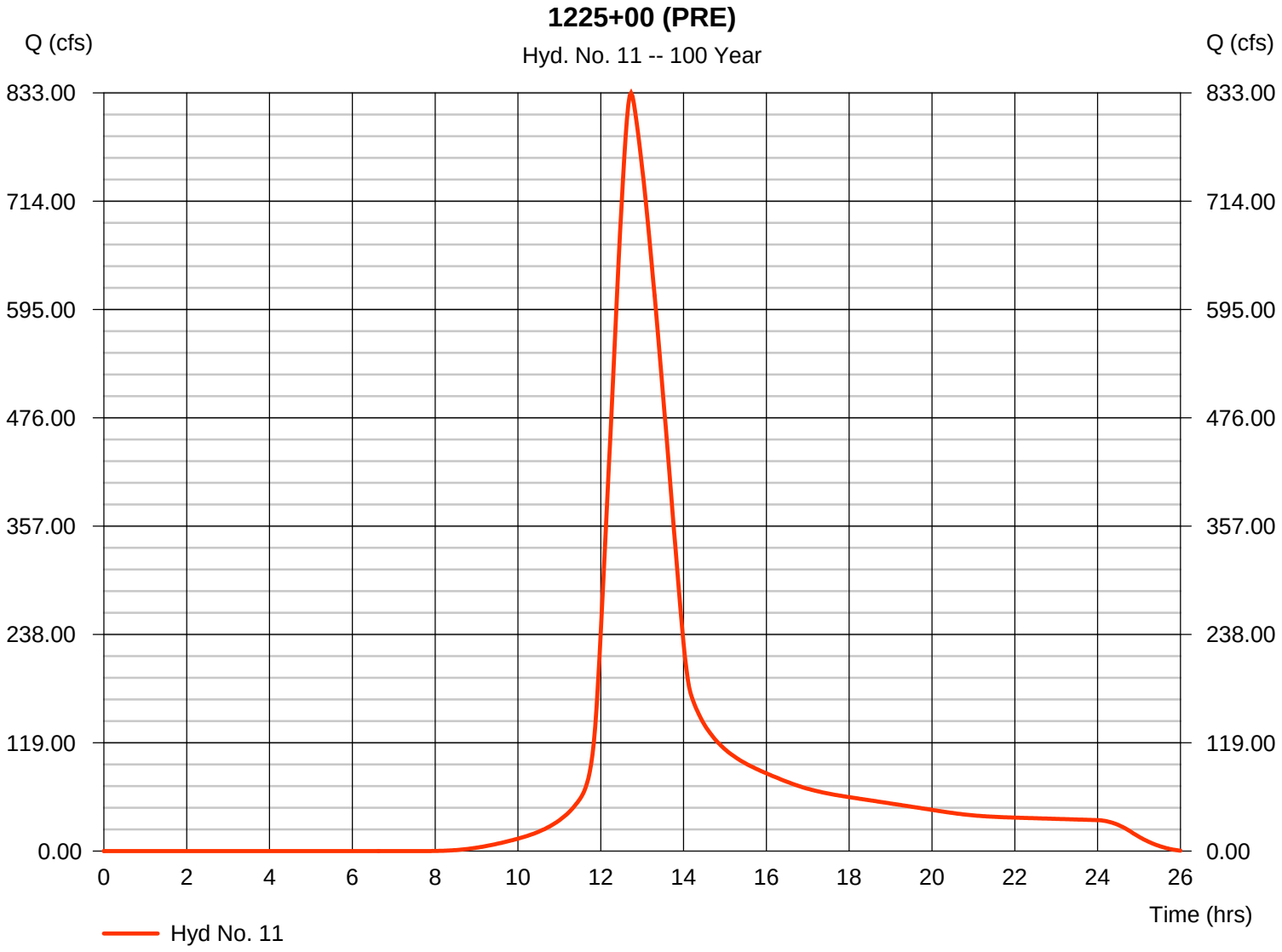
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 11

1225+00 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 832.86 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.73 hrs
Time interval	= 2 min	Hyd. volume	= 6,887,813 cuft
Drainage area	= 416.120 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 83.00 min
Total precip.	= 8.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



Hydrograph Report

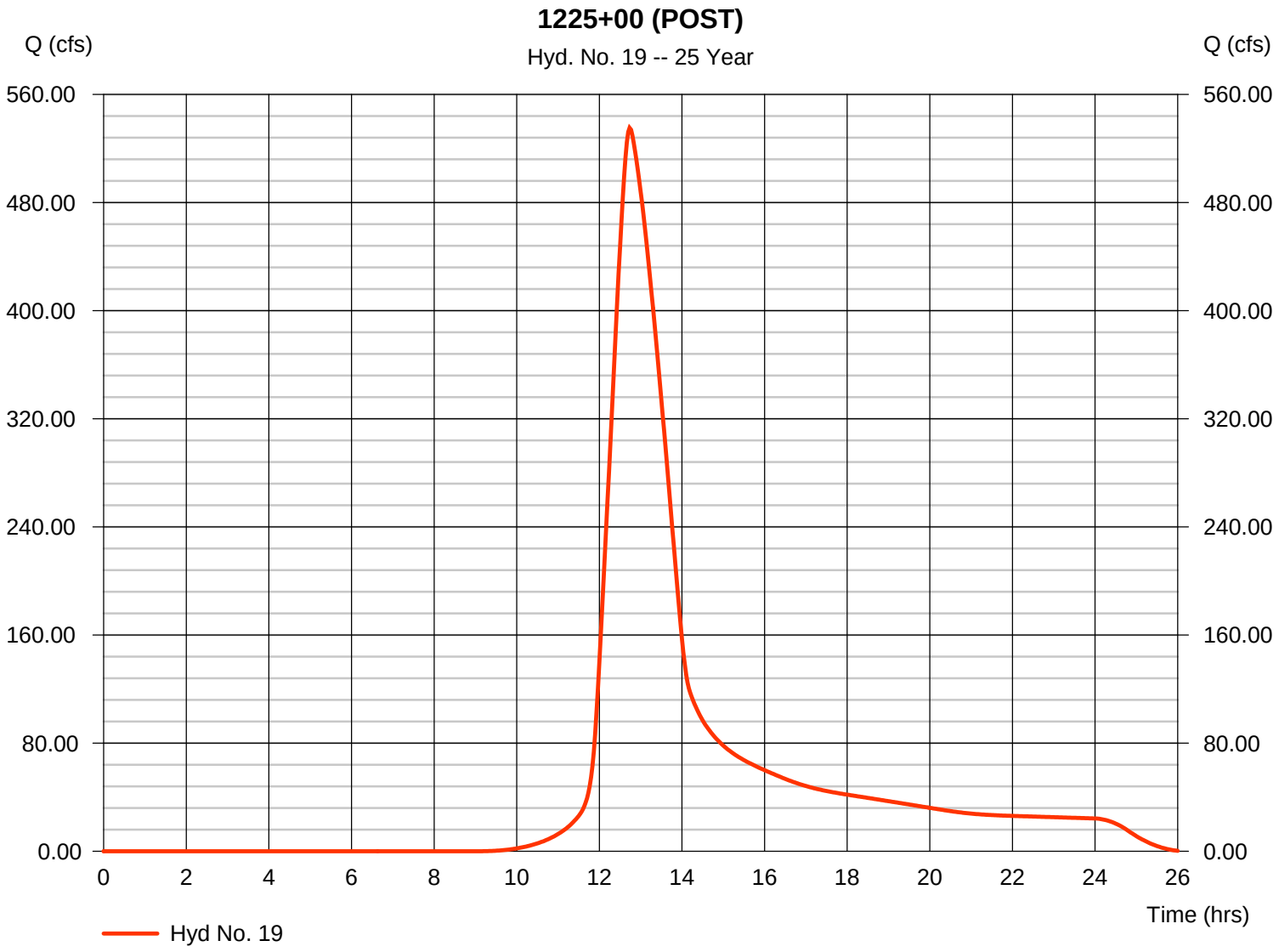
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 19

1225+00 (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 535.25 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.73 hrs
Time interval	= 2 min	Hyd. volume	= 4,500,539 cuft
Drainage area	= 416.120 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 83.00 min
Total precip.	= 6.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



Hydrograph Report

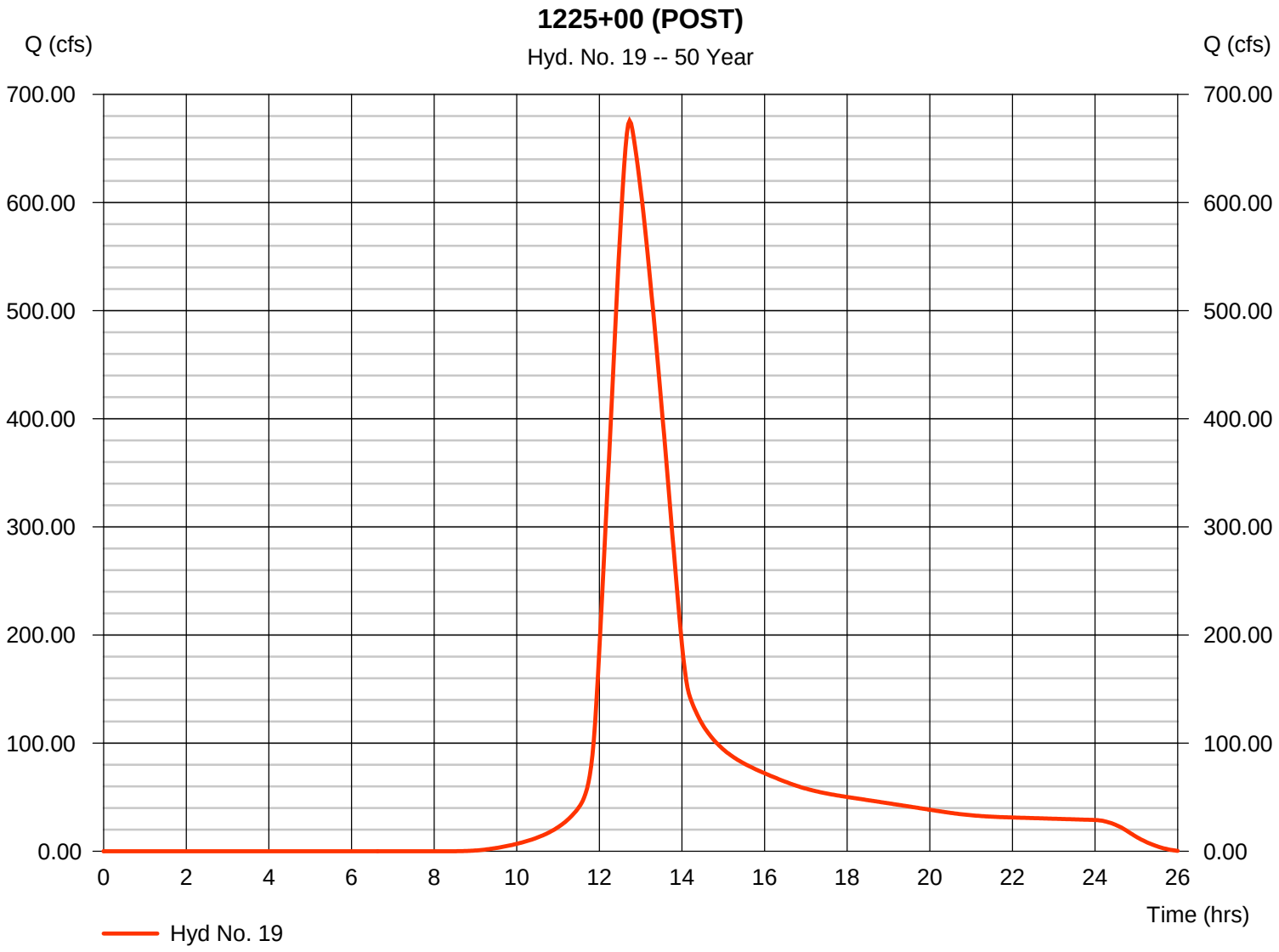
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 19

1225+00 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	675.55 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.73 hrs
Time interval	=	2 min	Hyd. volume	=	5,622,142 cuft
Drainage area	=	416.120 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	83.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



Hydrograph Report

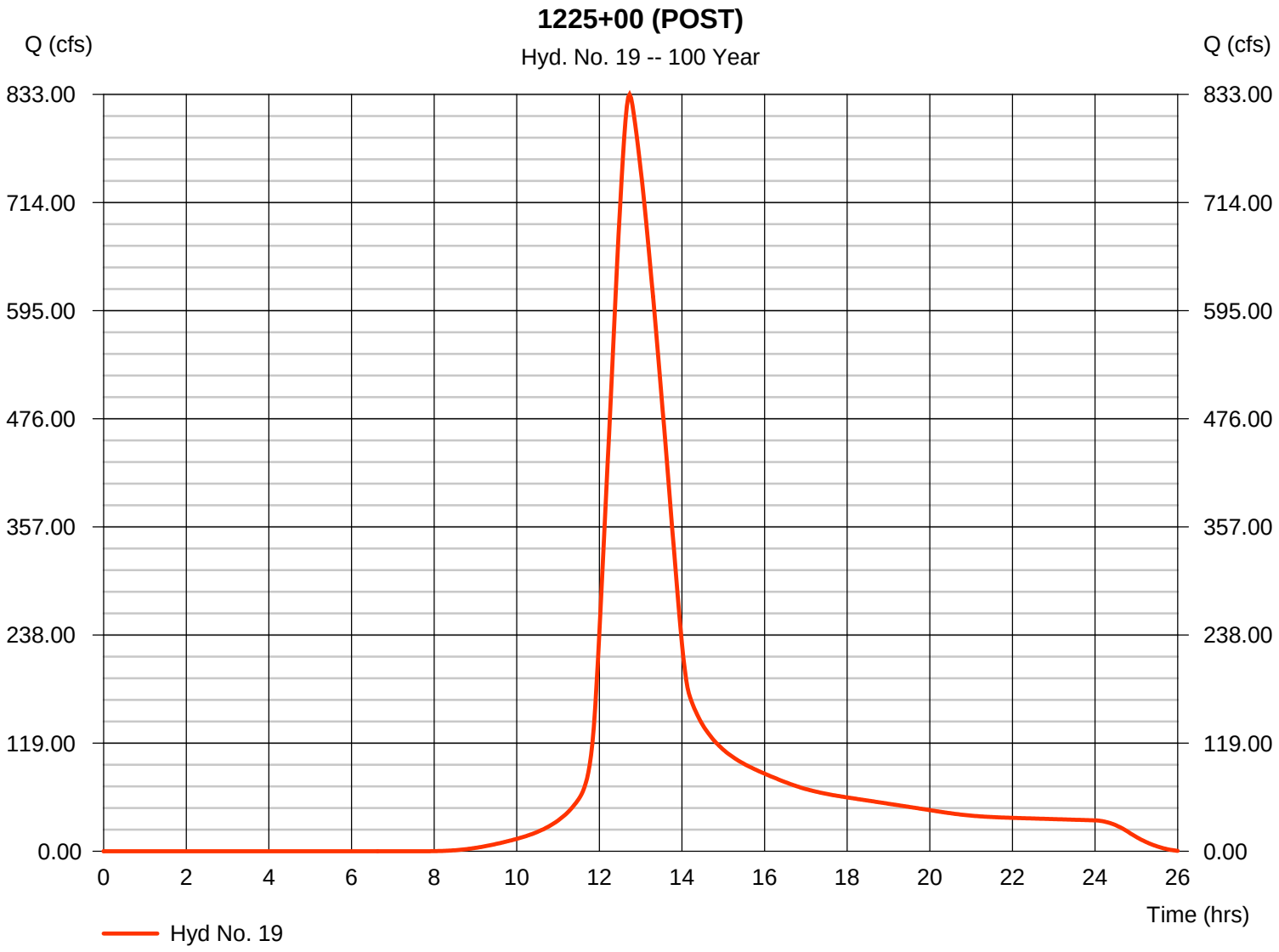
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 19

1225+00 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	832.86 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.73 hrs
Time interval	=	2 min	Hyd. volume	=	6,887,813 cuft
Drainage area	=	416.120 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	83.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(32.260 x 98) + (25.000 x 80) + (128.700 x 77) + (60.430 x 70) + (25.000 x 61) + (144.730 x 55)] / 416.120



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 535.25 cfs

Design Flow: 675.55 cfs

Maximum Flow: 832.86 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1225+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	8x8 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
415.72	535.25	535.25	0.00	1
416.02	565.01	565.01	0.00	1
416.32	594.77	594.77	0.00	1
416.62	624.53	624.53	0.00	1
416.92	654.29	654.29	0.00	1
417.14	675.55	675.55	0.00	1
417.53	713.82	713.82	0.00	1
417.84	743.58	743.58	0.00	1
418.15	773.34	773.34	0.00	1
418.47	803.10	803.10	0.00	1
418.79	832.86	832.86	0.00	1
428.00	1423.41	1423.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 8x8 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
535.25	535.25	415.72	8.024	6.889	5-JS1t	3.555	5.180	6.737	6.737	9.931	3.384
565.01	565.01	416.02	8.324	7.244	5-JS1t	3.701	5.371	6.911	6.911	10.220	3.432
594.77	594.77	416.32	8.623	7.603	5-S2n	3.846	5.558	4.391	7.079	16.931	3.478
624.53	624.53	416.62	8.922	7.967	5-S2n	3.989	5.741	4.556	7.242	17.135	3.522
654.29	654.29	416.92	9.222	8.336	5-S2n	4.132	5.922	4.719	7.401	17.332	3.564
675.55	675.55	417.14	9.437	8.602	5-S2n	4.233	6.050	4.835	7.512	17.465	3.594
713.82	713.82	417.53	9.828	9.090	5-S2n	4.414	6.276	5.041	7.706	17.701	3.645
743.58	743.58	417.84	10.136	9.477	5-S2n	4.554	6.450	5.199	7.853	17.879	3.683
773.34	773.34	418.15	10.448	9.870	5-S2n	4.693	6.621	5.356	7.997	18.048	3.720
803.10	803.10	418.47	10.766	10.269	5-JS1f	4.831	6.789	8.000	8.137	12.548	3.757
832.86	832.86	418.79	11.089	10.675	5-JS1f	4.969	6.956	8.000	8.274	13.013	3.792

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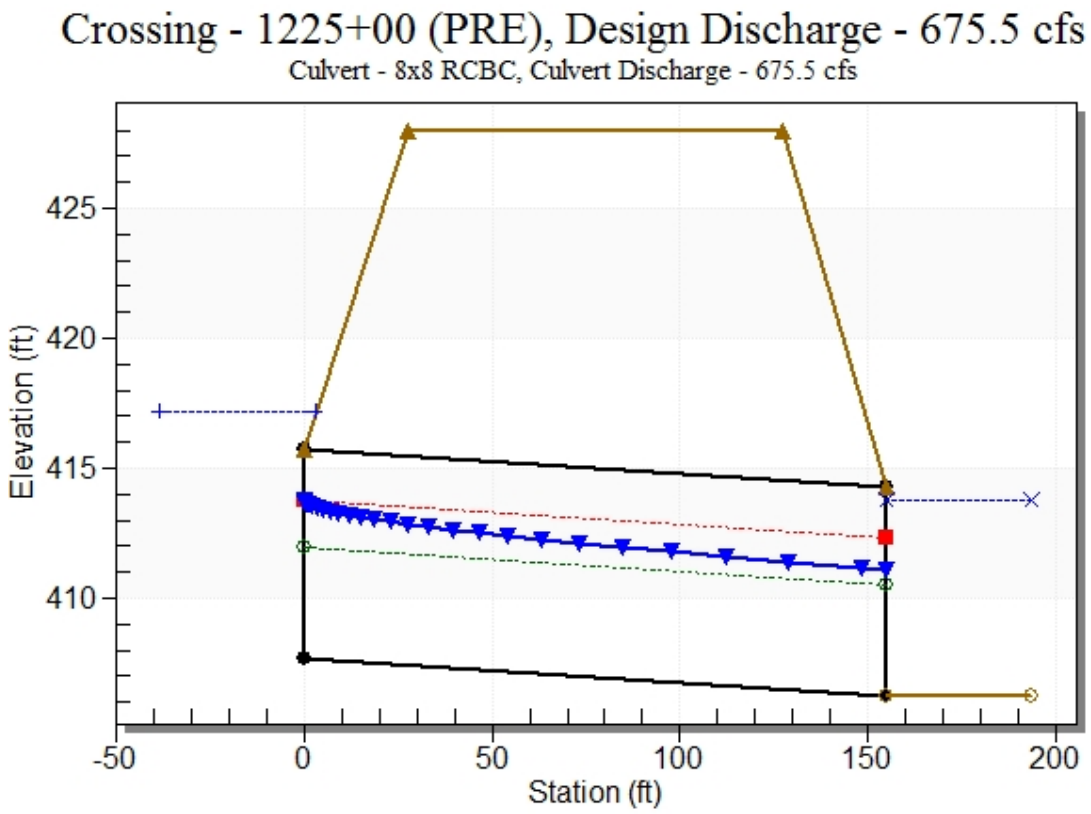
Straight Culvert

Inlet Elevation (invert): 407.70 ft, Outlet Elevation (invert): 406.27 ft

Culvert Length: 155.01 ft, Culvert Slope: 0.0092

****

Water Surface Profile Plot for Culvert: 8x8 RCBC



Site Data - 8x8 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 407.70 ft

Outlet Station: 155.00 ft

Outlet Elevation: 406.27 ft

Number of Barrels: 1

Culvert Data Summary - 8x8 RCBC

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 8.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1225+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
535.25	413.01	6.74	3.38	1.26	0.29
565.01	413.18	6.91	3.43	1.29	0.29
594.77	413.35	7.08	3.48	1.33	0.29
624.53	413.51	7.24	3.52	1.36	0.29
654.29	413.67	7.40	3.56	1.39	0.29
675.55	413.78	7.51	3.59	1.41	0.29
713.82	413.98	7.71	3.64	1.44	0.29
743.58	414.12	7.85	3.68	1.47	0.29
773.34	414.27	8.00	3.72	1.50	0.29
803.10	414.41	8.14	3.76	1.52	0.30
832.86	414.54	8.27	3.79	1.55	0.30

Tailwater Channel Data - 1225+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0600

Channel Invert Elevation: 406.27 ft

Roadway Data for Crossing: 1225+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 535.25 cfs

Design Flow: 675.55 cfs

Maximum Flow: 832.86 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1225+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	8x8 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
415.72	535.25	535.25	0.00	1
416.02	565.01	565.01	0.00	1
416.32	594.77	594.77	0.00	1
416.62	624.53	624.53	0.00	1
416.92	654.29	654.29	0.00	1
417.14	675.55	675.55	0.00	1
417.53	713.82	713.82	0.00	1
417.84	743.58	743.58	0.00	1
418.15	773.34	773.34	0.00	1
418.47	803.10	803.10	0.00	1
418.79	832.86	832.86	0.00	1
428.00	1423.41	1423.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 8x8 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
535.25	535.25	415.72	8.024	6.889	5-JS1t	3.555	5.180	6.737	6.737	9.931	3.384
565.01	565.01	416.02	8.324	7.244	5-JS1t	3.701	5.371	6.911	6.911	10.220	3.432
594.77	594.77	416.32	8.623	7.603	5-S2n	3.846	5.558	4.391	7.079	16.931	3.478
624.53	624.53	416.62	8.922	7.967	5-S2n	3.989	5.741	4.556	7.242	17.135	3.522
654.29	654.29	416.92	9.222	8.336	5-S2n	4.132	5.922	4.719	7.401	17.332	3.564
675.55	675.55	417.14	9.437	8.602	5-S2n	4.233	6.050	4.835	7.512	17.465	3.594
713.82	713.82	417.53	9.828	9.090	5-S2n	4.414	6.276	5.041	7.706	17.701	3.645
743.58	743.58	417.84	10.136	9.477	5-S2n	4.554	6.450	5.199	7.853	17.879	3.683
773.34	773.34	418.15	10.448	9.870	5-S2n	4.693	6.621	5.356	7.997	18.048	3.720
803.10	803.10	418.47	10.766	10.269	5-JS1f	4.831	6.789	8.000	8.137	12.548	3.757
832.86	832.86	418.79	11.089	10.675	5-JS1f	4.969	6.956	8.000	8.274	13.013	3.792

****

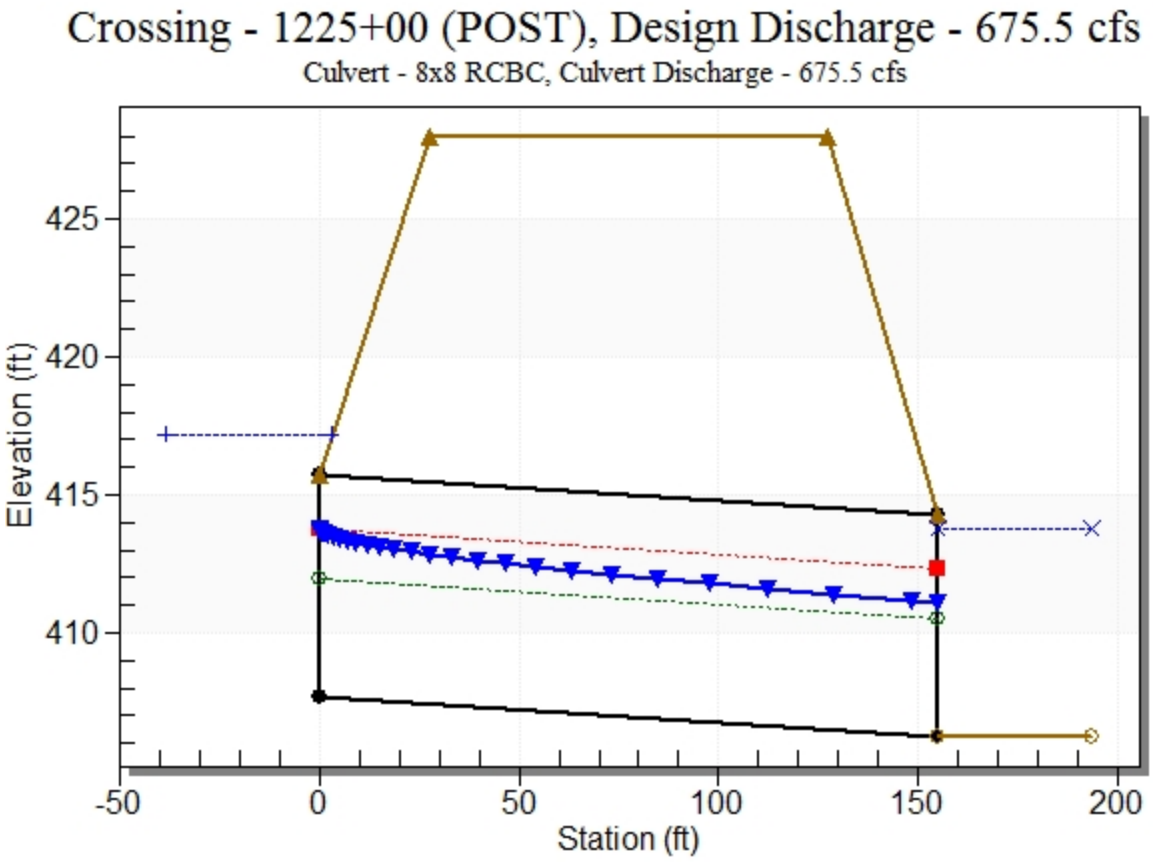
Straight Culvert

Inlet Elevation (invert): 407.70 ft, Outlet Elevation (invert): 406.27 ft

Culvert Length: 155.01 ft, Culvert Slope: 0.0092

****

Water Surface Profile Plot for Culvert: 8x8 RCBC



Site Data - 8x8 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 407.70 ft

Outlet Station: 155.00 ft

Outlet Elevation: 406.27 ft

Number of Barrels: 1

Culvert Data Summary - 8x8 RCBC

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 8.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1225+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
535.25	413.01	6.74	3.38	1.26	0.29
565.01	413.18	6.91	3.43	1.29	0.29
594.77	413.35	7.08	3.48	1.33	0.29
624.53	413.51	7.24	3.52	1.36	0.29
654.29	413.67	7.40	3.56	1.39	0.29
675.55	413.78	7.51	3.59	1.41	0.29
713.82	413.98	7.71	3.64	1.44	0.29
743.58	414.12	7.85	3.68	1.47	0.29
773.34	414.27	8.00	3.72	1.50	0.29
803.10	414.41	8.14	3.76	1.52	0.30
832.86	414.54	8.27	3.79	1.55	0.30

Tailwater Channel Data - 1225+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0600

Channel Invert Elevation: 406.27 ft

Roadway Data for Crossing: 1225+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 106

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 106**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3875
Grass	0.25	0.48	0.1207
Woods	0.15	0.00	0.0000
	Σ	**0.91**	0.5082

$C_{ave} = \frac{0.5082}{0.91} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.61	0.5490
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.61**	0.5490

$C_{ave} = \frac{0.5490}{0.61} = 0.90$

T_c =	5.00	min.
I_{05} =	6.32	in / hr
I_{10} =	7.04	in / hr
I_{25} =	8.10	in / hr
I_{50} =	8.95	in / hr
I_{100} =	9.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.32	x	0.91	x	1	=	**3.21**	cfs
Q_{10} =	0.56	x	7.04	x	0.91	x	1	=	**3.58**	cfs
Q_{25} =	0.56	x	8.10	x	0.91	x	1.1	=	**4.53**	cfs
Q_{50} =	0.56	x	8.95	x	0.91	x	1.2	=	**5.46**	cfs
Q_{100} =	0.56	x	9.80	x	0.91	x	1.25	=	**6.23**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.32	x	0.61	x	1	=	**3.47**	cfs
Q_{10} =	0.90	x	7.04	x	0.61	x	1	=	**3.86**	cfs
Q_{25} =	0.90	x	8.10	x	0.61	x	1.1	=	**4.89**	cfs
Q_{50} =	0.90	x	8.95	x	0.61	x	1.2	=	**5.90**	cfs
Q_{100} =	0.90	x	9.80	x	0.61	x	1.25	=	**6.73**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.53 cfs

Design Flow: 5.46 cfs

Maximum Flow: 6.23 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1227+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
430.04	4.53	4.53	0.00	1
430.08	4.70	4.70	0.00	1
430.12	4.87	4.87	0.00	1
430.16	5.04	5.04	0.00	1
430.21	5.21	5.21	0.00	1
430.25	5.38	5.38	0.00	1
430.28	5.46	5.46	0.00	1
430.35	5.72	5.72	0.00	1
430.40	5.89	5.89	0.00	1
430.45	6.06	6.06	0.00	1
430.51	6.23	6.23	0.00	1
432.32	10.36	10.36	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.53	4.53	430.04	1.307	0.0*	5-S2n	0.350	0.860	0.350	0.666	15.611	2.043
4.70	4.70	430.08	1.348	0.0*	5-S2n	0.356	0.876	0.356	0.678	15.794	2.064
4.87	4.87	430.12	1.390	0.0*	5-S2n	0.363	0.892	0.363	0.691	15.980	2.084
5.04	5.04	430.16	1.433	0.0*	5-S2n	0.369	0.907	0.369	0.703	16.157	2.104
5.21	5.21	430.21	1.478	0.0*	5-S2n	0.376	0.922	0.396	0.715	15.104	2.123
5.38	5.38	430.25	1.524	0.0*	5-S2n	0.382	0.937	0.382	0.727	16.376	2.142
5.46	5.46	430.28	1.546	0.0*	5-S2n	0.385	0.943	0.385	0.733	16.447	2.151
5.72	5.72	430.35	1.620	0.0*	5-S2n	0.394	0.965	0.394	0.750	16.695	2.178
5.89	5.89	430.40	1.671	0.0*	5-S2n	0.400	0.978	0.400	0.762	16.849	2.195
6.06	6.06	430.45	1.723	0.0*	5-S2n	0.407	0.991	0.407	0.773	16.916	2.213
6.23	6.23	430.51	1.776	0.0*	5-S2n	0.413	1.004	0.450	0.783	15.155	2.229

* Full Flow Headwater elevation is below inlet invert.

****

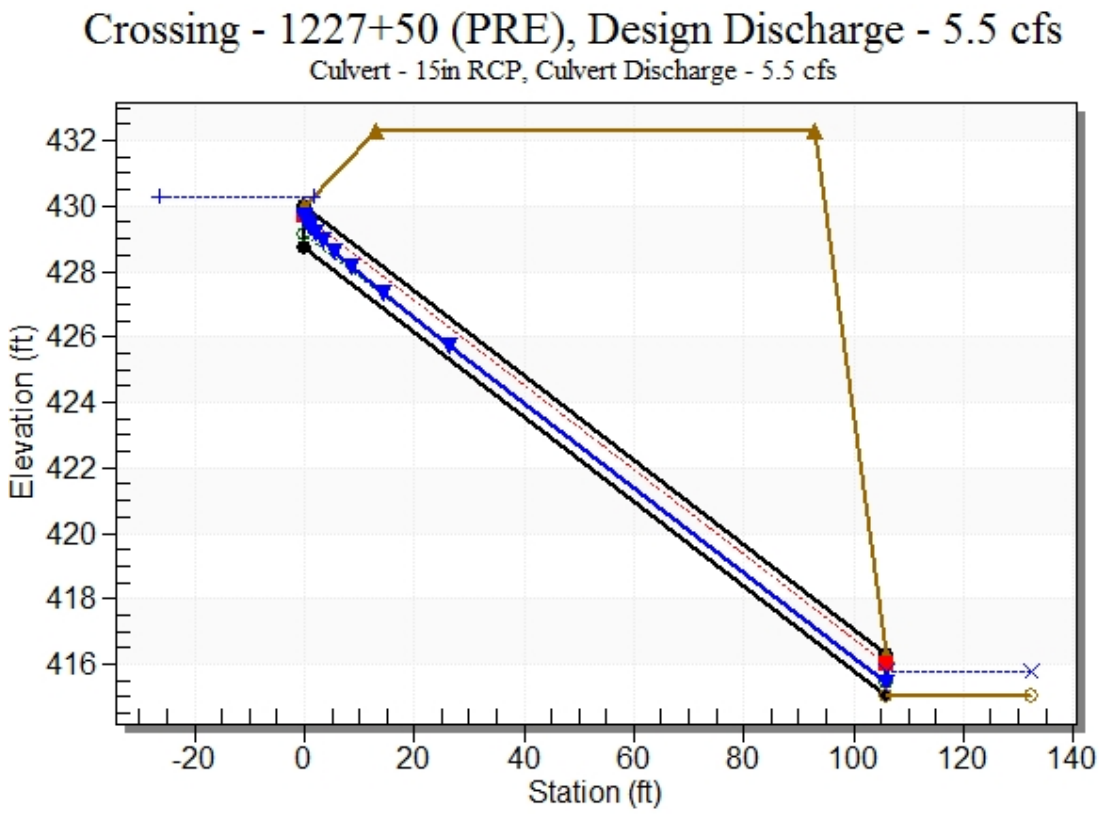
Straight Culvert

Inlet Elevation (invert): 428.73 ft, Outlet Elevation (invert): 415.05 ft

Culvert Length: 106.88 ft, Culvert Slope: 0.1291

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 428.73 ft

Outlet Station: 106.00 ft

Outlet Elevation: 415.05 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1227+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.53	415.72	0.67	2.04	0.83	0.52
4.70	415.73	0.68	2.06	0.85	0.52
4.87	415.74	0.69	2.08	0.86	0.52
5.04	415.75	0.70	2.10	0.88	0.53
5.21	415.77	0.72	2.12	0.89	0.53
5.38	415.78	0.73	2.14	0.91	0.53
5.46	415.78	0.73	2.15	0.91	0.53
5.72	415.80	0.75	2.18	0.94	0.53
5.89	415.81	0.76	2.20	0.95	0.53
6.06	415.82	0.77	2.21	0.96	0.53
6.23	415.83	0.78	2.23	0.98	0.53

Tailwater Channel Data - 1227+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.05 ft

Roadway Data for Crossing: 1227+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.32 ft

Roadway Surface: Paved

Roadway Top Width: 80.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.89 cfs

Design Flow: 5.9 cfs

Maximum Flow: 6.73 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1227+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
430.12	4.89	4.89	0.00	1
430.17	5.07	5.07	0.00	1
430.22	5.26	5.26	0.00	1
430.27	5.44	5.44	0.00	1
430.32	5.63	5.63	0.00	1
430.38	5.81	5.81	0.00	1
430.40	5.90	5.90	0.00	1
430.49	6.18	6.18	0.00	1
430.55	6.36	6.36	0.00	1
430.61	6.55	6.55	0.00	1
430.67	6.73	6.73	0.00	1
432.32	10.36	10.36	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.89	4.89	430.12	1.395	0.0*	5-S2n	0.363	0.894	0.363	0.692	16.001	2.087
5.07	5.07	430.17	1.442	0.0*	5-S2n	0.370	0.910	0.409	0.706	14.033	2.108
5.26	5.26	430.22	1.491	0.0*	5-S2n	0.377	0.926	0.391	0.719	15.498	2.129
5.44	5.44	430.27	1.541	0.0*	5-S2n	0.384	0.942	0.384	0.731	16.430	2.149
5.63	5.63	430.32	1.593	0.0*	5-S2n	0.391	0.957	0.391	0.744	16.607	2.168
5.81	5.81	430.38	1.647	0.0*	5-S2n	0.398	0.972	0.398	0.756	16.777	2.187
5.90	5.90	430.40	1.674	0.0*	5-S2n	0.401	0.979	0.401	0.762	16.858	2.197
6.18	6.18	430.49	1.760	0.0*	5-S2n	0.411	1.000	0.411	0.780	17.010	2.224
6.36	6.36	430.55	1.819	0.0*	5-S2n	0.417	1.014	0.445	0.792	15.724	2.242
6.55	6.55	430.61	1.880	0.0*	5-S2n	0.423	1.027	0.436	0.803	16.594	2.259
6.73	6.73	430.67	1.943	0.0*	5-S2n	0.430	1.040	0.430	0.815	17.455	2.276

* Full Flow Headwater elevation is below inlet invert.

****

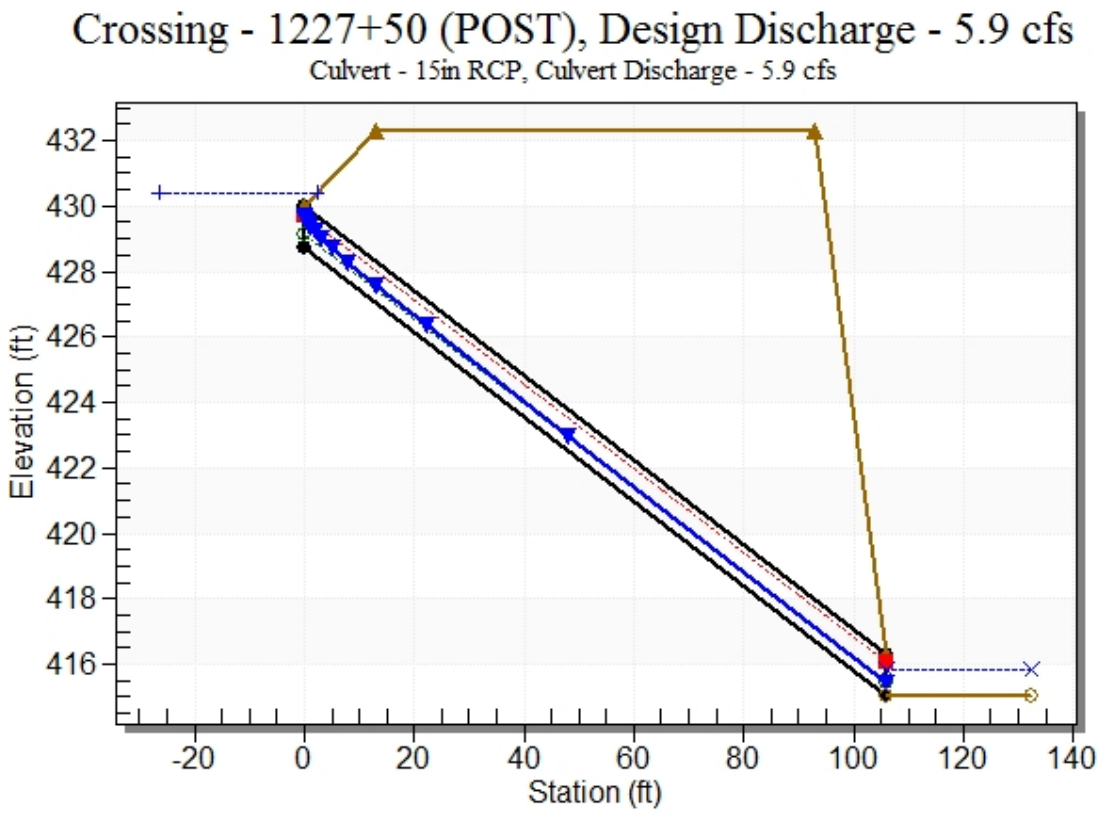
Straight Culvert

Inlet Elevation (invert): 428.73 ft, Outlet Elevation (invert): 415.05 ft

Culvert Length: 106.88 ft, Culvert Slope: 0.1291

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 428.73 ft

Outlet Station: 106.00 ft

Outlet Elevation: 415.05 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1227+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.89	415.74	0.69	2.09	0.86	0.52
5.07	415.76	0.71	2.11	0.88	0.53
5.26	415.77	0.72	2.13	0.90	0.53
5.44	415.78	0.73	2.15	0.91	0.53
5.63	415.79	0.74	2.17	0.93	0.53
5.81	415.81	0.76	2.19	0.94	0.53
5.90	415.81	0.76	2.20	0.95	0.53
6.18	415.83	0.78	2.22	0.97	0.53
6.36	415.84	0.79	2.24	0.99	0.53
6.55	415.85	0.80	2.26	1.00	0.53
6.73	415.86	0.81	2.28	1.02	0.53

Tailwater Channel Data - 1227+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.05 ft

Roadway Data for Crossing: 1227+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.32 ft

Roadway Surface: Paved

Roadway Top Width: 80.00 ft

CULVERT 108

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 108**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.16	0.1461
Grass	0.25	0.10	0.0238
Woods	0.15	1.55	0.2329
	Σ	**1.81**	0.4027

$C_{ave} = \frac{0.4027}{1.81} = 0.22$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.23	0.2091
Grass	0.25	0.10	0.0238
Woods	0.15	1.55	0.2329
	Σ	**1.88**	0.4657

$C_{ave} = \frac{0.4657}{1.88} = 0.25$

T_c =	30.71	min.
I_{05} =	3.68	in / hr
I_{10} =	4.08	in / hr
I_{25} =	4.65	in / hr
I_{50} =	5.07	in / hr
I_{100} =	5.51	in / hr

Pre Construction Runoff:

Q_{05} =	0.22	x	3.68	x	1.81	x	1	=	**1.48**	cfs
Q_{10} =	0.22	x	4.08	x	1.81	x	1	=	**1.64**	cfs
Q_{25} =	0.22	x	4.65	x	1.81	x	1.1	=	**2.06**	cfs
Q_{50} =	0.22	x	5.07	x	1.81	x	1.2	=	**2.45**	cfs
Q_{100} =	0.22	x	5.51	x	1.81	x	1.25	=	**2.77**	cfs

Post Construction Runoff:

Q_{05} =	0.25	x	3.68	x	1.88	x	1	=	**1.72**	cfs
Q_{10} =	0.25	x	4.08	x	1.88	x	1	=	**1.90**	cfs
Q_{25} =	0.25	x	4.65	x	1.88	x	1.1	=	**2.38**	cfs
Q_{50} =	0.25	x	5.07	x	1.88	x	1.2	=	**2.84**	cfs
Q_{100} =	0.25	x	5.51	x	1.88	x	1.25	=	**3.21**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 108	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**200**				
9	Watercourse slope, s		ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)		ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.011**	+		=	**0.011**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.512**
							min	**30.71**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.06 cfs

Design Flow: 2.45 cfs

Maximum Flow: 2.77 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1230+10 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
448.31	2.06	2.06	0.00	1
448.32	2.13	2.13	0.00	1
448.33	2.20	2.20	0.00	1
448.35	2.27	2.27	0.00	1
448.36	2.34	2.34	0.00	1
448.37	2.42	2.42	0.00	1
448.38	2.45	2.45	0.00	1
448.40	2.56	2.56	0.00	1
448.42	2.63	2.63	0.00	1
448.43	2.70	2.70	0.00	1
448.45	2.77	2.77	0.00	1
450.00	10.72	10.72	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.06	2.06	448.31	0.690	0.0*	1-S2n	0.234	0.539	0.234	0.324	11.489	2.400
2.13	2.13	448.32	0.703	0.0*	1-S2n	0.238	0.549	0.238	0.330	11.646	2.425
2.20	2.20	448.33	0.714	0.0*	1-S2n	0.242	0.555	0.242	0.336	11.797	2.450
2.27	2.27	448.35	0.727	0.0*	1-S2n	0.246	0.565	0.246	0.342	11.654	2.473
2.34	2.34	448.36	0.739	0.0*	1-S2n	0.249	0.575	0.249	0.348	11.776	2.497
2.42	2.42	448.37	0.752	0.0*	1-S2n	0.253	0.584	0.253	0.354	11.893	2.519
2.45	2.45	448.38	0.759	0.0*	1-S2n	0.255	0.589	0.255	0.357	11.950	2.530
2.56	2.56	448.40	0.782	0.0*	1-S2n	0.260	0.603	0.260	0.365	12.115	2.563
2.63	2.63	448.42	0.797	0.0*	1-S2n	0.264	0.612	0.264	0.371	12.220	2.584
2.70	2.70	448.43	0.812	0.0*	1-S2n	0.268	0.621	0.268	0.376	12.321	2.604
2.77	2.77	448.45	0.826	0.0*	1-S2n	0.271	0.630	0.271	0.382	12.435	2.625

* Full Flow Headwater elevation is below inlet invert.

****

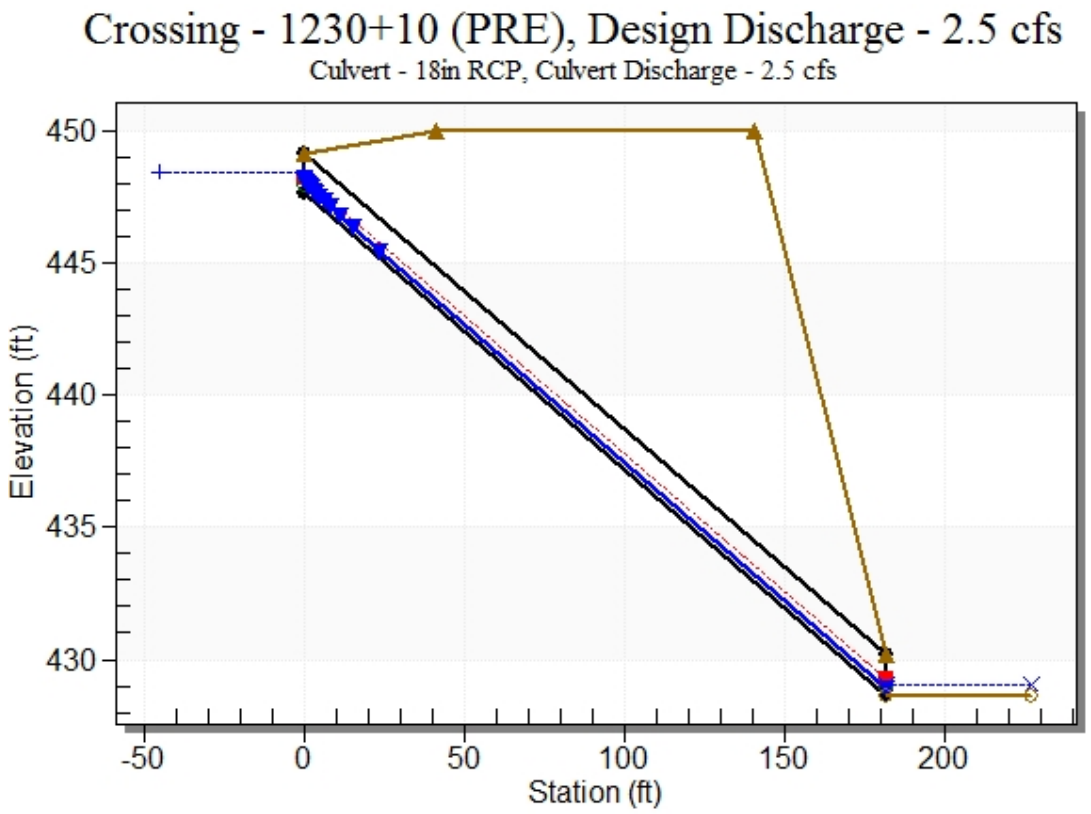
Straight Culvert

Inlet Elevation (invert): 447.62 ft, Outlet Elevation (invert): 428.65 ft

Culvert Length: 182.99 ft, Culvert Slope: 0.1042

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 447.62 ft

Outlet Station: 182.00 ft

Outlet Elevation: 428.65 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1230+10 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.06	428.97	0.32	2.40	1.21	0.83
2.13	428.98	0.33	2.43	1.24	0.83
2.20	428.99	0.34	2.45	1.26	0.83
2.27	428.99	0.34	2.47	1.28	0.83
2.34	429.00	0.35	2.50	1.30	0.84
2.42	429.00	0.35	2.52	1.33	0.84
2.45	429.01	0.36	2.53	1.34	0.84
2.56	429.02	0.37	2.56	1.37	0.84
2.63	429.02	0.37	2.58	1.39	0.84
2.70	429.03	0.38	2.60	1.41	0.84
2.77	429.03	0.38	2.62	1.43	0.85

Tailwater Channel Data - 1230+10 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 428.65 ft

Roadway Data for Crossing: 1230+10 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 450.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.38 cfs

Design Flow: 2.84 cfs

Maximum Flow: 3.21 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1230+10 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
448.37	2.38	2.38	0.00	1
448.38	2.46	2.46	0.00	1
448.40	2.55	2.55	0.00	1
448.42	2.63	2.63	0.00	1
448.43	2.71	2.71	0.00	1
448.45	2.79	2.79	0.00	1
448.46	2.84	2.84	0.00	1
448.48	2.96	2.96	0.00	1
448.50	3.04	3.04	0.00	1
448.52	3.13	3.13	0.00	1
448.53	3.21	3.21	0.00	1
450.00	10.72	10.72	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.38	2.38	448.37	0.745	0.0*	1-S2n	0.251	0.580	0.251	0.351	11.836	2.508
2.46	2.46	448.38	0.762	0.0*	1-S2n	0.255	0.591	0.255	0.358	11.970	2.534
2.55	2.55	448.40	0.780	0.0*	1-S2n	0.260	0.602	0.260	0.364	12.099	2.560
2.63	2.63	448.42	0.797	0.0*	1-S2n	0.264	0.613	0.264	0.371	12.221	2.584
2.71	2.71	448.43	0.815	0.0*	1-S2n	0.268	0.623	0.268	0.377	12.339	2.608
2.79	2.79	448.45	0.831	0.0*	1-S2n	0.272	0.633	0.272	0.384	12.478	2.632
2.84	2.84	448.46	0.841	0.0*	1-S2n	0.274	0.639	0.274	0.387	12.555	2.644
2.96	2.96	448.48	0.865	0.0*	1-S2n	0.280	0.653	0.280	0.396	12.755	2.677
3.04	3.04	448.50	0.881	0.0*	1-S2n	0.284	0.663	0.284	0.402	12.671	2.699
3.13	3.13	448.52	0.897	0.0*	1-S2n	0.287	0.673	0.287	0.408	12.784	2.722
3.21	3.21	448.53	0.913	0.0*	1-S2n	0.291	0.682	0.291	0.414	12.894	2.742

* Full Flow Headwater elevation is below inlet invert.

****

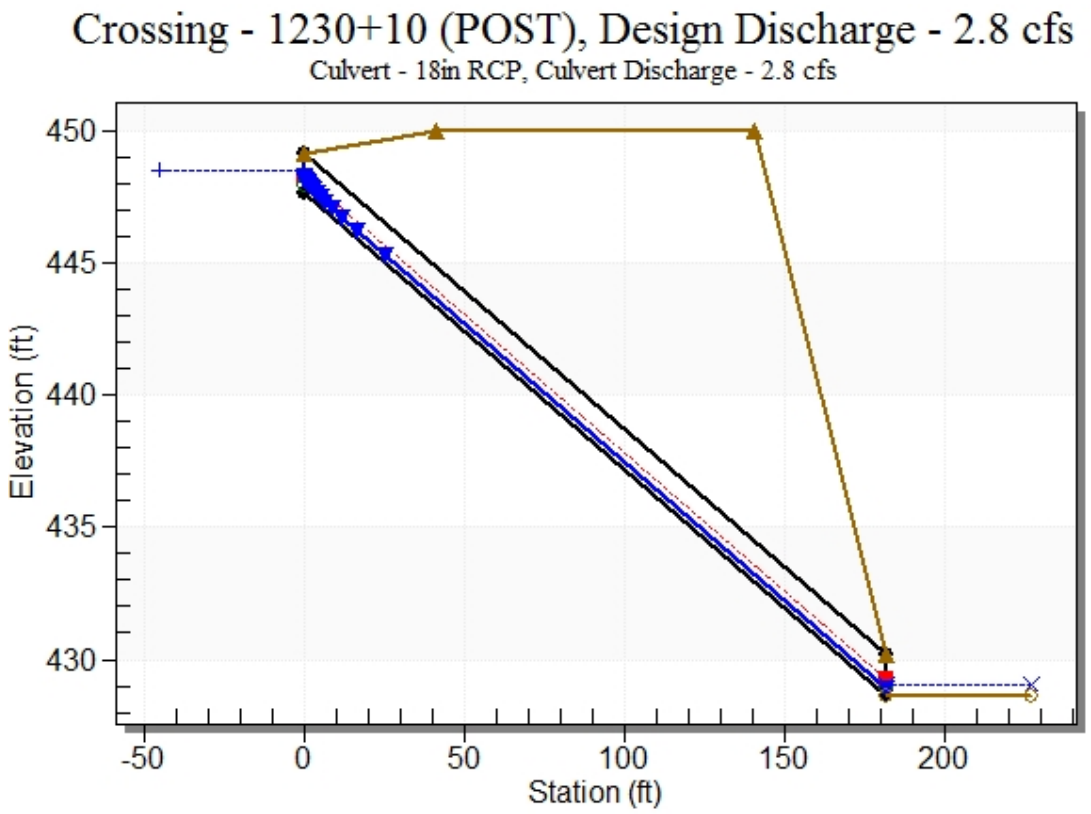
Straight Culvert

Inlet Elevation (invert): 447.62 ft, Outlet Elevation (invert): 428.65 ft

Culvert Length: 182.99 ft, Culvert Slope: 0.1042

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 447.62 ft

Outlet Station: 182.00 ft

Outlet Elevation: 428.65 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1230+10 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.38	429.00	0.35	2.51	1.31	0.84
2.46	429.01	0.36	2.53	1.34	0.84
2.55	429.01	0.36	2.56	1.36	0.84
2.63	429.02	0.37	2.58	1.39	0.84
2.71	429.03	0.38	2.61	1.41	0.84
2.79	429.03	0.38	2.63	1.44	0.85
2.84	429.04	0.39	2.64	1.45	0.85
2.96	429.05	0.40	2.68	1.48	0.85
3.04	429.05	0.40	2.70	1.51	0.85
3.13	429.06	0.41	2.72	1.53	0.85
3.21	429.06	0.41	2.74	1.55	0.85

Tailwater Channel Data - 1230+10 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 428.65 ft

Roadway Data for Crossing: 1230+10 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 450.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 109

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 109**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5952
Grass	0.25	0.60	0.1489
Woods	0.15	1.27	0.1908
	Σ	**2.53**	0.9349

$C_{ave} = \frac{0.9349}{2.53} = 0.37$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.00	0.9042
Grass	0.25	0.13	0.0330
Woods	0.15	1.27	0.1908
	Σ	**2.41**	1.1281

$C_{ave} = \frac{1.1281}{2.41} = 0.47$

T_c =	27.13	min.								
I_{05} =	3.91	in / hr								
I_{10} =	4.33	in / hr								
I_{25} =	4.94	in / hr								
I_{50} =	5.40	in / hr								
I_{100} =	5.87	in / hr								

Pre Construction Runoff:

Q_{05} =	0.37	**x**	3.91	**x**	2.53	**x**	1	=	**3.65**	cfs
Q_{10} =	0.37	**x**	4.33	**x**	2.53	**x**	1	=	**4.05**	cfs
Q_{25} =	0.37	**x**	4.94	**x**	2.53	**x**	1.1	=	**5.08**	cfs
Q_{50} =	0.37	**x**	5.40	**x**	2.53	**x**	1.2	=	**6.06**	cfs
Q_{100} =	0.37	**x**	5.87	**x**	2.53	**x**	1.25	=	**6.85**	cfs

Post Construction Runoff:

Q_{05} =	0.47	**x**	3.91	**x**	2.41	**x**	1	=	**4.41**	cfs
Q_{10} =	0.47	**x**	4.33	**x**	2.41	**x**	1	=	**4.88**	cfs
Q_{25} =	0.47	**x**	4.94	**x**	2.41	**x**	1.1	=	**6.13**	cfs
Q_{50} =	0.47	**x**	5.40	**x**	2.41	**x**	1.2	=	**7.31**	cfs
Q_{100} =	0.47	**x**	5.87	**x**	2.41	**x**	1.25	=	**8.27**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 109	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID				
1	Surface Desciption (table 3-1)			Woods			
2	Manning's roughness coeff., n (table 3-1)			**0.800**			
3	Flow length, L (total L < or = 100)		ft	**100**			
4	Two-yr 24-hr rainfall, P_2		in	**3.58**			
5	Land slope, s		ft/ft	**0.0800**			
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.338**	+		= **0.338**
Shallow Concentrated Flow			Segment ID				
7	Surface Desciption (paved or unpaved)			unpaved			
8	Flow length, L		ft	**125**			
9	Watercourse slope, s		ft/ft	**0.1100**			
10	Average velocity, V (figure 3-1)		ft/s	**5.35**			
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.006**	+		= **0.006**
Channel Flow			Segment ID				
	Front Slope, (_ : 1)			**3**			
	Back Slope, (_ : 1)			**3**			
	Bottom Width		ft	**2**			
	Flow Depth		ft	**0.5**			
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**		
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**		
15	Channel Slope, s		ft/ft	**0.0400**			
16	Manning's roughness coeff., n			**0.15**			
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**0.97**	**#DIV/0!**		
18	Flow length, L		ft	**373**			
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.107**	+ **0.000**	=	**0.107**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)					hr	**0.452**
						min	**27.13**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.08 cfs

Design Flow: 6.06 cfs

Maximum Flow: 6.85 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1233+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
458.04	5.08	5.08	0.00	1
458.07	5.26	5.26	0.00	1
458.10	5.43	5.43	0.00	1
458.13	5.61	5.61	0.00	1
458.16	5.79	5.79	0.00	1
458.19	5.96	5.96	0.00	1
458.21	6.06	6.06	0.00	1
458.25	6.32	6.32	0.00	1
458.28	6.50	6.50	0.00	1
458.31	6.67	6.67	0.00	1
458.34	6.85	6.85	0.00	1
459.00	9.99	9.99	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.08	5.08	458.04	1.284	0.0*	1-S2n	0.470	0.862	0.470	0.556	10.398	2.935
5.26	5.26	458.07	1.313	0.0*	1-S2n	0.478	0.881	0.478	0.566	10.467	2.963
5.43	5.43	458.10	1.342	0.0*	1-S2n	0.487	0.896	0.487	0.576	10.570	2.991
5.61	5.61	458.13	1.372	0.0*	1-S2n	0.495	0.910	0.495	0.586	10.667	3.018
5.79	5.79	458.16	1.401	0.0*	1-S2n	0.503	0.925	0.503	0.596	10.765	3.045
5.96	5.96	458.19	1.430	0.0*	1-S2n	0.511	0.939	0.511	0.605	10.867	3.070
6.06	6.06	458.21	1.446	0.0*	1-S2n	0.515	0.946	0.515	0.610	10.885	3.084
6.32	6.32	458.25	1.490	0.0*	1-S2n	0.527	0.966	0.527	0.624	11.017	3.120
6.50	6.50	458.28	1.520	0.0*	5-S2n	0.535	0.984	0.562	0.633	10.394	3.144
6.67	6.67	458.31	1.551	0.0*	5-S2n	0.543	0.997	0.553	0.642	10.898	3.168
6.85	6.85	458.34	1.582	0.0*	5-S2n	0.550	1.010	0.550	0.650	11.254	3.191

* Full Flow Headwater elevation is below inlet invert.

****

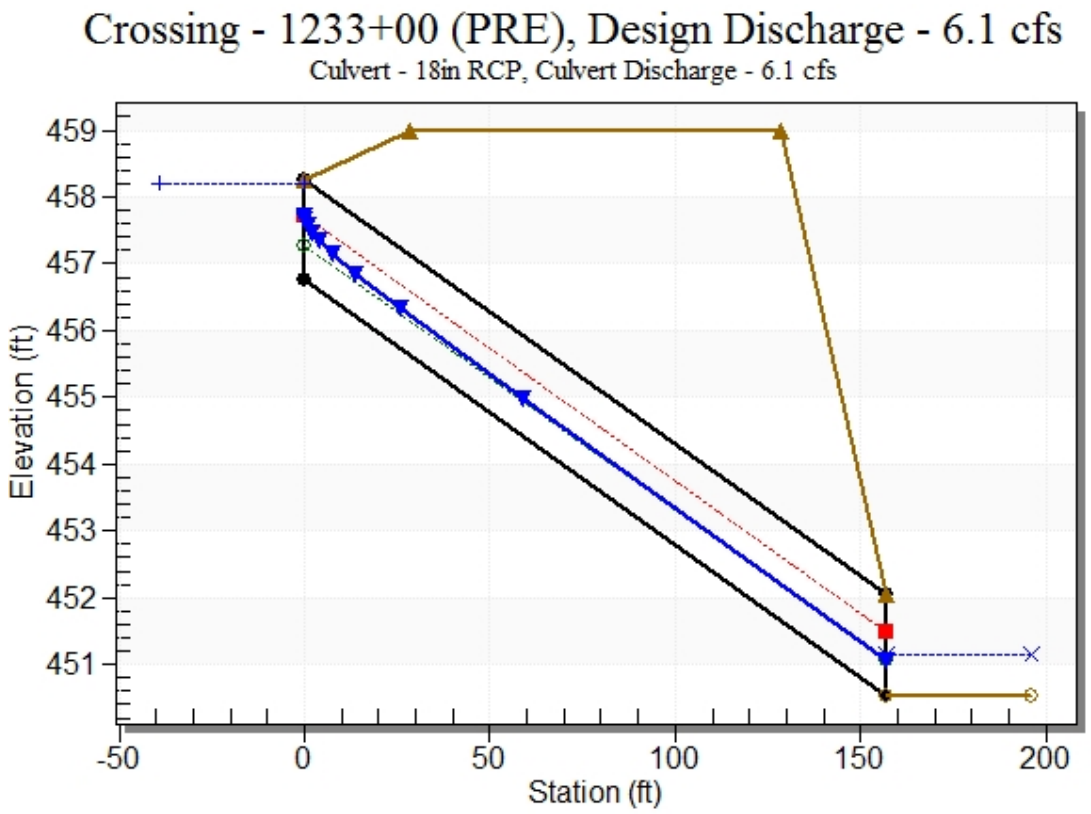
Straight Culvert

Inlet Elevation (invert): 456.76 ft, Outlet Elevation (invert): 450.54 ft

Culvert Length: 157.12 ft, Culvert Slope: 0.0396

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 456.76 ft

Outlet Station: 157.00 ft

Outlet Elevation: 450.54 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1233+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.08	451.10	0.56	2.93	1.74	0.81
5.26	451.11	0.57	2.96	1.77	0.81
5.43	451.12	0.58	2.99	1.80	0.81
5.61	451.13	0.59	3.02	1.83	0.81
5.79	451.14	0.60	3.04	1.86	0.81
5.96	451.15	0.61	3.07	1.89	0.82
6.06	451.15	0.61	3.08	1.90	0.82
6.32	451.16	0.62	3.12	1.95	0.82
6.50	451.17	0.63	3.14	1.97	0.82
6.67	451.18	0.64	3.17	2.00	0.82
6.85	451.19	0.65	3.19	2.03	0.82

Tailwater Channel Data - 1233+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 450.54 ft

Roadway Data for Crossing: 1233+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 459.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.13 cfs

Design Flow: 7.31 cfs

Maximum Flow: 8.27 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1233+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
458.22	6.13	6.13	0.00	1
458.25	6.34	6.34	0.00	1
458.29	6.56	6.56	0.00	1
458.33	6.77	6.77	0.00	1
458.37	6.99	6.99	0.00	1
458.40	7.20	7.20	0.00	1
458.42	7.31	7.31	0.00	1
458.48	7.63	7.63	0.00	1
458.53	7.84	7.84	0.00	1
458.57	8.06	8.06	0.00	1
458.61	8.27	8.27	0.00	1
459.00	10.00	10.00	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.13	6.13	458.22	1.458	0.0*	1-S2n	0.519	0.952	0.519	0.614	10.922	3.094
6.34	6.34	458.25	1.494	0.0*	1-S2n	0.528	0.968	0.528	0.625	11.029	3.123
6.56	6.56	458.29	1.531	0.0*	5-S2n	0.538	0.988	0.559	0.636	10.566	3.152
6.77	6.77	458.33	1.568	0.0*	5-S2n	0.547	1.005	0.547	0.647	11.240	3.181
6.99	6.99	458.37	1.606	0.0*	5-S2n	0.556	1.020	0.556	0.657	11.317	3.208
7.20	7.20	458.40	1.645	0.0*	5-S2n	0.566	1.036	0.566	0.667	11.413	3.235
7.31	7.31	458.42	1.665	0.0*	5-S2n	0.570	1.044	0.570	0.673	11.461	3.248
7.63	7.63	458.48	1.725	0.0*	5-S2n	0.584	1.066	0.584	0.688	11.600	3.287
7.84	7.84	458.53	1.766	0.0*	5-S2n	0.593	1.081	0.593	0.697	11.673	3.312
8.06	8.06	458.57	1.808	0.0*	5-S2n	0.601	1.096	0.645	0.707	10.716	3.336
8.27	8.27	458.61	1.851	0.0*	5-S2n	0.610	1.110	0.644	0.717	11.023	3.361

* Full Flow Headwater elevation is below inlet invert.

****

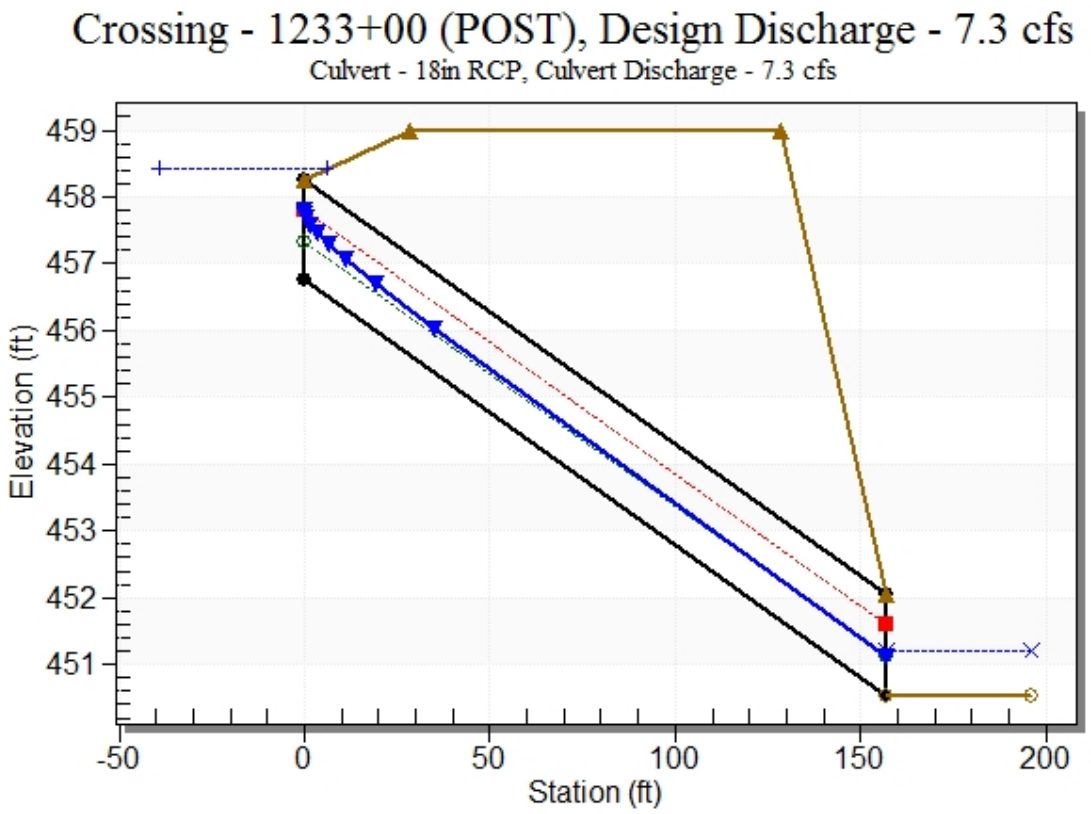
Straight Culvert

Inlet Elevation (invert): 456.76 ft, Outlet Elevation (invert): 450.54 ft

Culvert Length: 157.12 ft, Culvert Slope: 0.0396

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 456.76 ft

Outlet Station: 157.00 ft

Outlet Elevation: 450.54 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1233+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.13	451.15	0.61	3.09	1.92	0.82
6.34	451.16	0.62	3.12	1.95	0.82
6.56	451.18	0.64	3.15	1.98	0.82
6.77	451.19	0.65	3.18	2.02	0.82
6.99	451.20	0.66	3.21	2.05	0.82
7.20	451.21	0.67	3.24	2.08	0.83
7.31	451.21	0.67	3.25	2.10	0.83
7.63	451.23	0.69	3.29	2.15	0.83
7.84	451.24	0.70	3.31	2.18	0.83
8.06	451.25	0.71	3.34	2.21	0.83
8.27	451.26	0.72	3.36	2.24	0.83

Tailwater Channel Data - 1233+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 450.54 ft

Roadway Data for Crossing: 1233+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 459.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 110

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 110**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4333
Grass	0.25	0.51	0.1286
Woods	0.15	2.09	0.3132
	Σ	**3.08**	0.8750

$C_{ave} = \frac{0.8750}{3.08} = 0.28$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.85	0.7607
Grass	0.25	0.03	0.0076
Woods	0.15	2.09	0.3132
	Σ	**2.96**	1.0815

$C_{ave} = \frac{1.0815}{2.96} = 0.36$

T_c =	31.71	min.								
I_{05} =	3.63	in / hr								
I_{10} =	4.01	in / hr								
I_{25} =	4.57	in / hr								
I_{50} =	4.99	in / hr								
I_{100} =	5.42	in / hr								

Pre Construction Runoff:

Q_{05} =	0.28	**x**	3.63	**x**	3.08	**x**	1	=	**3.17**	cfs
Q_{10} =	0.28	**x**	4.01	**x**	3.08	**x**	1	=	**3.51**	cfs
Q_{25} =	0.28	**x**	4.57	**x**	3.08	**x**	1.1	=	**4.40**	cfs
Q_{50} =	0.28	**x**	4.99	**x**	3.08	**x**	1.2	=	**5.24**	cfs
Q_{100} =	0.28	**x**	5.42	**x**	3.08	**x**	1.25	=	**5.93**	cfs

Post Construction Runoff:

Q_{05} =	0.36	**x**	3.63	**x**	2.96	**x**	1	=	**3.92**	cfs
Q_{10} =	0.36	**x**	4.01	**x**	2.96	**x**	1	=	**4.34**	cfs
Q_{25} =	0.36	**x**	4.57	**x**	2.96	**x**	1.1	=	**5.44**	cfs
Q_{50} =	0.36	**x**	4.99	**x**	2.96	**x**	1.2	=	**6.48**	cfs
Q_{100} =	0.36	**x**	5.42	**x**	2.96	**x**	1.25	=	**7.32**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 110	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**424**				
9	Watercourse slope, s		ft/ft	**0.0700**				
10	Average velocity, V (figure 3-1)		ft/s	**4.27**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.028**	+		=	**0.028**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0**				
12	Cross sectional flow area, a		ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**2.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.00**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0400**				
16	Manning's roughness coeff., n			**0.15**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**0.00**	**#DIV/0!**			
18	Flow length, L		ft	**0**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.529**
							min	**31.71**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.4 cfs

Design Flow: 5.24 cfs

Maximum Flow: 5.93 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1238+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
470.19	4.40	4.40	0.00	1
470.21	4.55	4.55	0.00	1
470.24	4.71	4.71	0.00	1
470.26	4.86	4.86	0.00	1
470.29	5.01	5.01	0.00	1
470.31	5.17	5.17	0.00	1
470.32	5.24	5.24	0.00	1
470.36	5.47	5.47	0.00	1
470.39	5.62	5.62	0.00	1
470.41	5.78	5.78	0.00	1
470.44	5.93	5.93	0.00	1
477.00	23.20	23.20	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.40	4.40	470.19	1.126	0.0*	1-S2n	0.344	0.803	0.344	0.491	13.964	3.007
4.55	4.55	470.21	1.151	0.0*	1-S2n	0.350	0.817	0.350	0.500	14.126	3.036
4.71	4.71	470.24	1.177	0.0*	1-S2n	0.355	0.830	0.355	0.509	14.292	3.065
4.86	4.86	470.26	1.202	0.0*	1-S2n	0.361	0.844	0.361	0.518	14.319	3.093
5.01	5.01	470.29	1.227	0.0*	1-S2n	0.367	0.857	0.406	0.526	12.548	3.120
5.17	5.17	470.31	1.252	0.0*	1-S2n	0.373	0.869	0.373	0.535	14.594	3.148
5.24	5.24	470.32	1.265	0.0*	1-S2n	0.375	0.879	0.375	0.539	14.658	3.161
5.47	5.47	470.36	1.303	0.0*	1-S2n	0.384	0.899	0.384	0.551	14.847	3.200
5.62	5.62	470.39	1.328	0.0*	1-S2n	0.389	0.911	0.389	0.559	14.986	3.224
5.78	5.78	470.41	1.353	0.0*	1-S2n	0.394	0.924	0.394	0.567	15.124	3.249
5.93	5.93	470.44	1.378	0.0*	1-S2n	0.400	0.936	0.400	0.575	15.152	3.273

* Full Flow Headwater elevation is below inlet invert.

****

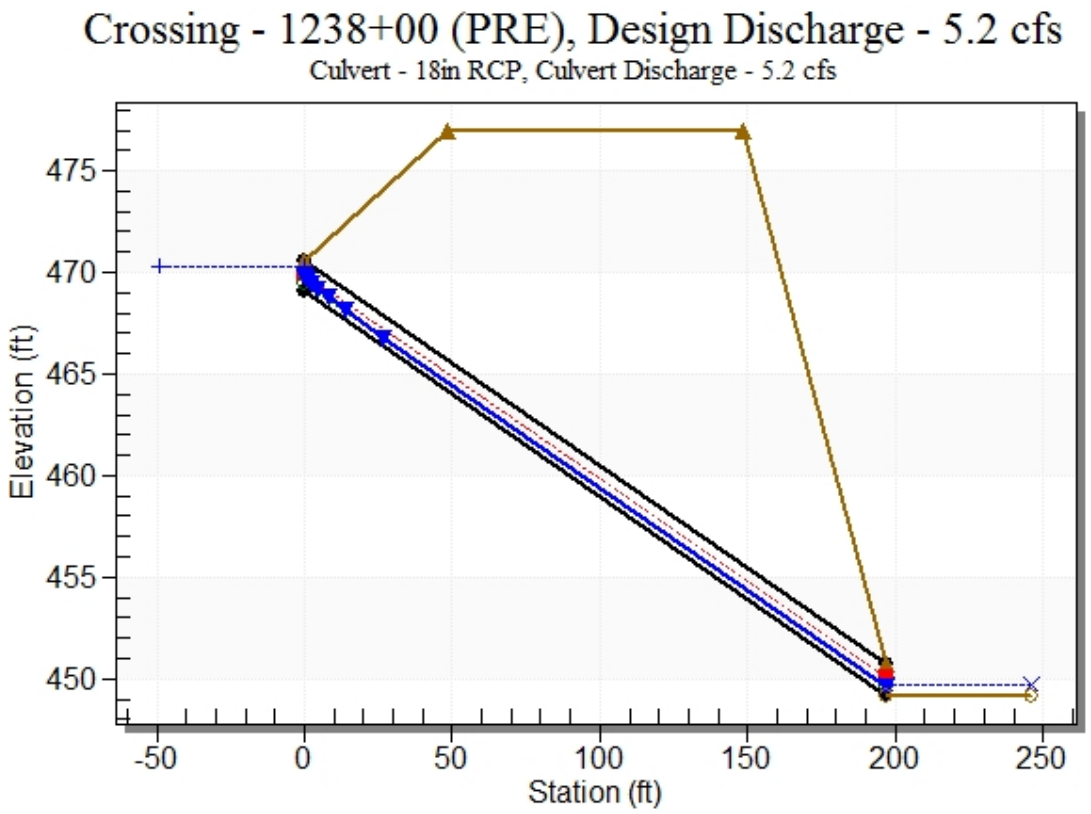
Straight Culvert

Inlet Elevation (invert): 469.06 ft, Outlet Elevation (invert): 449.19 ft

Culvert Length: 198.00 ft, Culvert Slope: 0.1009

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 469.06 ft

Outlet Station: 197.00 ft

Outlet Elevation: 449.19 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1238+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.40	449.68	0.49	3.01	1.84	0.87
4.55	449.69	0.50	3.04	1.87	0.87
4.71	449.70	0.51	3.06	1.91	0.88
4.86	449.71	0.52	3.09	1.94	0.88
5.01	449.72	0.53	3.12	1.97	0.88
5.17	449.72	0.53	3.15	2.00	0.88
5.24	449.73	0.54	3.16	2.02	0.88
5.47	449.74	0.55	3.20	2.06	0.88
5.62	449.75	0.56	3.22	2.09	0.89
5.78	449.76	0.57	3.25	2.12	0.89
5.93	449.77	0.58	3.27	2.15	0.89

Tailwater Channel Data - 1238+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 449.19 ft

Roadway Data for Crossing: 1238+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 477.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.44 cfs

Design Flow: 6.48 cfs

Maximum Flow: 7.32 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1238+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
470.36	5.44	5.44	0.00	1
470.39	5.63	5.63	0.00	1
470.42	5.82	5.82	0.00	1
470.45	6.00	6.00	0.00	1
470.48	6.19	6.19	0.00	1
470.51	6.38	6.38	0.00	1
470.53	6.48	6.48	0.00	1
470.58	6.76	6.76	0.00	1
470.61	6.94	6.94	0.00	1
470.65	7.13	7.13	0.00	1
470.68	7.32	7.32	0.00	1
477.00	23.20	23.20	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.44	5.44	470.36	1.297	0.0*	1-S2n	0.383	0.896	0.383	0.550	14.822	3.194
5.63	5.63	470.39	1.328	0.0*	1-S2n	0.389	0.912	0.389	0.559	14.990	3.225
5.82	5.82	470.42	1.359	0.0*	1-S2n	0.396	0.927	0.396	0.569	15.158	3.255
6.00	6.00	470.45	1.391	0.0*	1-S2n	0.402	0.942	0.402	0.579	15.210	3.284
6.19	6.19	470.48	1.422	0.0*	1-S2n	0.409	0.957	0.409	0.588	15.354	3.313
6.38	6.38	470.51	1.454	0.0*	1-S2n	0.415	0.971	0.415	0.598	15.492	3.341
6.48	6.48	470.53	1.471	0.0*	1-S2n	0.418	0.982	0.418	0.602	15.563	3.356
6.76	6.76	470.58	1.519	0.0*	5-S2n	0.427	1.003	0.427	0.616	15.767	3.395
6.94	6.94	470.61	1.553	0.0*	5-S2n	0.433	1.017	0.433	0.625	15.910	3.421
7.13	7.13	470.65	1.586	0.0*	5-S2n	0.439	1.031	0.476	0.633	14.305	3.446
7.32	7.32	470.68	1.621	0.0*	5-S2n	0.445	1.045	0.445	0.642	16.088	3.471

* Full Flow Headwater elevation is below inlet invert.

****

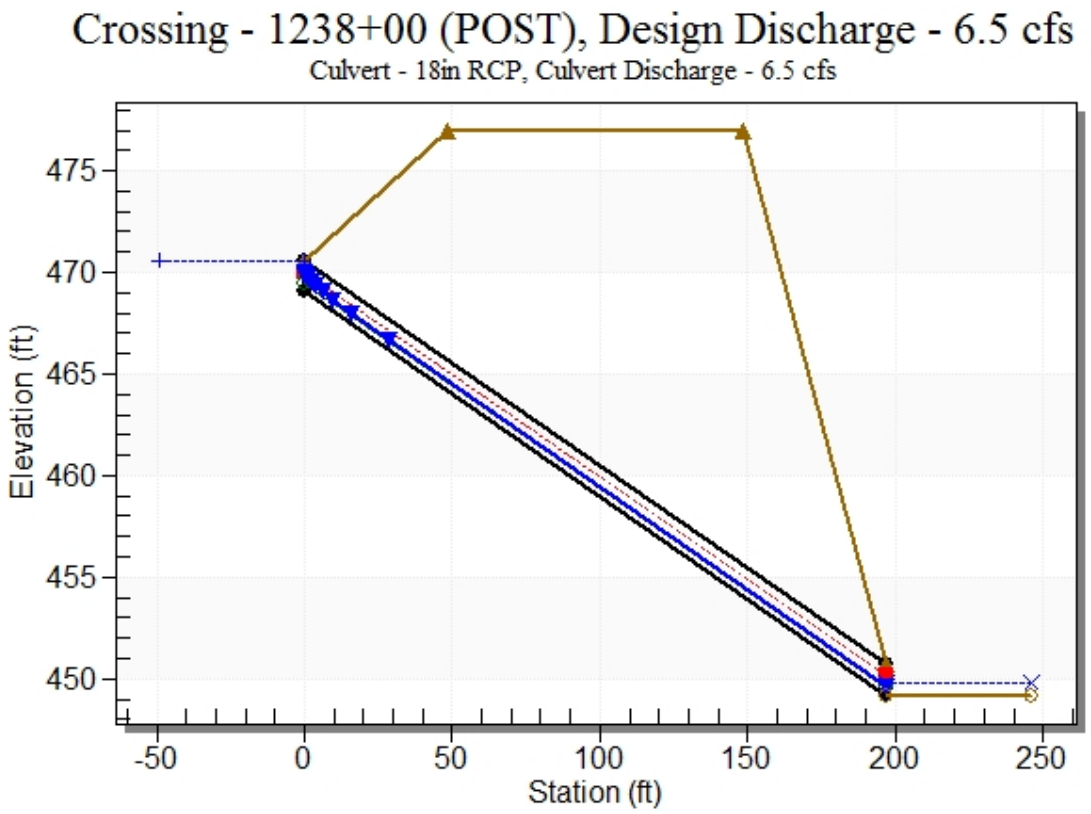
Straight Culvert

Inlet Elevation (invert): 469.06 ft, Outlet Elevation (invert): 449.19 ft

Culvert Length: 198.00 ft, Culvert Slope: 0.1009

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 469.06 ft

Outlet Station: 197.00 ft

Outlet Elevation: 449.19 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1238+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.44	449.74	0.55	3.19	2.06	0.88
5.63	449.75	0.56	3.23	2.09	0.89
5.82	449.76	0.57	3.25	2.13	0.89
6.00	449.77	0.58	3.28	2.17	0.89
6.19	449.78	0.59	3.31	2.20	0.89
6.38	449.79	0.60	3.34	2.24	0.89
6.48	449.79	0.60	3.36	2.26	0.89
6.76	449.81	0.62	3.39	2.31	0.90
6.94	449.81	0.62	3.42	2.34	0.90
7.13	449.82	0.63	3.45	2.37	0.90
7.32	449.83	0.64	3.47	2.40	0.90

Tailwater Channel Data - 1238+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 449.19 ft

Roadway Data for Crossing: 1238+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 477.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 111

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 111**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.26	1.1348
Grass	0.25	1.04	0.2602
Woods	0.15	13.43	2.0145
	Σ	**15.73**	3.4094

$C_{ave} = \frac{3.4094}{15.73} = 0.22$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.87	1.6800
Grass	0.25	0.49	0.1224
Woods	0.15	13.43	2.0145
	Σ	**15.79**	3.8169

$C_{ave} = \frac{3.8169}{15.79} = 0.24$

T_c =	50.80	min.								
I_{05} =	2.79	in / hr								
I_{10} =	3.08	in / hr								
I_{25} =	3.49	in / hr								
I_{50} =	3.80	in / hr								
I_{100} =	4.11	in / hr								

Pre Construction Runoff:

Q_{05} =	0.22	x	2.79	x	15.73	x	1	=	**9.50**	cfs
Q_{10} =	0.22	x	3.08	x	15.73	x	1	=	**10.49**	cfs
Q_{25} =	0.22	x	3.49	x	15.73	x	1.1	=	**13.09**	cfs
Q_{50} =	0.22	x	3.80	x	15.73	x	1.2	=	**15.54**	cfs
Q_{100} =	0.22	x	4.11	x	15.73	x	1.25	=	**17.52**	cfs

Post Construction Runoff:

Q_{05} =	0.24	x	2.79	x	15.79	x	1	=	**10.64**	cfs
Q_{10} =	0.24	x	3.08	x	15.79	x	1	=	**11.74**	cfs
Q_{25} =	0.24	x	3.49	x	15.79	x	1.1	=	**14.66**	cfs
Q_{50} =	0.24	x	3.80	x	15.79	x	1.2	=	**17.40**	cfs
Q_{100} =	0.24	x	4.11	x	15.79	x	1.25	=	**19.62**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 111	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved		unpaved		
8	Flow length, L	----------	ft	**900**				
9	Watercourse slope, s	----------	ft/ft	**0.0500**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.61**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.069**	+		=	**0.069**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.847**
							min	**50.80**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 13.09 cfs

Design Flow: 15.54 cfs

Maximum Flow: 17.52 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1240+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
469.16	13.09	13.09	0.00	1
469.20	13.53	13.53	0.00	1
469.25	13.98	13.98	0.00	1
469.29	14.42	14.42	0.00	1
469.33	14.86	14.86	0.00	1
469.38	15.31	15.31	0.00	1
469.40	15.54	15.54	0.00	1
469.47	16.19	16.19	0.00	1
469.51	16.63	16.63	0.00	1
469.56	17.08	17.08	0.00	1
469.61	17.52	17.52	0.00	1
481.00	60.66	60.66	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
13.09	13.09	469.16	1.862	0.0*	1-S2n	0.616	1.299	0.616	0.803	15.348	4.518
13.53	13.53	469.20	1.904	0.0*	1-S2n	0.627	1.321	0.627	0.817	15.506	4.560
13.98	13.98	469.25	1.946	0.0*	1-S2n	0.637	1.343	0.655	0.830	15.113	4.599
14.42	14.42	469.29	1.989	0.0*	1-S2n	0.648	1.364	0.648	0.843	15.800	4.638
14.86	14.86	469.33	2.032	0.0*	5-S2n	0.659	1.385	0.659	0.856	15.938	4.676
15.31	15.31	469.38	2.076	0.0*	5-S2n	0.669	1.406	0.669	0.869	16.035	4.712
15.54	15.54	469.40	2.099	0.0*	5-S2n	0.674	1.417	0.674	0.875	16.109	4.732
16.19	16.19	469.47	2.166	0.0*	5-S2n	0.689	1.446	0.713	0.894	15.585	4.783
16.63	16.63	469.51	2.213	0.0*	5-S2n	0.699	1.469	0.699	0.906	16.432	4.818
17.08	17.08	469.56	2.260	0.0*	5-S2n	0.709	1.488	0.709	0.918	16.554	4.853
17.52	17.52	469.61	2.309	0.0*	5-S2n	0.719	1.506	0.719	0.929	16.644	4.886

* Full Flow Headwater elevation is below inlet invert.

****

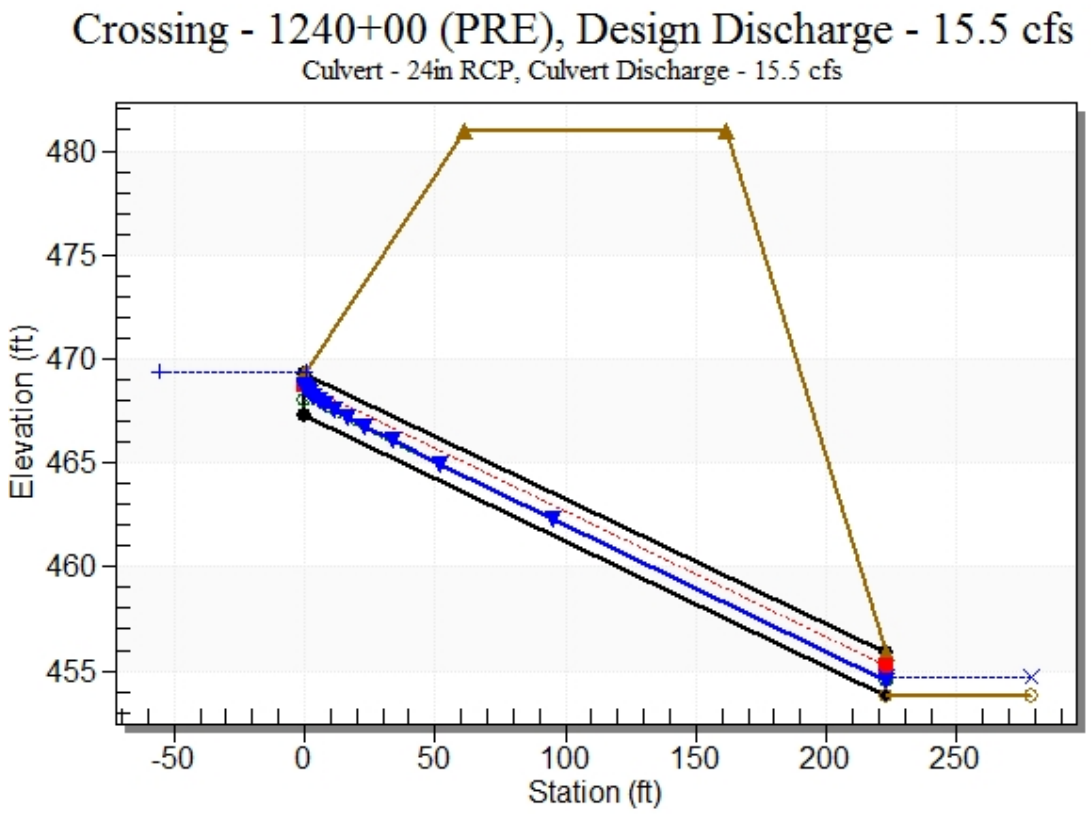
Straight Culvert

Inlet Elevation (invert): 467.30 ft, Outlet Elevation (invert): 453.83 ft

Culvert Length: 223.41 ft, Culvert Slope: 0.0604

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 467.30 ft

Outlet Station: 223.00 ft

Outlet Elevation: 453.83 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1240+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
13.09	454.63	0.80	4.52	4.01	1.07
13.53	454.65	0.82	4.56	4.08	1.07
13.98	454.66	0.83	4.60	4.14	1.07
14.42	454.67	0.84	4.64	4.21	1.07
14.86	454.69	0.86	4.68	4.27	1.08
15.31	454.70	0.87	4.71	4.34	1.08
15.54	454.71	0.88	4.73	4.37	1.08
16.19	454.72	0.89	4.78	4.46	1.08
16.63	454.74	0.91	4.82	4.52	1.08
17.08	454.75	0.92	4.85	4.58	1.09
17.52	454.76	0.93	4.89	4.64	1.09

Tailwater Channel Data - 1240+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 453.83 ft

Roadway Data for Crossing: 1240+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 481.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 14.66 cfs

Design Flow: 17.4 cfs

Maximum Flow: 19.62 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1240+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
469.31	14.66	14.66	0.00	1
469.36	15.16	15.16	0.00	1
469.41	15.65	15.65	0.00	1
469.46	16.15	16.15	0.00	1
469.51	16.64	16.64	0.00	1
469.57	17.14	17.14	0.00	1
469.60	17.40	17.40	0.00	1
469.68	18.13	18.13	0.00	1
469.74	18.63	18.63	0.00	1
469.79	19.12	19.12	0.00	1
469.85	19.62	19.62	0.00	1
481.00	60.66	60.66	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
14.66	14.66	469.31	2.012	0.0*	5-S2n	0.654	1.376	0.654	0.850	15.876	4.659
15.16	15.16	469.36	2.061	0.0*	5-S2n	0.666	1.399	0.666	0.865	15.990	4.700
15.65	15.65	469.41	2.111	0.0*	5-S2n	0.677	1.422	0.677	0.879	16.143	4.740
16.15	16.15	469.46	2.162	0.0*	5-S2n	0.688	1.444	0.714	0.892	15.510	4.780
16.64	16.64	469.51	2.214	0.0*	5-S2n	0.699	1.469	0.699	0.906	16.435	4.820
17.14	17.14	469.57	2.267	0.0*	5-S2n	0.710	1.490	0.710	0.919	16.571	4.857
17.40	17.40	469.60	2.295	0.0*	5-S2n	0.716	1.501	0.716	0.926	16.640	4.877
18.13	18.13	469.68	2.378	0.0*	5-S2n	0.732	1.532	0.776	0.945	15.545	4.930
18.63	18.63	469.74	2.435	0.0*	5-S2n	0.743	1.552	0.771	0.958	16.111	4.967
19.12	19.12	469.79	2.494	0.0*	5-S2n	0.754	1.571	0.754	0.970	17.066	5.001
19.62	19.62	469.85	2.554	0.0*	5-S2n	0.764	1.590	0.764	0.983	17.187	5.035

* Full Flow Headwater elevation is below inlet invert.

****

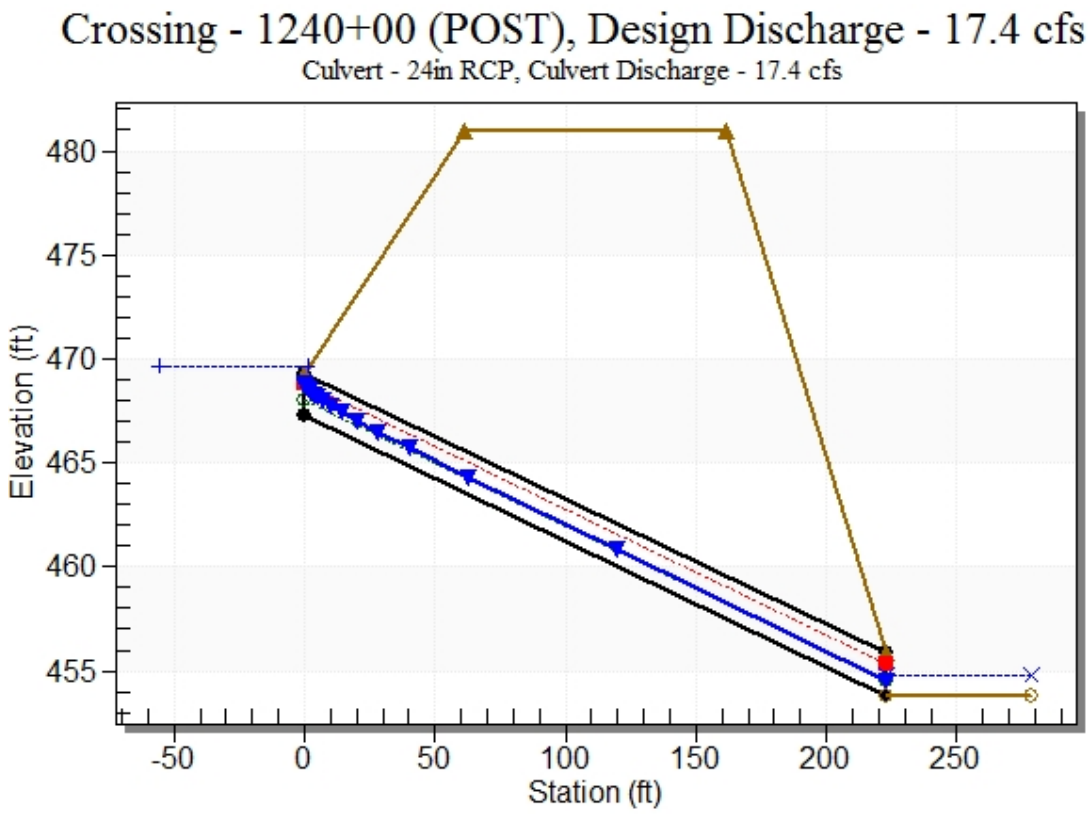
Straight Culvert

Inlet Elevation (invert): 467.30 ft, Outlet Elevation (invert): 453.83 ft

Culvert Length: 223.41 ft, Culvert Slope: 0.0604

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 467.30 ft

Outlet Station: 223.00 ft

Outlet Elevation: 453.83 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1240+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
14.66	454.68	0.85	4.66	4.24	1.08
15.16	454.69	0.86	4.70	4.32	1.08
15.65	454.71	0.88	4.74	4.39	1.08
16.15	454.72	0.89	4.78	4.46	1.08
16.64	454.74	0.91	4.82	4.52	1.08
17.14	454.75	0.92	4.86	4.59	1.09
17.40	454.76	0.93	4.88	4.62	1.09
18.13	454.78	0.95	4.93	4.72	1.09
18.63	454.79	0.96	4.97	4.78	1.09
19.12	454.80	0.97	5.00	4.84	1.09
19.62	454.81	0.98	5.04	4.91	1.09

Tailwater Channel Data - 1240+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 453.83 ft

Roadway Data for Crossing: 1240+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 481.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 112

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 112**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5937
Grass	0.25	0.73	0.1816
Woods	0.15	0.49	0.0734
	Σ	**1.88**	0.8487

$C_{ave} = \frac{0.8487}{1.88} = 0.45$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.07	0.9637
Grass	0.25	0.18	0.0438
Woods	0.15	0.49	0.0734
	Σ	**1.74**	1.0810

$C_{ave} = \frac{1.0810}{1.74} = 0.62$

T_c =	30.42	min.								
I_{05} =	3.70	in / hr								
I_{10} =	4.10	in / hr								
I_{25} =	4.67	in / hr								
I_{50} =	5.10	in / hr								
I_{100} =	5.54	in / hr								

Pre Construction Runoff:

Q_{05} =	0.45	x	3.70	x	1.88	x	1	=	**3.14**	cfs
Q_{10} =	0.45	x	4.10	x	1.88	x	1	=	**3.48**	cfs
Q_{25} =	0.45	x	4.67	x	1.88	x	1.1	=	**4.36**	cfs
Q_{50} =	0.45	x	5.10	x	1.88	x	1.2	=	**5.19**	cfs
Q_{100} =	0.45	x	5.54	x	1.88	x	1.25	=	**5.87**	cfs

Post Construction Runoff:

Q_{05} =	0.62	x	3.70	x	1.74	x	1	=	**4.00**	cfs
Q_{10} =	0.62	x	4.10	x	1.74	x	1	=	**4.43**	cfs
Q_{25} =	0.62	x	4.67	x	1.74	x	1.1	=	**5.55**	cfs
Q_{50} =	0.62	x	5.10	x	1.74	x	1.2	=	**6.61**	cfs
Q_{100} =	0.62	x	5.54	x	1.74	x	1.25	=	**7.48**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 112	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**100**				
9	Watercourse slope, s	----------	ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.006**	+		=	**0.006**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.507**
							min	**30.42**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.36 cfs

Design Flow: 5.19 cfs

Maximum Flow: 5.87 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1242+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.19	4.36	4.36	0.00	1
476.22	4.51	4.51	0.00	1
476.24	4.66	4.66	0.00	1
476.27	4.81	4.81	0.00	1
476.29	4.96	4.96	0.00	1
476.32	5.12	5.12	0.00	1
476.33	5.19	5.19	0.00	1
476.36	5.42	5.42	0.00	1
476.39	5.57	5.57	0.00	1
476.41	5.72	5.72	0.00	1
476.44	5.87	5.87	0.00	1
477.21	9.77	9.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.36	4.36	476.19	1.190	0.0*	1-S2n	0.721	0.799	0.721	0.587	5.025	2.340
4.51	4.51	476.22	1.216	0.220	1-S2n	0.735	0.813	0.735	0.598	5.068	2.363
4.66	4.66	476.24	1.241	0.261	1-S2n	0.750	0.826	0.750	0.608	5.109	2.384
4.81	4.81	476.27	1.266	0.302	1-S2n	0.764	0.840	0.764	0.618	5.149	2.405
4.96	4.96	476.29	1.290	0.345	1-S2n	0.778	0.853	0.800	0.628	5.015	2.426
5.12	5.12	476.32	1.315	0.388	1-S2n	0.793	0.865	0.793	0.638	5.225	2.447
5.19	5.19	476.33	1.327	0.409	1-S2n	0.800	0.871	0.800	0.643	5.242	2.456
5.42	5.42	476.36	1.365	0.480	1-S2n	0.821	0.894	0.821	0.657	5.296	2.486
5.57	5.57	476.39	1.390	0.526	1-S2n	0.836	0.907	0.836	0.667	5.329	2.505
5.72	5.72	476.41	1.414	0.572	1-S2n	0.850	0.919	0.875	0.676	5.181	2.523
5.87	5.87	476.44	1.439	0.620	1-S2n	0.865	0.931	0.865	0.685	5.393	2.542

* Full Flow Headwater elevation is below inlet invert.

****

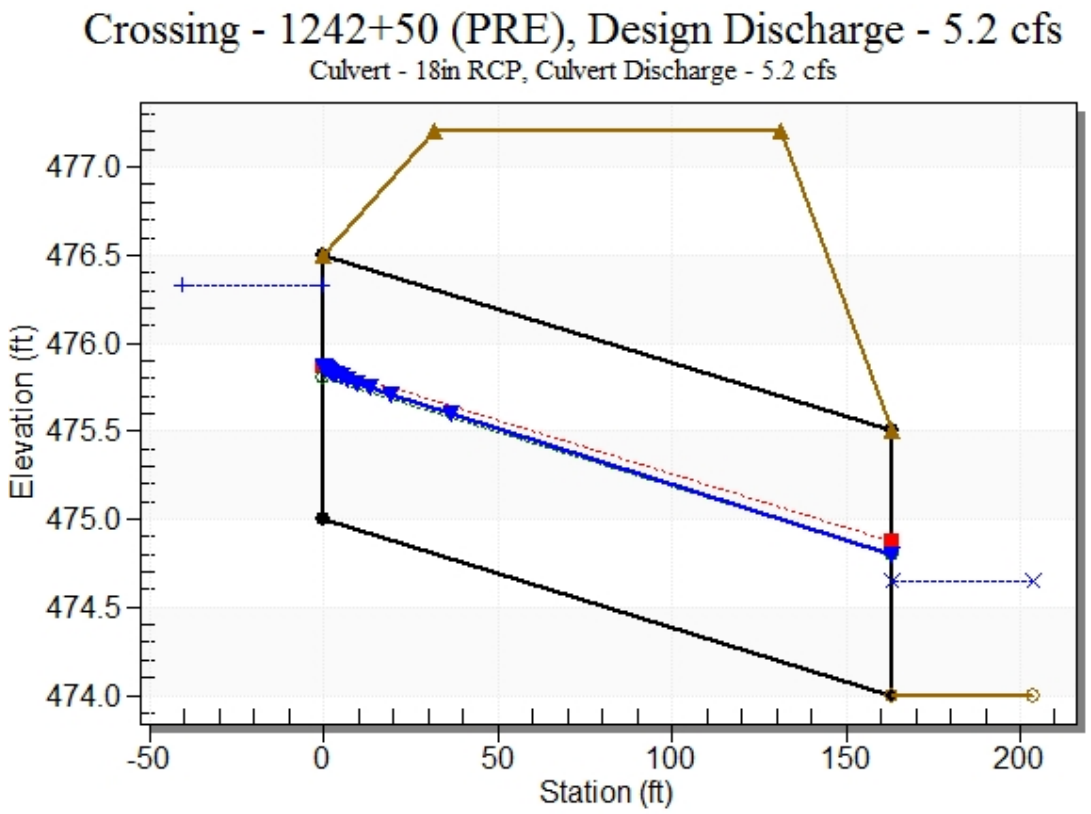
Straight Culvert

Inlet Elevation (invert): 475.00 ft, Outlet Elevation (invert): 474.00 ft

Culvert Length: 163.00 ft, Culvert Slope: 0.0061

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 475.00 ft

Outlet Station: 163.00 ft

Outlet Elevation: 474.00 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1242+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.36	474.59	0.59	2.34	1.10	0.63
4.51	474.60	0.60	2.36	1.12	0.63
4.66	474.61	0.61	2.38	1.14	0.63
4.81	474.62	0.62	2.41	1.16	0.63
4.96	474.63	0.63	2.43	1.18	0.64
5.12	474.64	0.64	2.45	1.19	0.64
5.19	474.64	0.64	2.46	1.20	0.64
5.42	474.66	0.66	2.49	1.23	0.64
5.57	474.67	0.67	2.50	1.25	0.64
5.72	474.68	0.68	2.52	1.27	0.64
5.87	474.69	0.69	2.54	1.28	0.64

Tailwater Channel Data - 1242+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 474.00 ft

Roadway Data for Crossing: 1242+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 477.21 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.55 cfs

Design Flow: 6.61 cfs

Maximum Flow: 7.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1242+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.39	5.55	5.55	0.00	1
476.42	5.74	5.74	0.00	1
476.45	5.94	5.94	0.00	1
476.48	6.13	6.13	0.00	1
476.52	6.32	6.32	0.00	1
476.55	6.52	6.52	0.00	1
476.56	6.61	6.61	0.00	1
476.62	6.90	6.90	0.00	1
476.65	7.09	7.09	0.00	1
476.69	7.29	7.29	0.00	1
476.72	7.48	7.48	0.00	1
477.21	9.77	9.77	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.55	5.55	476.39	1.387	0.0*	1-S2n	0.834	0.905	0.834	0.666	5.325	2.503
5.74	5.74	476.42	1.418	0.580	1-S2n	0.852	0.921	0.852	0.678	5.365	2.526
5.94	5.94	476.45	1.450	0.640	1-S2n	0.871	0.937	0.871	0.689	5.406	2.549
6.13	6.13	476.48	1.483	0.702	1-S2n	0.889	0.952	0.889	0.701	5.442	2.572
6.32	6.32	476.52	1.515	0.765	5-S2n	0.908	0.966	0.908	0.712	5.479	2.594
6.52	6.52	476.55	1.549	0.833	5-S2n	0.926	0.985	0.953	0.723	5.334	2.615
6.61	6.61	476.56	1.565	0.865	5-S2n	0.936	0.992	0.936	0.728	5.530	2.626
6.90	6.90	476.62	1.616	0.965	5-S2n	0.964	1.014	0.964	0.744	5.574	2.657
7.09	7.09	476.65	1.651	1.034	5-S2n	0.984	1.028	0.984	0.755	5.605	2.677
7.29	7.29	476.69	1.686	1.103	5-S2n	1.003	1.042	1.003	0.765	5.629	2.696
7.48	7.48	476.72	1.722	1.174	5-S2n	1.024	1.056	1.024	0.776	5.656	2.716

* Full Flow Headwater elevation is below inlet invert.

****

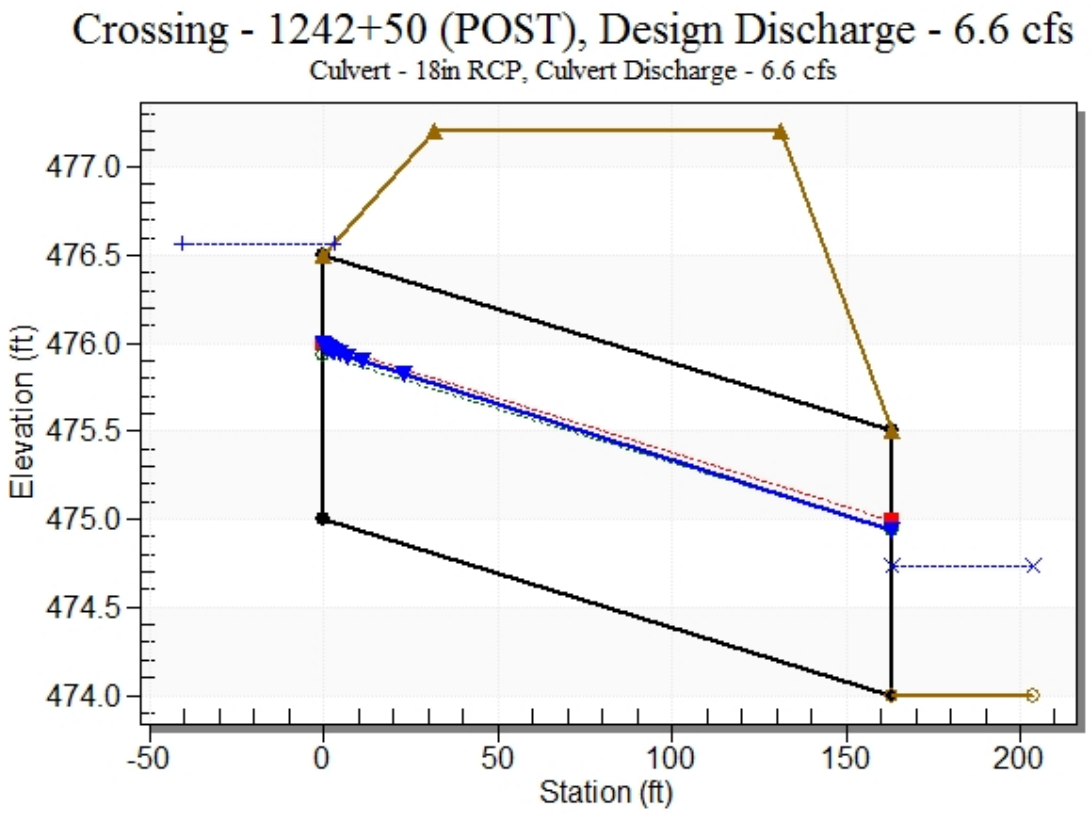
Straight Culvert

Inlet Elevation (invert): 475.00 ft, Outlet Elevation (invert): 474.00 ft

Culvert Length: 163.00 ft, Culvert Slope: 0.0061

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 475.00 ft

Outlet Station: 163.00 ft

Outlet Elevation: 474.00 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1242+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.55	474.67	0.67	2.50	1.25	0.64
5.74	474.68	0.68	2.53	1.27	0.64
5.94	474.69	0.69	2.55	1.29	0.64
6.13	474.70	0.70	2.57	1.31	0.64
6.32	474.71	0.71	2.59	1.33	0.64
6.52	474.72	0.72	2.62	1.35	0.65
6.61	474.73	0.73	2.63	1.36	0.65
6.90	474.74	0.74	2.66	1.39	0.65
7.09	474.75	0.75	2.68	1.41	0.65
7.29	474.77	0.77	2.70	1.43	0.65
7.48	474.78	0.78	2.72	1.45	0.65

Tailwater Channel Data - 1242+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 474.00 ft

Roadway Data for Crossing: 1242+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 477.21 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 113

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 113**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.54	0.4893
Grass	0.25	0.66	0.1651
Woods	0.15	0.00	0.0000
	Σ	**1.20**	0.6544

$C_{ave} = \frac{0.6544}{1.20} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.86	0.7740
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.86**	0.7740

$C_{ave} = \frac{0.7740}{0.86} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.54	x	6.23	x	1.20	x	1	=	**4.08**	cfs
Q_{10} =	0.54	x	6.98	x	1.20	x	1	=	**4.57**	cfs
Q_{25} =	0.54	x	8.08	x	1.20	x	1.1	=	**5.82**	cfs
Q_{50} =	0.54	x	8.93	x	1.20	x	1.2	=	**7.01**	cfs
Q_{100} =	0.54	x	9.81	x	1.20	x	1.25	=	**8.02**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.86	x	1	=	**4.82**	cfs
Q_{10} =	0.90	x	6.98	x	0.86	x	1	=	**5.40**	cfs
Q_{25} =	0.90	x	8.08	x	0.86	x	1.1	=	**6.88**	cfs
Q_{50} =	0.90	x	8.93	x	0.86	x	1.2	=	**8.29**	cfs
Q_{100} =	0.90	x	9.81	x	0.86	x	1.25	=	**9.49**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.82 cfs

Design Flow: 7.01 cfs

Maximum Flow: 8.02 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1248+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
477.84	5.82	5.82	0.00	1
477.87	6.04	6.04	0.00	1
477.91	6.26	6.26	0.00	1
477.95	6.48	6.48	0.00	1
477.99	6.70	6.70	0.00	1
478.02	6.92	6.92	0.00	1
478.04	7.01	7.01	0.00	1
478.10	7.36	7.36	0.00	1
478.15	7.58	7.58	0.00	1
478.19	7.80	7.80	0.00	1
478.23	8.02	8.02	0.00	1
480.84	16.43	16.43	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.82	5.82	477.84	1.426	0.0*	1-S2n	0.693	0.927	0.719	0.528	6.730	3.610
6.04	6.04	477.87	1.463	0.356	1-S2n	0.708	0.945	0.734	0.538	6.794	3.648
6.26	6.26	477.91	1.500	0.412	5-S2n	0.723	0.962	0.750	0.549	6.855	3.685
6.48	6.48	477.95	1.538	0.472	5-S2n	0.738	0.982	0.766	0.559	6.914	3.721
6.70	6.70	477.99	1.576	0.531	5-S2n	0.753	0.999	0.781	0.569	6.973	3.756
6.92	6.92	478.02	1.615	0.590	5-S2n	0.768	1.016	0.796	0.578	7.029	3.790
7.01	7.01	478.04	1.631	0.615	5-S2n	0.774	1.022	0.801	0.582	7.068	3.805
7.36	7.36	478.10	1.695	0.712	5-S2n	0.797	1.048	0.826	0.597	7.147	3.856
7.58	7.58	478.15	1.736	0.774	5-S2n	0.812	1.063	0.841	0.607	7.196	3.889
7.80	7.80	478.19	1.778	0.838	5-S2n	0.827	1.078	0.857	0.616	7.244	3.920
8.02	8.02	478.23	1.821	0.903	5-S2n	0.841	1.093	0.872	0.625	7.294	3.950

* Full Flow Headwater elevation is below inlet invert.

****

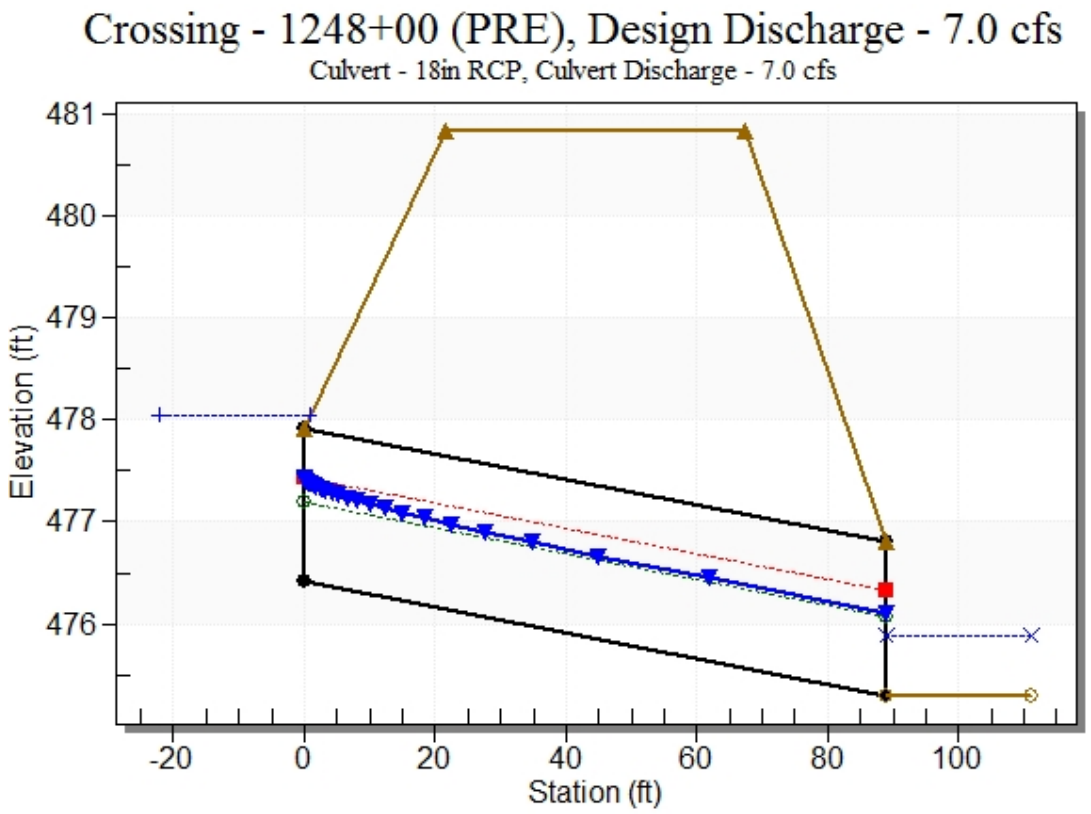
Straight Culvert

Inlet Elevation (invert): 476.41 ft, Outlet Elevation (invert): 475.30 ft

Culvert Length: 89.01 ft, Culvert Slope: 0.0125

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 476.41 ft

Outlet Station: 89.00 ft

Outlet Elevation: 475.30 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1248+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.82	475.83	0.53	3.61	2.63	1.02
6.04	475.84	0.54	3.65	2.69	1.02
6.26	475.85	0.55	3.68	2.74	1.02
6.48	475.86	0.56	3.72	2.79	1.02
6.70	475.87	0.57	3.76	2.84	1.02
6.92	475.88	0.58	3.79	2.89	1.03
7.01	475.88	0.58	3.80	2.91	1.03
7.36	475.90	0.60	3.86	2.98	1.03
7.58	475.91	0.61	3.89	3.03	1.03
7.80	475.92	0.62	3.92	3.07	1.03
8.02	475.92	0.62	3.95	3.12	1.04

Tailwater Channel Data - 1248+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 475.30 ft

Roadway Data for Crossing: 1248+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 480.84 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.88 cfs

Design Flow: 8.29 cfs

Maximum Flow: 9.49 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1248+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
478.02	6.88	6.88	0.00	1
478.06	7.14	7.14	0.00	1
478.11	7.40	7.40	0.00	1
478.16	7.66	7.66	0.00	1
478.21	7.92	7.92	0.00	1
478.26	8.19	8.19	0.00	1
478.29	8.29	8.29	0.00	1
478.37	8.71	8.71	0.00	1
478.43	8.97	8.97	0.00	1
478.49	9.23	9.23	0.00	1
478.55	9.49	9.49	0.00	1
480.84	16.43	16.43	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.88	6.88	478.02	1.608	0.0*	5-S2n	0.765	1.013	0.794	0.577	7.019	3.785
7.14	7.14	478.06	1.654	0.651	5-S2n	0.783	1.032	0.811	0.588	7.096	3.824
7.40	7.40	478.11	1.702	0.724	5-S2n	0.800	1.051	0.829	0.599	7.156	3.863
7.66	7.66	478.16	1.752	0.798	5-S2n	0.817	1.069	0.847	0.610	7.214	3.900
7.92	7.92	478.21	1.802	0.874	5-S2n	0.835	1.087	0.865	0.621	7.273	3.937
8.19	8.19	478.26	1.854	0.952	5-S2n	0.852	1.104	0.883	0.631	7.328	3.972
8.29	8.29	478.29	1.875	0.983	5-S2n	0.859	1.111	0.890	0.636	7.349	3.987
8.71	8.71	478.37	1.963	1.293	5-S2n	0.887	1.138	0.887	0.652	7.754	4.042
8.97	8.97	478.43	2.020	1.367	5-S2n	0.905	1.154	0.936	0.662	7.502	4.075
9.23	9.23	478.49	2.078	1.444	5-S2n	0.922	1.173	0.955	0.672	7.545	4.107
9.49	9.49	478.55	2.138	1.522	5-S2n	0.940	1.189	0.973	0.682	7.590	4.139

* Full Flow Headwater elevation is below inlet invert.

****

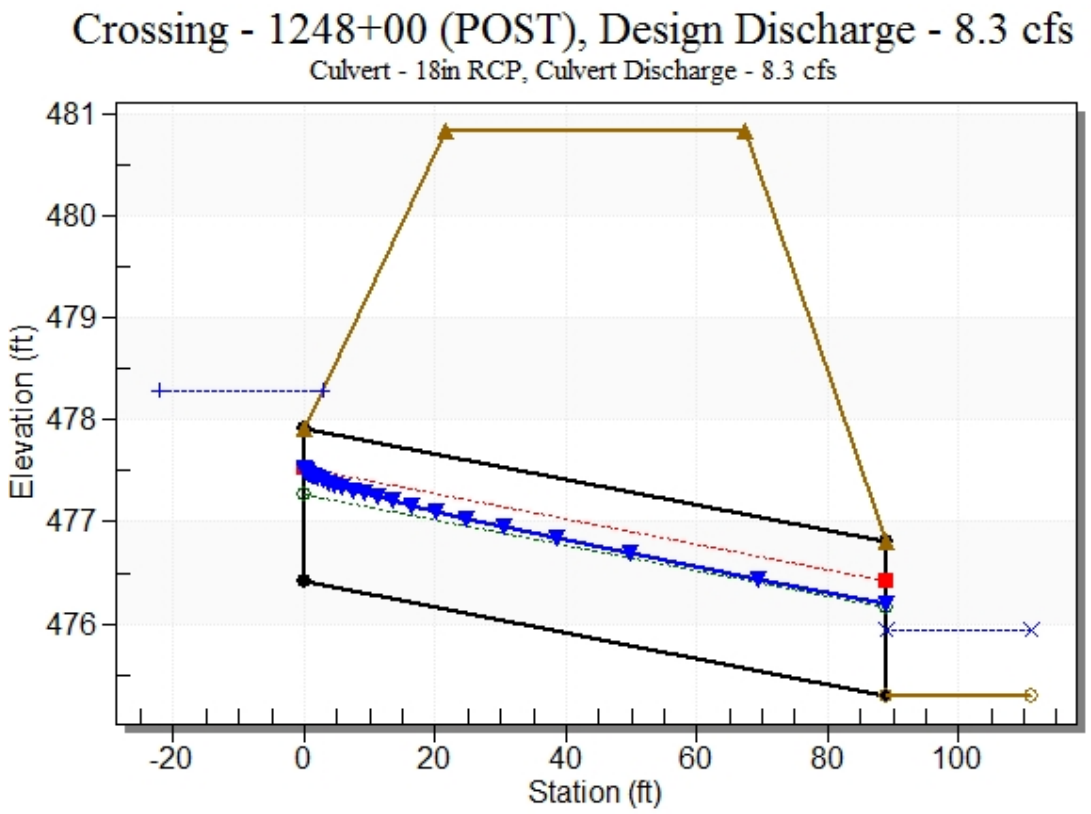
Straight Culvert

Inlet Elevation (invert): 476.41 ft, Outlet Elevation (invert): 475.30 ft

Culvert Length: 89.01 ft, Culvert Slope: 0.0125

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 476.41 ft

Outlet Station: 89.00 ft

Outlet Elevation: 475.30 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1248+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.88	475.88	0.58	3.78	2.88	1.03
7.14	475.89	0.59	3.82	2.94	1.03
7.40	475.90	0.60	3.86	2.99	1.03
7.66	475.91	0.61	3.90	3.05	1.03
7.92	475.92	0.62	3.94	3.10	1.04
8.19	475.93	0.63	3.97	3.15	1.04
8.29	475.94	0.64	3.99	3.17	1.04
8.71	475.95	0.65	4.04	3.25	1.04
8.97	475.96	0.66	4.07	3.30	1.04
9.23	475.97	0.67	4.11	3.35	1.05
9.49	475.98	0.68	4.14	3.40	1.05

Tailwater Channel Data - 1248+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 475.30 ft

Roadway Data for Crossing: 1248+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 480.84 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 114

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 114**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.75	0.6750
Grass	0.25	1.85	0.4625
Woods	0.15	27.18	4.0770
	Σ	**29.78**	5.2145

$C_{ave} = \frac{5.2145}{29.78} = 0.18$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.07	0.9630
Grass	0.25	1.85	0.4625
Woods	0.15	27.18	4.0770
	Σ	**30.10**	5.5025

$C_{ave} = \frac{5.5025}{30.10} = 0.18$

T_c =	47.18	min.								
I_{05} =	2.91	in / hr								
I_{10} =	3.22	in / hr								
I_{25} =	3.65	in / hr								
I_{50} =	3.98	in / hr								
I_{100} =	4.31	in / hr								

Pre Construction Runoff:

Q_{05} =	0.18	**x**	2.91	**x**	29.78	**x**	1	=	**15.20**	cfs
Q_{10} =	0.18	**x**	3.22	**x**	29.78	**x**	1	=	**16.78**	cfs
Q_{25} =	0.18	**x**	3.65	**x**	29.78	**x**	1.1	=	**20.96**	cfs
Q_{50} =	0.18	**x**	3.98	**x**	29.78	**x**	1.2	=	**24.89**	cfs
Q_{100} =	0.18	**x**	4.31	**x**	29.78	**x**	1.25	=	**28.08**	cfs

Post Construction Runoff:

Q_{05} =	0.18	**x**	2.91	**x**	30.10	**x**	1	=	**16.04**	cfs
Q_{10} =	0.18	**x**	3.22	**x**	30.10	**x**	1	=	**17.71**	cfs
Q_{25} =	0.18	**x**	3.65	**x**	30.10	**x**	1.1	=	**22.12**	cfs
Q_{50} =	0.18	**x**	3.98	**x**	30.10	**x**	1.2	=	**26.27**	cfs
Q_{100} =	0.18	**x**	4.31	**x**	30.10	**x**	1.25	=	**29.63**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 114	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**1673**				
9	Watercourse slope, s		ft/ft	**0.0500**				
10	Average velocity, V (figure 3-1)		ft/s	**3.61**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.129**	+		=	**0.129**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**			
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0400**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**2.41**	**#DIV/0!**			
18	Flow length, L		ft	**594**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.068**	+	**0.000**	=	**0.068**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.786**
							min	**47.18**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 20.96 cfs

Design Flow: 24.89 cfs

Maximum Flow: 28.08 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1250+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	42in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.08	20.96	20.96	0.00	1
476.12	21.67	21.67	0.00	1
476.15	22.38	22.38	0.00	1
476.19	23.10	23.10	0.00	1
476.23	23.81	23.81	0.00	1
476.27	24.52	24.52	0.00	1
476.29	24.89	24.89	0.00	1
476.34	25.94	25.94	0.00	1
476.37	26.66	26.66	0.00	1
476.41	27.37	27.37	0.00	1
476.44	28.08	28.08	0.00	1
488.00	180.72	180.72	0.00	Overtopping

Table 2 - Culvert Summary Table: 42in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.96	20.96	476.08	1.866	0.0*	1-S2n	0.665	1.401	0.665	1.352	15.902	2.312
21.67	21.67	476.12	1.906	0.0*	1-S2n	0.676	1.422	0.676	1.376	16.077	2.334
22.38	22.38	476.15	1.944	0.0*	1-S2n	0.688	1.448	0.714	1.399	15.290	2.355
23.10	23.10	476.19	1.982	0.0*	1-S2n	0.699	1.473	0.699	1.421	16.279	2.375
23.81	23.81	476.23	2.019	0.0*	1-S2n	0.710	1.497	0.710	1.444	16.415	2.395
24.52	24.52	476.27	2.056	0.0*	1-S2n	0.720	1.521	0.764	1.465	15.278	2.414
24.89	24.89	476.29	2.075	0.0*	1-S2n	0.726	1.533	0.761	1.477	15.597	2.424
25.94	25.94	476.34	2.128	0.0*	1-S2n	0.740	1.568	0.740	1.508	16.875	2.452
26.66	26.66	476.37	2.163	0.0*	1-S2n	0.750	1.590	0.750	1.529	17.026	2.470
27.37	27.37	476.41	2.198	0.0*	1-S2n	0.760	1.613	0.806	1.550	15.750	2.488
28.08	28.08	476.44	2.232	0.0*	1-S2n	0.770	1.635	0.803	1.570	16.237	2.505

* Full Flow Headwater elevation is below inlet invert.

****

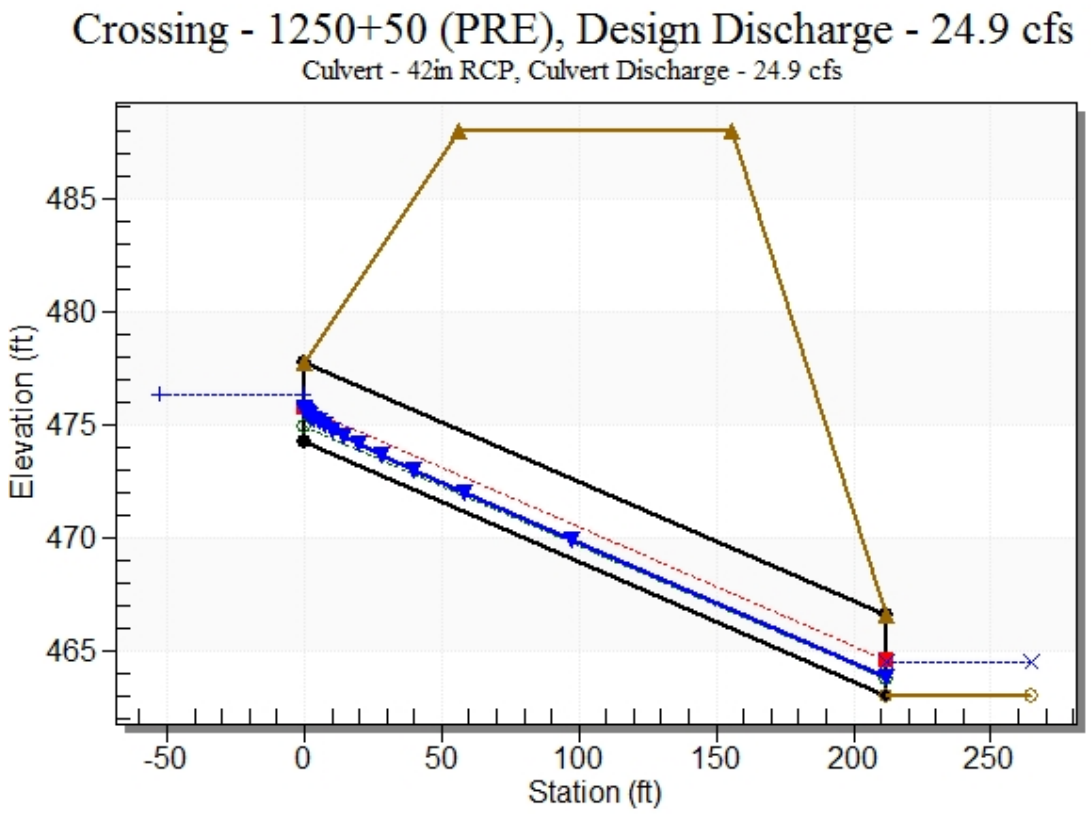
Straight Culvert

Inlet Elevation (invert): 474.21 ft, Outlet Elevation (invert): 463.05 ft

Culvert Length: 212.29 ft, Culvert Slope: 0.0526

****

Water Surface Profile Plot for Culvert: 42in RCP



Site Data - 42in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 474.21 ft

Outlet Station: 212.00 ft

Outlet Elevation: 463.05 ft

Number of Barrels: 1

Culvert Data Summary - 42in RCP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1250+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
20.96	464.40	1.35	2.31	0.84	0.42
21.67	464.43	1.38	2.33	0.86	0.42
22.38	464.45	1.40	2.35	0.87	0.42
23.10	464.47	1.42	2.37	0.89	0.42
23.81	464.49	1.44	2.39	0.90	0.42
24.52	464.52	1.47	2.41	0.91	0.42
24.89	464.53	1.48	2.42	0.92	0.42
25.94	464.56	1.51	2.45	0.94	0.42
26.66	464.58	1.53	2.47	0.95	0.42
27.37	464.60	1.55	2.49	0.97	0.42
28.08	464.62	1.57	2.50	0.98	0.42

Tailwater Channel Data - 1250+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 463.05 ft

Roadway Data for Crossing: 1250+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 488.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 22.12 cfs

Design Flow: 26.27 cfs

Maximum Flow: 29.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1250+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	42in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.14	22.12	22.12	0.00	1
476.18	22.87	22.87	0.00	1
476.22	23.62	23.62	0.00	1
476.26	24.37	24.37	0.00	1
476.30	25.12	25.12	0.00	1
476.33	25.88	25.88	0.00	1
476.35	26.27	26.27	0.00	1
476.41	27.38	27.38	0.00	1
476.44	28.13	28.13	0.00	1
476.48	28.88	28.88	0.00	1
476.51	29.63	29.63	0.00	1
488.00	180.71	180.71	0.00	Overtopping

Table 2 - Culvert Summary Table: 42in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
22.12	22.12	476.14	1.930	0.0*	1-S2n	0.683	1.438	0.720	1.390	14.961	2.347
22.87	22.87	476.18	1.970	0.0*	1-S2n	0.695	1.465	0.695	1.414	16.235	2.369
23.62	23.62	476.22	2.010	0.0*	1-S2n	0.707	1.491	0.707	1.438	16.380	2.390
24.37	24.37	476.26	2.049	0.0*	1-S2n	0.718	1.516	0.764	1.461	15.168	2.410
25.12	25.12	476.30	2.087	0.0*	1-S2n	0.729	1.541	0.758	1.484	15.826	2.430
25.88	25.88	476.33	2.125	0.0*	1-S2n	0.739	1.565	0.739	1.506	16.860	2.450
26.27	26.27	476.35	2.144	0.0*	1-S2n	0.745	1.578	0.745	1.518	16.945	2.460
27.38	27.38	476.41	2.198	0.0*	1-S2n	0.760	1.613	0.806	1.550	15.755	2.488
28.13	28.13	476.44	2.234	0.0*	1-S2n	0.770	1.636	0.803	1.571	16.275	2.506
28.88	28.88	476.48	2.270	0.0*	1-S2n	0.781	1.659	0.781	1.592	17.376	2.524
29.63	29.63	476.51	2.305	0.0*	1-S2n	0.791	1.681	0.791	1.613	17.501	2.542

* Full Flow Headwater elevation is below inlet invert.

****

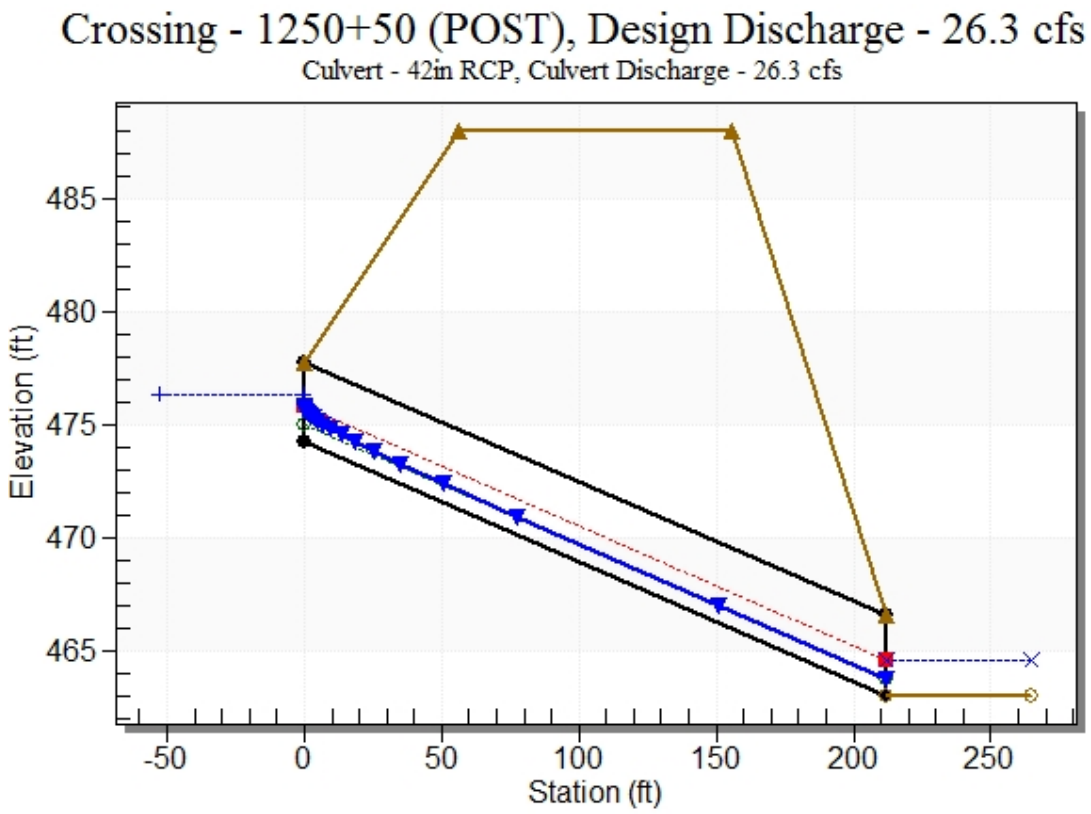
Straight Culvert

Inlet Elevation (invert): 474.21 ft, Outlet Elevation (invert): 463.05 ft

Culvert Length: 212.29 ft, Culvert Slope: 0.0526

****

Water Surface Profile Plot for Culvert: 42in RCP



Site Data - 42in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 474.21 ft

Outlet Station: 212.00 ft

Outlet Elevation: 463.05 ft

Number of Barrels: 1

Culvert Data Summary - 42in RCP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1250+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
22.12	464.44	1.39	2.35	0.87	0.42
22.87	464.46	1.41	2.37	0.88	0.42
23.62	464.49	1.44	2.39	0.90	0.42
24.37	464.51	1.46	2.41	0.91	0.42
25.12	464.53	1.48	2.43	0.93	0.42
25.88	464.56	1.51	2.45	0.94	0.42
26.27	464.57	1.52	2.46	0.95	0.42
27.38	464.60	1.55	2.49	0.97	0.42
28.13	464.62	1.57	2.51	0.98	0.42
28.88	464.64	1.59	2.52	0.99	0.42
29.63	464.66	1.61	2.54	1.01	0.42

Tailwater Channel Data - 1250+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 463.05 ft

Roadway Data for Crossing: 1250+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 488.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 115

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 115**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.57	0.5161
Grass	0.25	0.70	0.1755
Woods	0.15	0.00	0.0000
	Σ	**1.28**	0.6915

$C_{ave} = \frac{0.6915}{1.28} = 0.54$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.91	0.8145
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.91**	0.8145

$C_{ave} = \frac{0.8145}{0.91} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.54	x	6.23	x	1.28	x	1	=	**4.31**	cfs
Q_{10} =	0.54	x	6.98	x	1.28	x	1	=	**4.83**	cfs
Q_{25} =	0.54	x	8.08	x	1.28	x	1.1	=	**6.15**	cfs
Q_{50} =	0.54	x	8.93	x	1.28	x	1.2	=	**7.41**	cfs
Q_{100} =	0.54	x	9.81	x	1.28	x	1.25	=	**8.48**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.91	x	1	=	**5.07**	cfs
Q_{10} =	0.90	x	6.98	x	0.91	x	1	=	**5.68**	cfs
Q_{25} =	0.90	x	8.08	x	0.91	x	1.1	=	**7.24**	cfs
Q_{50} =	0.90	x	8.93	x	0.91	x	1.2	=	**8.72**	cfs
Q_{100} =	0.90	x	9.81	x	0.91	x	1.25	=	**9.99**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.15 cfs

Design Flow: 7.41 cfs

Maximum Flow: 8.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1254+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
482.37	6.15	6.15	0.00	1
482.44	6.38	6.38	0.00	1
482.52	6.62	6.62	0.00	1
482.60	6.85	6.85	0.00	1
482.69	7.08	7.08	0.00	1
482.77	7.32	7.32	0.00	1
482.81	7.41	7.41	0.00	1
482.96	7.78	7.78	0.00	1
483.06	8.01	8.01	0.00	1
483.16	8.25	8.25	0.00	1
483.26	8.48	8.48	0.00	1
485.00	11.68	11.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.15	6.15	482.37	1.758	0.0*	5-S2n	0.420	0.998	0.420	0.543	16.456	3.666
6.38	6.38	482.44	1.833	0.0*	5-S2n	0.428	1.015	0.428	0.554	16.647	3.706
6.62	6.62	482.52	1.911	0.0*	5-S2n	0.436	1.032	0.472	0.565	15.077	3.743
6.85	6.85	482.60	1.992	0.0*	5-S2n	0.444	1.048	0.471	0.575	15.633	3.779
7.08	7.08	482.69	2.077	0.0*	5-S2n	0.452	1.063	0.470	0.585	16.218	3.815
7.32	7.32	482.77	2.164	0.0*	5-S2n	0.460	1.077	0.460	0.595	17.267	3.850
7.41	7.41	482.81	2.201	0.0*	5-S2n	0.464	1.083	0.464	0.599	17.333	3.864
7.78	7.78	482.96	2.350	0.0*	5-S2n	0.476	1.103	0.476	0.615	17.527	3.917
8.01	8.01	483.06	2.447	0.0*	5-S2n	0.484	1.115	0.484	0.625	17.673	3.949
8.25	8.25	483.16	2.548	0.0*	5-S2n	0.491	1.126	0.491	0.634	17.822	3.981
8.48	8.48	483.26	2.651	0.0*	5-S2n	0.499	1.136	0.499	0.643	17.930	4.012

* Full Flow Headwater elevation is below inlet invert.

****

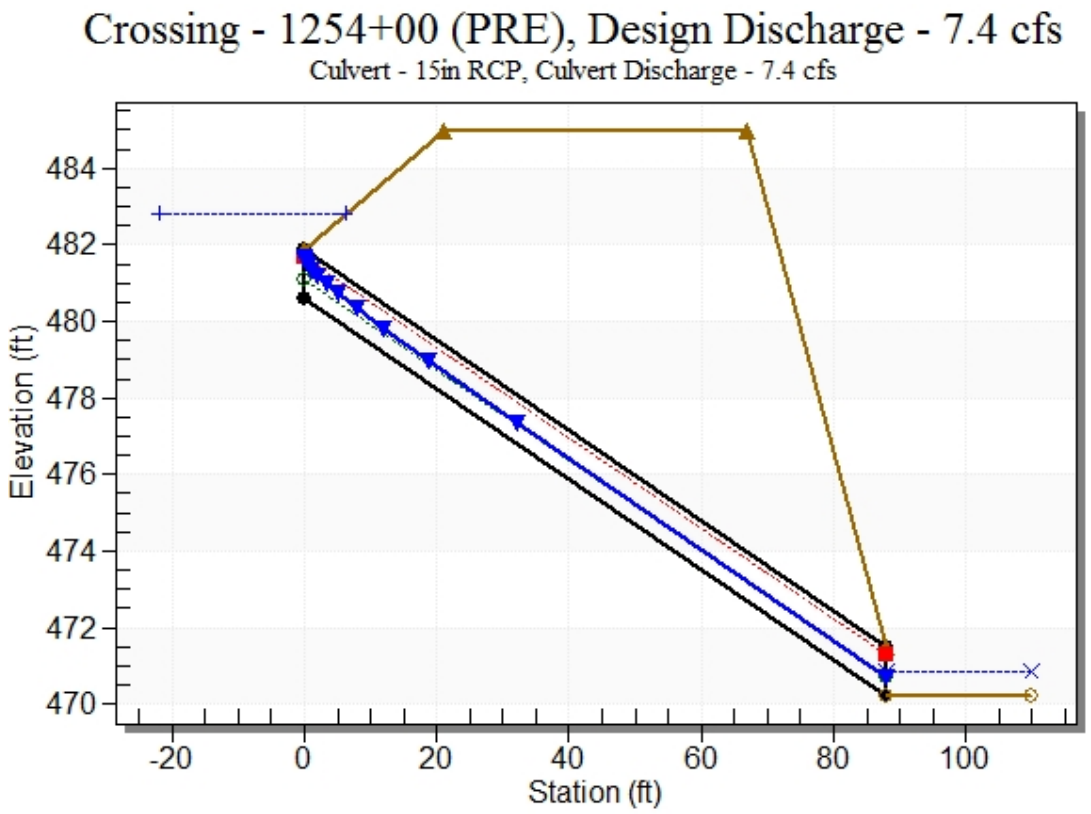
Straight Culvert

Inlet Elevation (invert): 480.61 ft, Outlet Elevation (invert): 470.23 ft

Culvert Length: 88.61 ft, Culvert Slope: 0.1180

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 480.61 ft

Outlet Station: 88.00 ft

Outlet Elevation: 470.23 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1254+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.15	470.77	0.54	3.67	2.71	1.02
6.38	470.78	0.55	3.71	2.77	1.02
6.62	470.79	0.56	3.74	2.82	1.02
6.85	470.81	0.58	3.78	2.87	1.03
7.08	470.82	0.59	3.81	2.92	1.03
7.32	470.83	0.60	3.85	2.97	1.03
7.41	470.83	0.60	3.86	2.99	1.03
7.78	470.85	0.62	3.92	3.07	1.03
8.01	470.85	0.62	3.95	3.12	1.04
8.25	470.86	0.63	3.98	3.16	1.04
8.48	470.87	0.64	4.01	3.21	1.04

Tailwater Channel Data - 1254+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 470.23 ft

Roadway Data for Crossing: 1254+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 485.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.24 cfs

Design Flow: 8.72 cfs

Maximum Flow: 9.99 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1254+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
482.75	7.24	7.24	0.00	1
482.85	7.52	7.52	0.00	1
482.96	7.79	7.79	0.00	1
483.08	8.06	8.06	0.00	1
483.20	8.34	8.34	0.00	1
483.32	8.62	8.62	0.00	1
483.37	8.72	8.72	0.00	1
483.58	9.17	9.17	0.00	1
483.72	9.44	9.44	0.00	1
483.86	9.71	9.71	0.00	1
484.01	9.99	9.99	0.00	1
485.00	11.68	11.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.24	7.24	482.75	2.136	0.0*	5-S2n	0.458	1.072	0.458	0.592	17.214	3.839
7.52	7.52	482.85	2.242	0.0*	5-S2n	0.467	1.089	0.467	0.604	17.359	3.879
7.79	7.79	482.96	2.353	0.0*	5-S2n	0.476	1.104	0.476	0.615	17.533	3.919
8.06	8.06	483.08	2.469	0.0*	5-S2n	0.485	1.118	0.485	0.627	17.706	3.957
8.34	8.34	483.20	2.589	0.0*	5-S2n	0.494	1.130	0.494	0.638	17.880	3.994
8.62	8.62	483.32	2.713	0.0*	5-S2n	0.503	1.142	0.503	0.648	18.007	4.030
8.72	8.72	483.37	2.761	0.0*	5-S2n	0.507	1.146	0.507	0.653	18.066	4.043
9.17	9.17	483.58	2.974	0.0*	5-S2n	0.521	1.160	0.521	0.670	18.317	4.099
9.44	9.44	483.72	3.110	0.0*	5-S2n	0.530	1.166	0.530	0.680	18.469	4.133
9.71	9.71	483.86	3.251	0.0*	5-S2n	0.538	1.180	0.538	0.690	18.585	4.165
9.99	9.99	484.01	3.395	0.0*	5-S2n	0.547	1.186	0.547	0.700	18.723	4.198

* Full Flow Headwater elevation is below inlet invert.

****

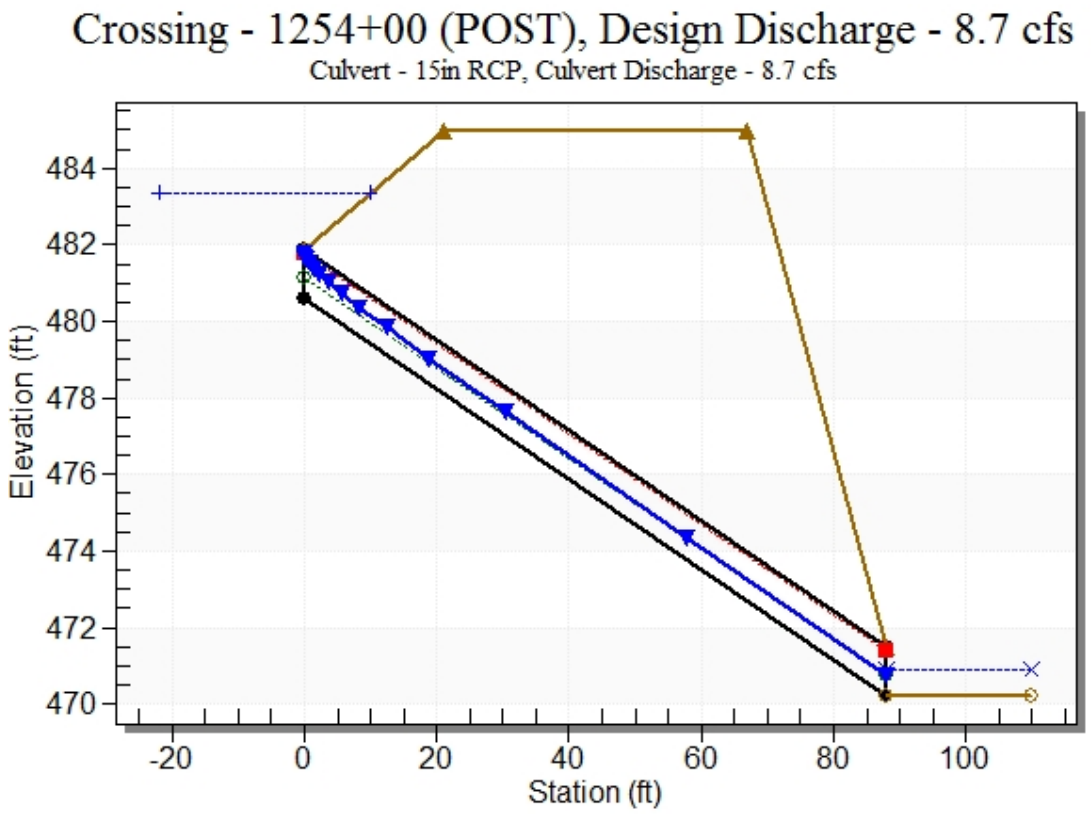
Straight Culvert

Inlet Elevation (invert): 480.61 ft, Outlet Elevation (invert): 470.23 ft

Culvert Length: 88.61 ft, Culvert Slope: 0.1180

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 480.61 ft

Outlet Station: 88.00 ft

Outlet Elevation: 470.23 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1254+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.24	470.82	0.59	3.84	2.96	1.03
7.52	470.83	0.60	3.88	3.01	1.03
7.79	470.85	0.62	3.92	3.07	1.03
8.06	470.86	0.63	3.96	3.13	1.04
8.34	470.87	0.64	3.99	3.18	1.04
8.62	470.88	0.65	4.03	3.24	1.04
8.72	470.88	0.65	4.04	3.26	1.04
9.17	470.90	0.67	4.10	3.34	1.04
9.44	470.91	0.68	4.13	3.39	1.05
9.71	470.92	0.69	4.17	3.44	1.05
9.99	470.93	0.70	4.20	3.49	1.05

Tailwater Channel Data - 1254+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 470.23 ft

Roadway Data for Crossing: 1254+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 485.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 116

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 116**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.11	0.9956
Grass	0.25	1.17	0.2923
Woods	0.15	1.55	0.2329
	Σ	**3.83**	1.5207

$C_{ave} = \frac{1.5207}{3.83} = 0.40$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.77	1.5931
Grass	0.25	0.30	0.0738
Woods	0.15	1.55	0.2329
	Σ	**3.62**	1.8998

$C_{ave} = \frac{1.8998}{3.62} = 0.53$

T_c =	32.38	min.								
I_{05} =	3.59	in / hr								
I_{10} =	3.97	in / hr								
I_{25} =	4.52	in / hr								
I_{50} =	4.94	in / hr								
I_{100} =	5.36	in / hr								

Pre Construction Runoff:

Q_{05} =	0.40	**x**	3.59	**x**	3.83	**x**	1	=	**5.46**	cfs
Q_{10} =	0.40	**x**	3.97	**x**	3.83	**x**	1	=	**6.04**	cfs
Q_{25} =	0.40	**x**	4.52	**x**	3.83	**x**	1.1	=	**7.57**	cfs
Q_{50} =	0.40	**x**	4.94	**x**	3.83	**x**	1.2	=	**9.01**	cfs
Q_{100} =	0.40	**x**	5.36	**x**	3.83	**x**	1.25	=	**10.18**	cfs

Post Construction Runoff:

Q_{05} =	0.53	**x**	3.59	**x**	3.62	**x**	1	=	**6.82**	cfs
Q_{10} =	0.53	**x**	3.97	**x**	3.62	**x**	1	=	**7.54**	cfs
Q_{25} =	0.53	**x**	4.52	**x**	3.62	**x**	1.1	=	**9.45**	cfs
Q_{50} =	0.53	**x**	4.94	**x**	3.62	**x**	1.2	=	**11.25**	cfs
Q_{100} =	0.53	**x**	5.36	**x**	3.62	**x**	1.25	=	**12.72**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 116	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**236**				
9	Watercourse slope, s		ft/ft	**0.1100**				
10	Average velocity, V (figure 3-1)		ft/s	**5.35**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**			
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0400**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**2.41**	**#DIV/0!**			
18	Flow length, L		ft	**230**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.026**	+	**0.000**	=	**0.026**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.540**
							min	**32.38**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.57 cfs

Design Flow: 9.01 cfs

Maximum Flow: 10.18 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1260+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
510.64	7.57	7.57	0.00	1
510.69	7.83	7.83	0.00	1
510.74	8.09	8.09	0.00	1
510.80	8.35	8.35	0.00	1
510.85	8.61	8.61	0.00	1
510.91	8.88	8.88	0.00	1
510.94	9.01	9.01	0.00	1
511.02	9.40	9.40	0.00	1
511.08	9.66	9.66	0.00	1
511.15	9.92	9.92	0.00	1
511.21	10.18	10.18	0.00	1
512.31	13.79	13.79	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.57	7.57	510.64	1.691	0.0*	5-S2n	0.499	1.062	0.499	0.606	14.243	3.887
7.83	7.83	510.69	1.741	0.0*	5-S2n	0.508	1.080	0.508	0.617	14.393	3.924
8.09	8.09	510.74	1.792	0.0*	5-S2n	0.517	1.098	0.517	0.628	14.493	3.960
8.35	8.35	510.80	1.845	0.0*	5-S2n	0.525	1.115	0.525	0.638	14.626	3.996
8.61	8.61	510.85	1.900	0.0*	5-S2n	0.534	1.132	0.565	0.648	13.666	4.030
8.88	8.88	510.91	1.956	0.0*	5-S2n	0.543	1.148	0.555	0.659	14.413	4.063
9.01	9.01	510.94	1.986	0.0*	5-S2n	0.547	1.157	0.547	0.664	14.950	4.080
9.40	9.40	511.02	2.073	0.0*	5-S2n	0.560	1.183	0.560	0.678	15.098	4.127
9.66	9.66	511.08	2.135	0.0*	5-S2n	0.568	1.198	0.568	0.688	15.214	4.159
9.92	9.92	511.15	2.198	0.0*	5-S2n	0.577	1.213	0.577	0.697	15.325	4.189
10.18	10.18	511.21	2.263	0.0*	5-S2n	0.585	1.227	0.585	0.707	15.443	4.220

* Full Flow Headwater elevation is below inlet invert.

****

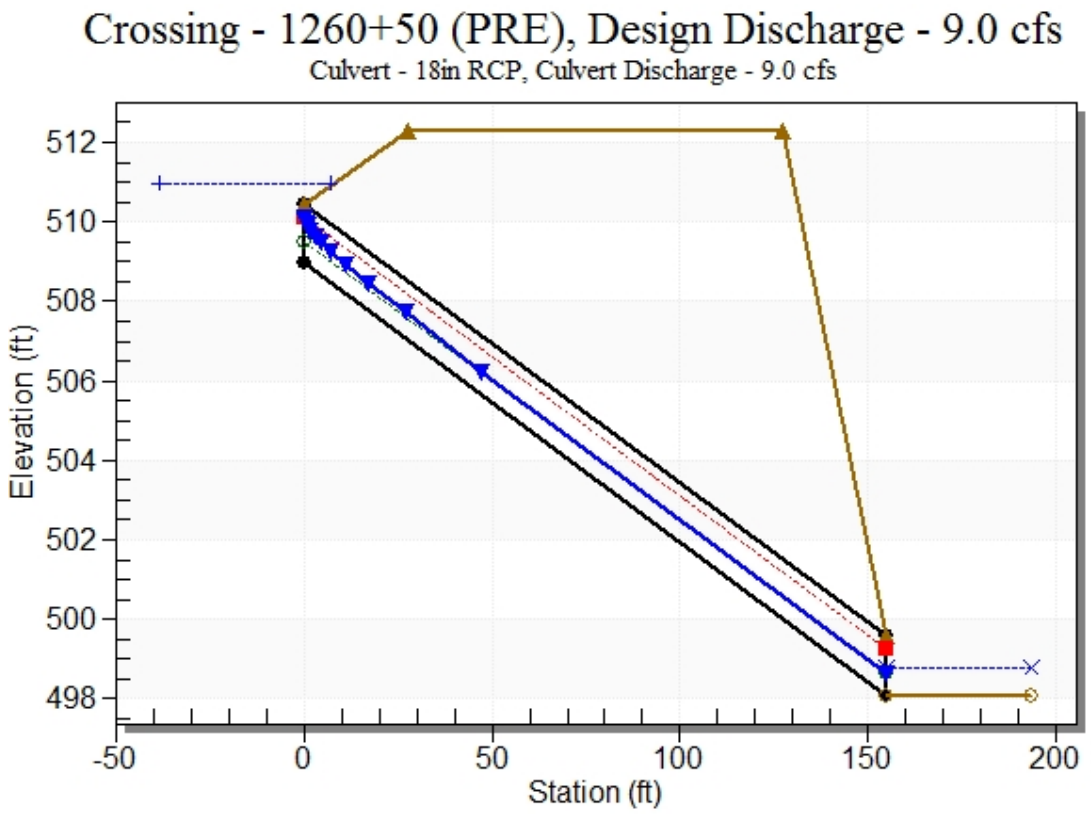
Straight Culvert

Inlet Elevation (invert): 508.95 ft, Outlet Elevation (invert): 498.09 ft

Culvert Length: 155.38 ft, Culvert Slope: 0.0701

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 508.95 ft

Outlet Station: 155.00 ft

Outlet Elevation: 498.09 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1260+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.57	498.70	0.61	3.89	3.03	1.03
7.83	498.71	0.62	3.92	3.08	1.03
8.09	498.72	0.63	3.96	3.13	1.04
8.35	498.73	0.64	4.00	3.19	1.04
8.61	498.74	0.65	4.03	3.24	1.04
8.88	498.75	0.66	4.06	3.29	1.04
9.01	498.75	0.66	4.08	3.31	1.04
9.40	498.77	0.68	4.13	3.39	1.05
9.66	498.78	0.69	4.16	3.43	1.05
9.92	498.79	0.70	4.19	3.48	1.05
10.18	498.80	0.71	4.22	3.53	1.05

Tailwater Channel Data - 1260+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 498.09 ft

Roadway Data for Crossing: 1260+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 512.31 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 9.45 cfs

Design Flow: 11.25 cfs

Maximum Flow: 12.72 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1260+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
511.04	9.45	9.45	0.00	1
511.11	9.78	9.78	0.00	1
511.19	10.10	10.10	0.00	1
511.28	10.43	10.43	0.00	1
511.36	10.76	10.76	0.00	1
511.45	11.09	11.09	0.00	1
511.50	11.25	11.25	0.00	1
511.64	11.74	11.74	0.00	1
511.74	12.07	12.07	0.00	1
511.84	12.39	12.39	0.00	1
511.95	12.72	12.72	0.00	1
512.31	13.78	13.78	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.45	9.45	511.04	2.086	0.0*	5-S2n	0.561	1.186	0.561	0.680	15.122	4.134
9.78	9.78	511.11	2.163	0.0*	5-S2n	0.572	1.205	0.572	0.692	15.265	4.173
10.10	10.10	511.19	2.244	0.0*	5-S2n	0.582	1.223	0.582	0.704	15.409	4.211
10.43	10.43	511.28	2.328	0.0*	5-S2n	0.593	1.241	0.630	0.716	14.316	4.247
10.76	10.76	511.36	2.414	0.0*	5-S2n	0.603	1.257	0.629	0.727	14.783	4.284
11.09	11.09	511.45	2.504	0.0*	5-S2n	0.613	1.273	0.629	0.738	15.241	4.319
11.25	11.25	511.50	2.550	0.0*	5-S2n	0.618	1.281	0.618	0.744	15.848	4.336
11.74	11.74	511.64	2.692	0.0*	5-S2n	0.633	1.303	0.633	0.760	16.018	4.387
12.07	12.07	511.74	2.791	0.0*	5-S2n	0.643	1.317	0.643	0.771	16.137	4.420
12.39	12.39	511.84	2.893	0.0*	5-S2n	0.652	1.329	0.652	0.781	16.250	4.452
12.72	12.72	511.95	2.998	0.0*	5-S2n	0.662	1.341	0.662	0.792	16.366	4.484

* Full Flow Headwater elevation is below inlet invert.

****

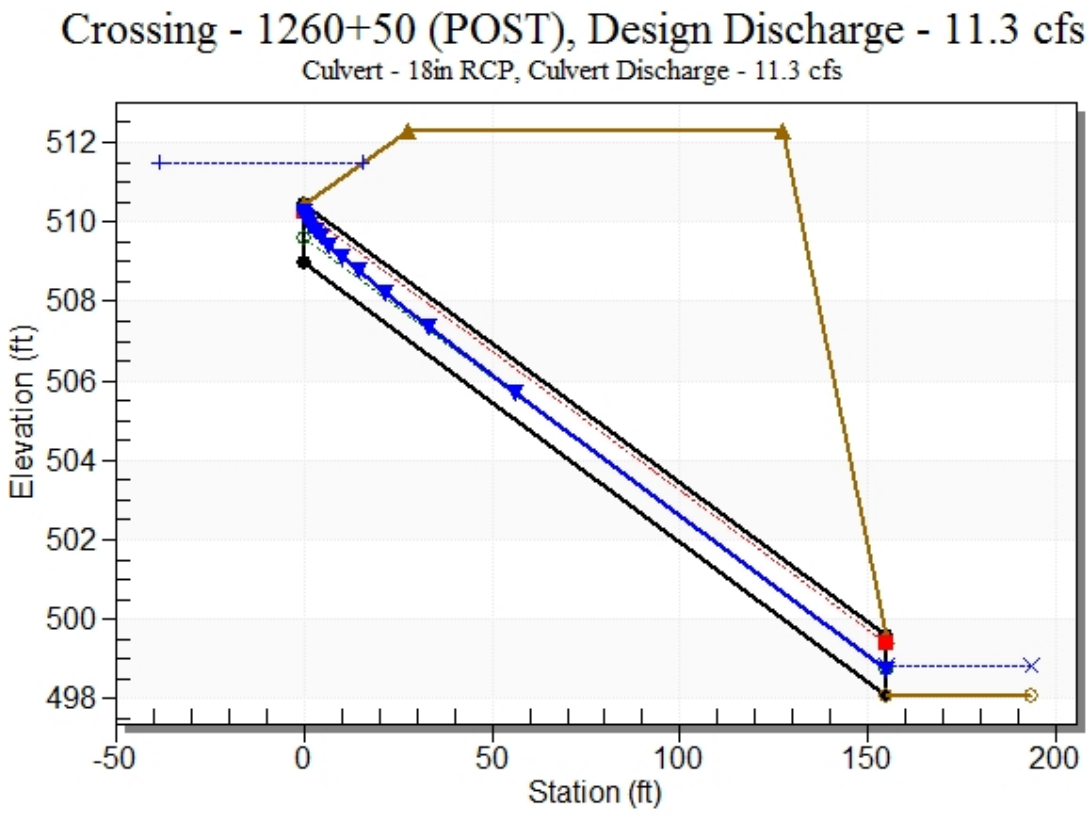
Straight Culvert

Inlet Elevation (invert): 508.95 ft, Outlet Elevation (invert): 498.09 ft

Culvert Length: 155.38 ft, Culvert Slope: 0.0701

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 508.95 ft

Outlet Station: 155.00 ft

Outlet Elevation: 498.09 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1260+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.45	498.77	0.68	4.13	3.40	1.05
9.78	498.78	0.69	4.17	3.46	1.05
10.10	498.79	0.70	4.21	3.51	1.05
10.43	498.81	0.72	4.25	3.57	1.05
10.76	498.82	0.73	4.28	3.63	1.06
11.09	498.83	0.74	4.32	3.69	1.06
11.25	498.83	0.74	4.34	3.71	1.06
11.74	498.85	0.76	4.39	3.79	1.06
12.07	498.86	0.77	4.42	3.85	1.06
12.39	498.87	0.78	4.45	3.90	1.06
12.72	498.88	0.79	4.48	3.95	1.07

Tailwater Channel Data - 1260+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 498.09 ft

Roadway Data for Crossing: 1260+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 512.31 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 117

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 117	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**1810**				
9	Watercourse slope, s		ft/ft	**0.0276**				
10	Average velocity, V (figure 3-1)		ft/s	**2.68**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.187**	+		=	**0.187**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0**				
12	Cross sectional flow area, a		ft^2	**0.00**	**0.00**			
13	Wetted perimeter, p_w		ft	**2.00**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.00**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0400**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**0.00**	**#DIV/0!**			
18	Flow length, L		ft	**0**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.777**
							min	**46.60**

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 117**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.39	2.1467
Grass	0.25	4.53	1.1333
Woods	0.15	13.36	2.0034
	Σ	**20.27**	5.2834

$C_{ave} = \frac{5.2834}{20.27} = 0.26$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.24	2.9148
Grass	0.25	3.68	0.9200
Woods	0.15	13.36	2.0034
	Σ	**20.27**	5.8382

$C_{ave} = \frac{5.8382}{20.27} = 0.29$

T_c =	46.60	min.								
I_{05} =	2.94	in / hr								
I_{10} =	3.24	in / hr								
I_{25} =	3.68	in / hr								
I_{50} =	4.01	in / hr								
I_{100} =	4.34	in / hr								

Pre Construction Runoff:

Q_{05} =	0.26	x	2.94	x	20.27	x	1	=	**15.52**	cfs
Q_{10} =	0.26	x	3.24	x	20.27	x	1	=	**17.13**	cfs
Q_{25} =	0.26	x	3.68	x	20.27	x	1.1	=	**21.40**	cfs
Q_{50} =	0.26	x	4.01	x	20.27	x	1.2	=	**25.42**	cfs
Q_{100} =	0.26	x	4.34	x	20.27	x	1.25	=	**28.67**	cfs

Post Construction Runoff:

Q_{05} =	0.29	x	2.94	x	20.27	x	1	=	**17.14**	cfs
Q_{10} =	0.29	x	3.24	x	20.27	x	1	=	**18.93**	cfs
Q_{25} =	0.29	x	3.68	x	20.27	x	1.1	=	**23.65**	cfs
Q_{50} =	0.29	x	4.01	x	20.27	x	1.2	=	**28.08**	cfs
Q_{100} =	0.29	x	4.34	x	20.27	x	1.25	=	**31.68**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 21.4 cfs

Design Flow: 25.42 cfs

Maximum Flow: 28.67 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1268+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
532.36	21.40	21.40	0.00	1
532.40	22.13	22.13	0.00	1
532.45	22.85	22.85	0.00	1
532.50	23.58	23.58	0.00	1
532.55	24.31	24.31	0.00	1
532.60	25.04	25.04	0.00	1
532.63	25.42	25.42	0.00	1
532.70	26.49	26.49	0.00	1
532.76	27.22	27.22	0.00	1
532.81	27.94	27.94	0.00	1
532.86	28.67	28.67	0.00	1
543.00	90.57	90.57	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
21.40	21.40	532.36	2.257	0.0*	1-S2n	0.815	1.570	0.853	1.065	13.970	3.919
22.13	22.13	532.40	2.305	0.0*	1-S2n	0.829	1.597	0.829	1.083	15.003	3.955
22.85	22.85	532.45	2.353	0.0*	1-S2n	0.844	1.623	0.844	1.101	15.145	3.990
23.58	23.58	532.50	2.402	0.0*	1-S2n	0.858	1.649	0.858	1.119	15.285	4.024
24.31	24.31	532.55	2.451	0.0*	1-S2n	0.872	1.675	0.919	1.136	14.349	4.057
25.04	25.04	532.60	2.501	0.0*	5-S2n	0.886	1.700	0.912	1.153	14.916	4.090
25.42	25.42	532.63	2.528	0.0*	5-S2n	0.893	1.713	0.893	1.162	15.589	4.107
26.49	26.49	532.70	2.603	0.0*	5-S2n	0.913	1.749	0.913	1.187	15.774	4.153
27.22	27.22	532.76	2.655	0.0*	5-S2n	0.926	1.777	0.926	1.203	15.897	4.183
27.94	27.94	532.81	2.708	0.0*	5-S2n	0.939	1.800	0.981	1.219	15.098	4.213
28.67	28.67	532.86	2.762	0.0*	5-S2n	0.953	1.823	0.979	1.235	15.542	4.243

* Full Flow Headwater elevation is below inlet invert.

****

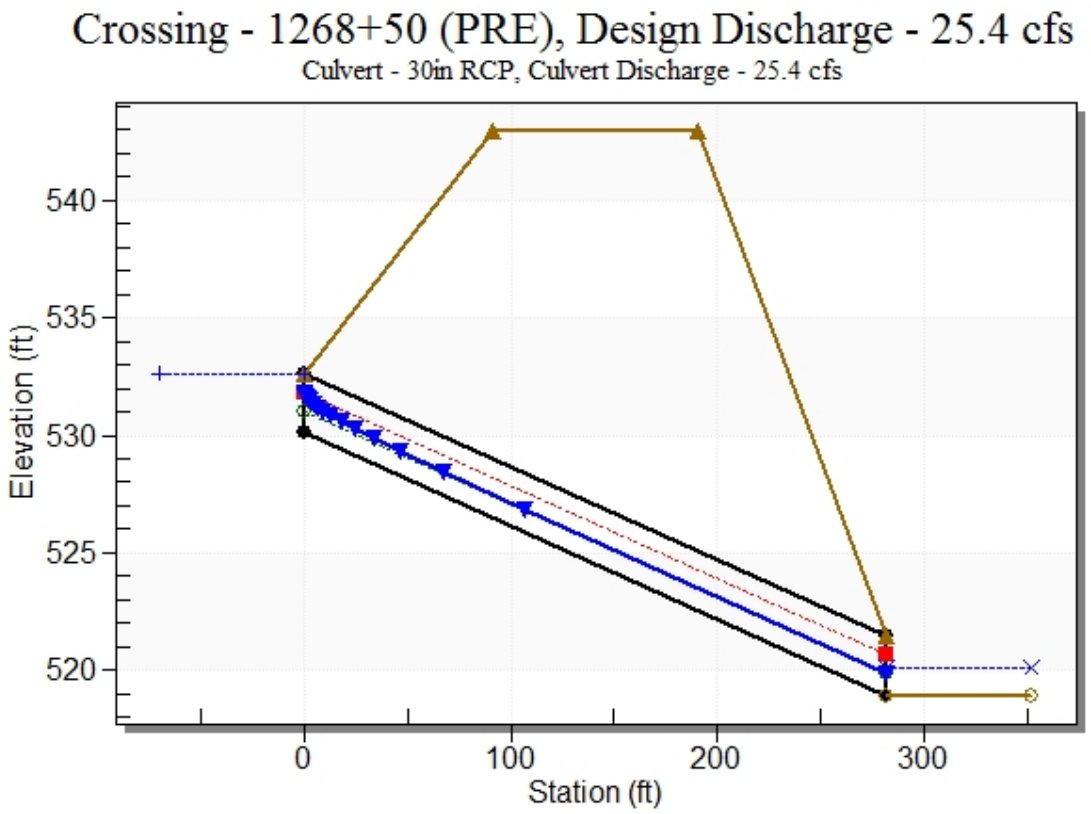
Straight Culvert

Inlet Elevation (invert): 530.10 ft, Outlet Elevation (invert): 518.93 ft

Culvert Length: 282.22 ft, Culvert Slope: 0.0396

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 530.10 ft

Outlet Station: 282.00 ft

Outlet Elevation: 518.93 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1268+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
21.40	519.99	1.06	3.92	2.66	0.80
22.13	520.01	1.08	3.95	2.70	0.80
22.85	520.03	1.10	3.99	2.75	0.80
23.58	520.05	1.12	4.02	2.79	0.80
24.31	520.07	1.14	4.06	2.84	0.80
25.04	520.08	1.15	4.09	2.88	0.80
25.42	520.09	1.16	4.11	2.90	0.80
26.49	520.12	1.19	4.15	2.96	0.81
27.22	520.13	1.20	4.18	3.00	0.81
27.94	520.15	1.22	4.21	3.04	0.81
28.67	520.17	1.24	4.24	3.08	0.81

Tailwater Channel Data - 1268+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 518.93 ft

Roadway Data for Crossing: 1268+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 543.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 23.65 cfs

Design Flow: 28.08 cfs

Maximum Flow: 31.68 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1268+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
532.51	23.65	23.65	0.00	1
532.56	24.45	24.45	0.00	1
532.62	25.26	25.26	0.00	1
532.67	26.06	26.06	0.00	1
532.73	26.86	26.86	0.00	1
532.79	27.66	27.66	0.00	1
532.82	28.08	28.08	0.00	1
532.91	29.27	29.27	0.00	1
532.97	30.07	30.07	0.00	1
533.03	30.88	30.88	0.00	1
533.10	31.68	31.68	0.00	1
543.00	90.57	90.57	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
23.65	23.65	532.51	2.407	0.0*	1-S2n	0.859	1.652	0.859	1.121	15.298	4.027
24.45	24.45	532.56	2.461	0.0*	1-S2n	0.874	1.680	0.918	1.140	14.454	4.064
25.26	25.26	532.62	2.516	0.0*	5-S2n	0.890	1.708	0.910	1.159	15.107	4.100
26.06	26.06	532.67	2.573	0.0*	5-S2n	0.905	1.735	0.905	1.177	15.699	4.135
26.86	26.86	532.73	2.630	0.0*	5-S2n	0.920	1.765	0.920	1.195	15.838	4.169
27.66	27.66	532.79	2.688	0.0*	5-S2n	0.934	1.791	0.982	1.213	14.944	4.202
28.08	28.08	532.82	2.719	0.0*	5-S2n	0.942	1.805	0.981	1.222	15.177	4.219
29.27	29.27	532.91	2.808	0.0*	5-S2n	0.964	1.842	0.964	1.248	16.200	4.267
30.07	30.07	532.97	2.870	0.0*	5-S2n	0.978	1.867	0.978	1.265	16.325	4.298
30.88	30.88	533.03	2.933	0.0*	5-S2n	0.992	1.891	0.992	1.282	16.446	4.328
31.68	31.68	533.10	2.998	0.0*	5-S2n	1.006	1.915	1.057	1.299	15.513	4.358

* Full Flow Headwater elevation is below inlet invert.

****

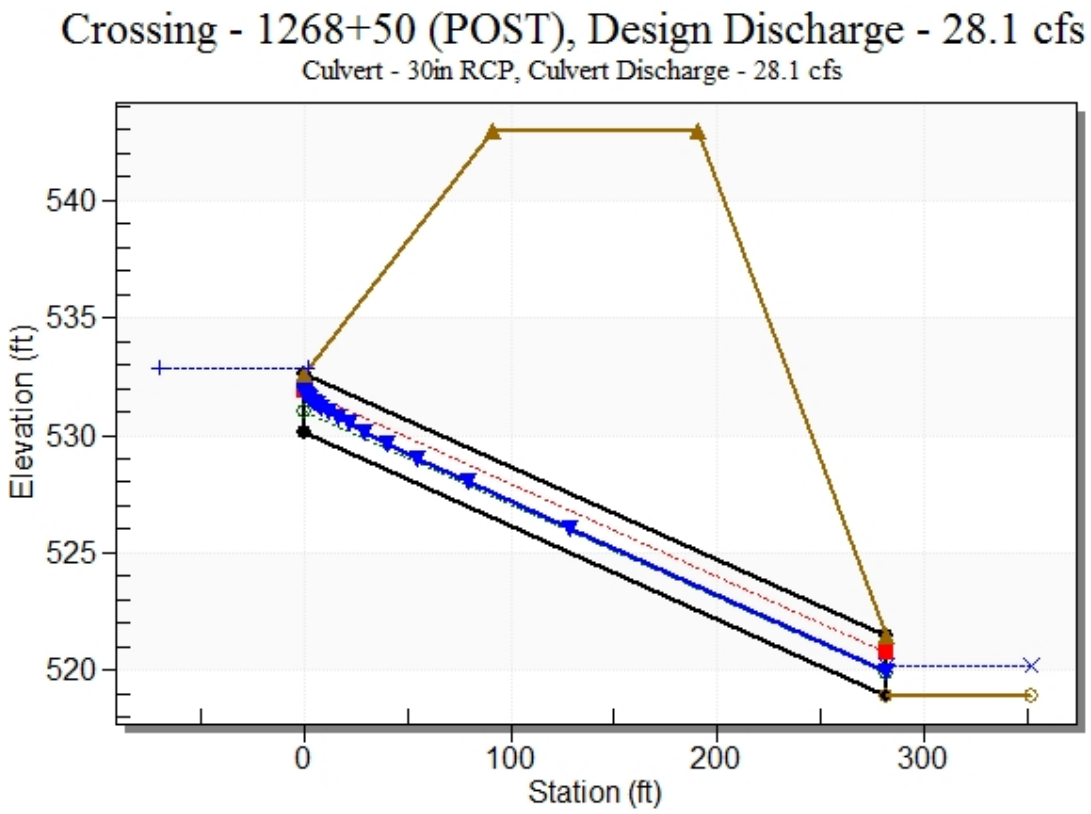
Straight Culvert

Inlet Elevation (invert): 530.10 ft, Outlet Elevation (invert): 518.93 ft

Culvert Length: 282.22 ft, Culvert Slope: 0.0396

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 530.10 ft

Outlet Station: 282.00 ft

Outlet Elevation: 518.93 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1268+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
23.65	520.05	1.12	4.03	2.80	0.80
24.45	520.07	1.14	4.06	2.84	0.80
25.26	520.09	1.16	4.10	2.89	0.80
26.06	520.11	1.18	4.13	2.94	0.81
26.86	520.13	1.20	4.17	2.98	0.81
27.66	520.14	1.21	4.20	3.03	0.81
28.08	520.15	1.22	4.22	3.05	0.81
29.27	520.18	1.25	4.27	3.12	0.81
30.07	520.20	1.27	4.30	3.16	0.81
30.88	520.21	1.28	4.33	3.20	0.81
31.68	520.23	1.30	4.36	3.24	0.82

Tailwater Channel Data - 1268+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 518.93 ft

Roadway Data for Crossing: 1268+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 543.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 118/119

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 118/119**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.59	0.5324
Grass	0.25	0.55	0.1386
Woods	0.15	0.00	0.0000
	Σ	**1.15**	0.6710

$C_{ave} = \frac{0.6710}{1.15} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.81	0.7271
Grass	0.25	0.26	0.0645
Woods	0.15	0.00	0.0000
	Σ	**1.07**	0.7916

$C_{ave} = \frac{0.7916}{1.07} = 0.74$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	1.15	x	1	=	**4.18**	cfs
Q_{10} =	0.59	x	6.98	x	1.15	x	1	=	**4.68**	cfs
Q_{25} =	0.59	x	8.08	x	1.15	x	1.1	=	**5.97**	cfs
Q_{50} =	0.59	x	8.93	x	1.15	x	1.2	=	**7.19**	cfs
Q_{100} =	0.59	x	9.81	x	1.15	x	1.25	=	**8.23**	cfs

Post Construction Runoff:

Q_{05} =	0.74	x	6.23	x	1.07	x	1	=	**4.93**	cfs
Q_{10} =	0.74	x	6.98	x	1.07	x	1	=	**5.52**	cfs
Q_{25} =	0.74	x	8.08	x	1.07	x	1.1	=	**7.04**	cfs
Q_{50} =	0.74	x	8.93	x	1.07	x	1.2	=	**8.48**	cfs
Q_{100} =	0.74	x	9.81	x	1.07	x	1.25	=	**9.71**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.97 cfs

Design Flow: 7.19 cfs

Maximum Flow: 8.23 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1276+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
562.10	5.97	5.97	0.00	1
562.17	6.20	6.20	0.00	1
562.24	6.42	6.42	0.00	1
562.32	6.65	6.65	0.00	1
562.40	6.87	6.87	0.00	1
562.48	7.10	7.10	0.00	1
562.52	7.19	7.19	0.00	1
562.66	7.55	7.55	0.00	1
562.75	7.78	7.78	0.00	1
562.84	8.00	8.00	0.00	1
562.94	8.23	8.23	0.00	1
563.00	8.37	8.37	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.97	5.97	562.10	1.741	0.0*	5-S2n	0.507	0.984	0.507	0.642	12.354	2.833
6.20	6.20	562.17	1.812	0.0*	5-S2n	0.518	1.002	0.518	0.654	12.481	2.863
6.42	6.42	562.24	1.885	0.0*	5-S2n	0.528	1.018	0.528	0.666	12.608	2.891
6.65	6.65	562.32	1.961	0.0*	5-S2n	0.539	1.034	0.571	0.678	11.768	2.919
6.87	6.87	562.40	2.040	0.0*	5-S2n	0.549	1.049	0.564	0.690	12.353	2.946
7.10	7.10	562.48	2.123	0.0*	5-S2n	0.559	1.064	0.559	0.702	12.935	2.973
7.19	7.19	562.52	2.156	0.0*	5-S2n	0.563	1.069	0.563	0.706	12.966	2.983
7.55	7.55	562.66	2.296	0.0*	5-S2n	0.579	1.091	0.579	0.724	13.131	3.023
7.78	7.78	562.75	2.388	0.0*	5-S2n	0.589	1.103	0.589	0.735	13.234	3.048
8.00	8.00	562.84	2.482	0.0*	5-S2n	0.599	1.115	0.599	0.746	13.323	3.072
8.23	8.23	562.94	2.579	0.0*	5-S2n	0.609	1.125	0.609	0.757	13.416	3.095

* Full Flow Headwater elevation is below inlet invert.

****

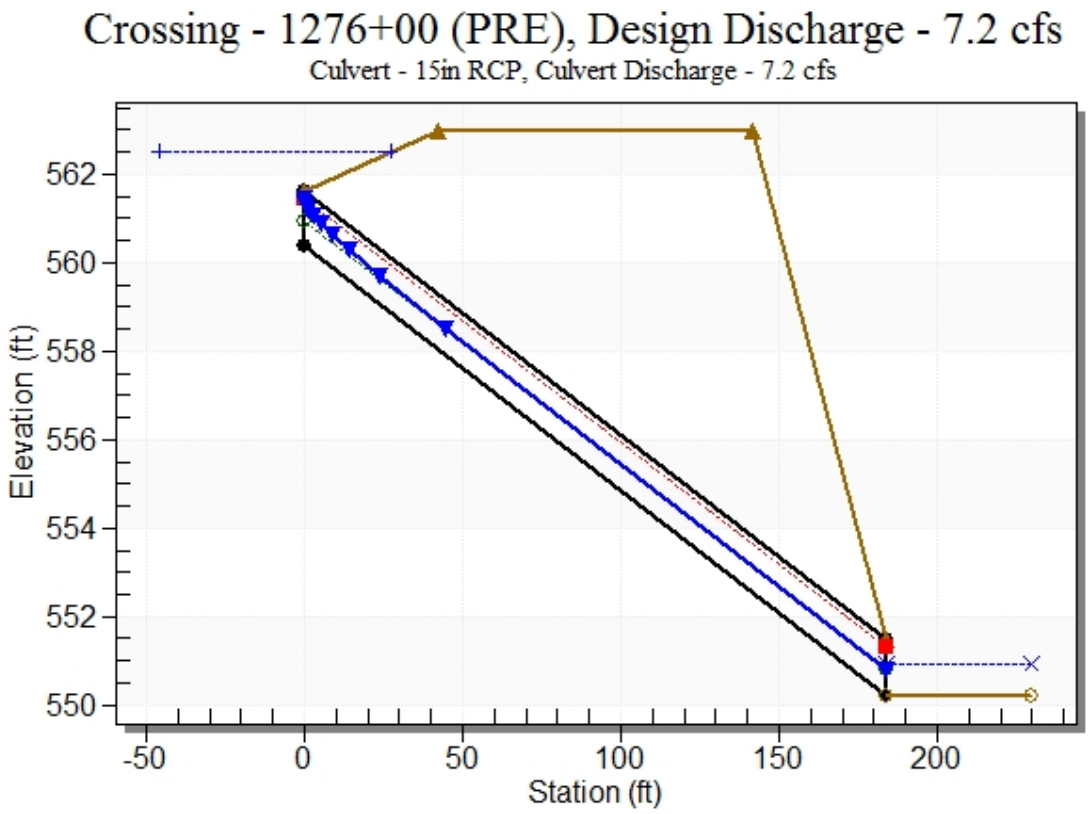
Straight Culvert

Inlet Elevation (invert): 560.36 ft, Outlet Elevation (invert): 550.22 ft

Culvert Length: 184.28 ft, Culvert Slope: 0.0551

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 560.36 ft

Outlet Station: 184.00 ft

Outlet Elevation: 550.22 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1276+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.97	550.86	0.64	2.83	1.60	0.74
6.20	550.87	0.65	2.86	1.63	0.74
6.42	550.89	0.67	2.89	1.66	0.74
6.65	550.90	0.68	2.92	1.69	0.74
6.87	550.91	0.69	2.95	1.72	0.74
7.10	550.92	0.70	2.97	1.75	0.74
7.19	550.93	0.71	2.98	1.76	0.74
7.55	550.94	0.72	3.02	1.81	0.75
7.78	550.96	0.74	3.05	1.84	0.75
8.00	550.97	0.75	3.07	1.86	0.75
8.23	550.98	0.76	3.10	1.89	0.75

Tailwater Channel Data - 1276+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 550.22 ft

Roadway Data for Crossing: 1276+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 563.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.04 cfs

Design Flow: 8.48 cfs

Maximum Flow: 9.71 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1276+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
562.46	7.04	7.04	0.00	1
562.56	7.31	7.31	0.00	1
562.67	7.57	7.57	0.00	1
562.77	7.84	7.84	0.00	1
562.89	8.11	8.11	0.00	1
562.98	8.38	8.32	0.00	33
563.00	8.48	8.38	0.05	13
563.02	8.91	8.41	0.44	5
563.03	9.18	8.43	0.71	4
563.03	9.44	8.45	0.94	3
563.04	9.71	8.46	1.20	3
563.00	8.37	8.37	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.04	7.04	562.46	2.101	0.0*	5-S2n	0.556	1.060	0.561	0.699	12.771	2.965
7.31	7.31	562.56	2.201	0.0*	5-S2n	0.568	1.076	0.568	0.712	13.020	2.996
7.57	7.57	562.67	2.305	0.0*	5-S2n	0.580	1.092	0.580	0.725	13.142	3.026
7.84	7.84	562.77	2.414	0.0*	5-S2n	0.592	1.106	0.592	0.738	13.262	3.055
8.11	8.11	562.89	2.526	0.0*	5-S2n	0.604	1.120	0.604	0.751	13.367	3.082
8.38	8.32	562.98	2.619	0.0*	5-S2n	0.613	1.130	0.613	0.764	13.454	3.109
8.48	8.38	563.00	2.645	0.0*	5-S2n	0.615	1.132	0.615	0.768	13.477	3.120
8.91	8.41	563.02	2.661	0.0*	5-S2n	0.617	1.134	0.617	0.788	13.492	3.162
9.18	8.43	563.03	2.669	0.0*	5-S2n	0.618	1.134	0.618	0.800	13.499	3.188
9.44	8.45	563.03	2.675	0.0*	5-S2n	0.618	1.135	0.618	0.811	13.504	3.212
9.71	8.46	563.04	2.681	0.0*	5-S2n	0.619	1.135	0.619	0.823	13.510	3.237

* Full Flow Headwater elevation is below inlet invert.

****

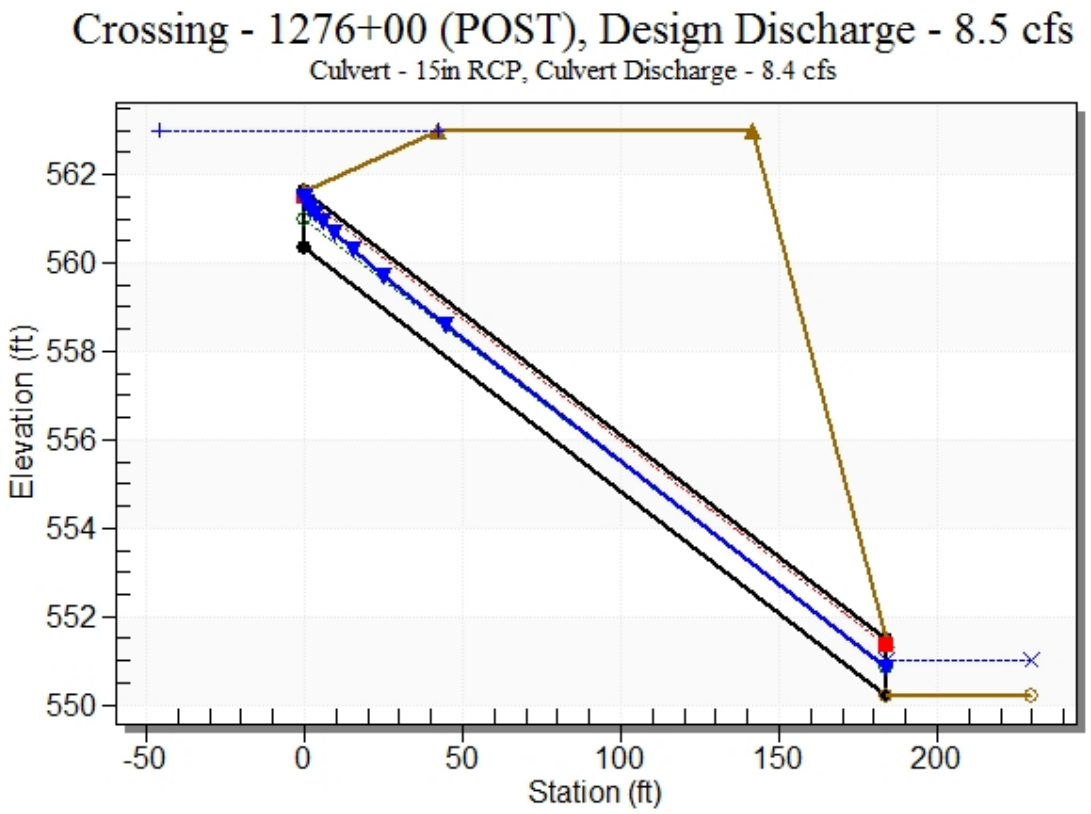
Straight Culvert

Inlet Elevation (invert): 560.36 ft, Outlet Elevation (invert): 550.22 ft

Culvert Length: 184.28 ft, Culvert Slope: 0.0551

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 560.36 ft

Outlet Station: 184.00 ft

Outlet Elevation: 550.22 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1276+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.04	550.92	0.70	2.97	1.74	0.74
7.31	550.93	0.71	3.00	1.78	0.74
7.57	550.95	0.73	3.03	1.81	0.75
7.84	550.96	0.74	3.05	1.84	0.75
8.11	550.97	0.75	3.08	1.87	0.75
8.38	550.98	0.76	3.11	1.91	0.75
8.48	550.99	0.77	3.12	1.92	0.75
8.91	551.01	0.79	3.16	1.97	0.75
9.18	551.02	0.80	3.19	2.00	0.75
9.44	551.03	0.81	3.21	2.03	0.76
9.71	551.04	0.82	3.24	2.05	0.76

Tailwater Channel Data - 1276+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 550.22 ft

Roadway Data for Crossing: 1276+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 563.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 120

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 120a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.08	0.0708
Grass	0.25	0.80	0.2012
Woods	0.15	1.37	0.2049
	Σ	**2.25**	0.4768

$C_{ave} = \frac{0.4768}{2.25} = 0.21$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.08	0.0708
Grass	0.25	0.80	0.2012
Woods	0.15	1.37	0.2049
	Σ	**2.25**	0.4768

$C_{ave} = \frac{0.4768}{2.25} = 0.21$

T_c =	14.69	min.
I_{05} =	4.95	in / hr
I_{10} =	5.51	in / hr
I_{25} =	6.32	in / hr
I_{50} =	6.94	in / hr
I_{100} =	7.57	in / hr

Pre Construction Runoff:

Q_{05} =	0.21	x	4.95	x	2.25	x	1	=	**2.36**	cfs
Q_{10} =	0.21	x	5.51	x	2.25	x	1	=	**2.63**	cfs
Q_{25} =	0.21	x	6.32	x	2.25	x	1.1	=	**3.32**	cfs
Q_{50} =	0.21	x	6.94	x	2.25	x	1.2	=	**3.97**	cfs
Q_{100} =	0.21	x	7.57	x	2.25	x	1.25	=	**4.51**	cfs

Post Construction Runoff:

Q_{05} =	0.21	x	4.95	x	2.25	x	1	=	**2.36**	cfs
Q_{10} =	0.21	x	5.51	x	2.25	x	1	=	**2.63**	cfs
Q_{25} =	0.21	x	6.32	x	2.25	x	1.1	=	**3.32**	cfs
Q_{50} =	0.21	x	6.94	x	2.25	x	1.2	=	**3.97**	cfs
Q_{100} =	0.21	x	7.57	x	2.25	x	1.25	=	**4.51**	cfs

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Location: **Site 120b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5962
Grass	0.25	0.50	0.1245
Woods	0.15	1.60	0.2399
	Σ	**2.76**	0.9605

$C_{ave} = \frac{0.9605}{2.76} = 0.35$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.94	0.8437
Grass	0.25	0.50	0.1245
Woods	0.15	1.60	0.2399
	Σ	**3.03**	1.2080

$C_{ave} = \frac{1.2080}{3.03} = 0.40$

T_c =	27.46	min.
I_{05} =	3.89	in / hr
I_{10} =	4.30	in / hr
I_{25} =	4.91	in / hr
I_{50} =	5.37	in / hr
I_{100} =	5.83	in / hr

Pre Construction Runoff:

Q_{05} =	0.35	x	3.89	x	2.76	x	1	=	**3.73**	cfs
Q_{10} =	0.35	x	4.30	x	2.76	x	1	=	**4.14**	cfs
Q_{25} =	0.35	x	4.91	x	2.76	x	1.1	=	**5.19**	cfs
Q_{50} =	0.35	x	5.37	x	2.76	x	1.2	=	**6.18**	cfs
Q_{100} =	0.35	x	5.83	x	2.76	x	1.25	=	**7.00**	cfs

Post Construction Runoff:

Q_{05} =	0.40	x	3.89	x	3.03	x	1	=	**4.69**	cfs
Q_{10} =	0.40	x	4.30	x	3.03	x	1	=	**5.20**	cfs
Q_{25} =	0.40	x	4.91	x	3.03	x	1.1	=	**6.53**	cfs
Q_{50} =	0.40	x	5.37	x	3.03	x	1.2	=	**7.78**	cfs
Q_{100} =	0.40	x	5.83	x	3.03	x	1.25	=	**8.80**	cfs

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Location: **Site 120c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.10	0.0864
Grass	0.25	0.06	0.0158
Woods	0.15	1.73	0.2597
	Σ	**1.89**	0.3619

$C_{ave} = \frac{0.3619}{1.89} = 0.19$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.16	0.1404
Grass	0.25	0.06	0.0158
Woods	0.15	1.73	0.2597
	Σ	**1.95**	0.4159

$C_{ave} = \frac{0.4159}{1.95} = 0.21$

T_c =	36.99	min.								
I_{05} =	3.35	in / hr								
I_{10} =	3.70	in / hr								
I_{25} =	4.21	in / hr								
I_{50} =	4.59	in / hr								
I_{100} =	4.98	in / hr								

Pre Construction Runoff:

Q_{05} =	0.19	x	3.35	x	1.89	x	1	=	**1.21**	cfs
Q_{10} =	0.19	x	3.70	x	1.89	x	1	=	**1.34**	cfs
Q_{25} =	0.19	x	4.21	x	1.89	x	1.1	=	**1.68**	cfs
Q_{50} =	0.19	x	4.59	x	1.89	x	1.2	=	**1.99**	cfs
Q_{100} =	0.19	x	4.98	x	1.89	x	1.25	=	**2.25**	cfs

Post Construction Runoff:

Q_{05} =	0.21	x	3.35	x	1.95	x	1	=	**1.39**	cfs
Q_{10} =	0.21	x	3.70	x	1.95	x	1	=	**1.54**	cfs
Q_{25} =	0.21	x	4.21	x	1.95	x	1.1	=	**1.93**	cfs
Q_{50} =	0.21	x	4.59	x	1.95	x	1.2	=	**2.29**	cfs
Q_{100} =	0.21	x	4.98	x	1.95	x	1.25	=	**2.59**	cfs

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Location: **Site 120d**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.96	0.8627
Grass	0.25	0.92	0.2290
Woods	0.15	0.00	0.0000
	Σ	**1.87**	1.0917

$C_{ave} = \frac{1.0917}{1.87} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.20	1.0778
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**1.20**	1.0778

$C_{ave} = \frac{1.0778}{1.20} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	1.87	x	1	=	**6.80**	cfs
Q_{10} =	0.58	x	6.98	x	1.87	x	1	=	**7.62**	cfs
Q_{25} =	0.58	x	8.08	x	1.87	x	1.1	=	**9.71**	cfs
Q_{50} =	0.58	x	8.93	x	1.87	x	1.2	=	**11.69**	cfs
Q_{100} =	0.58	x	9.81	x	1.87	x	1.25	=	**13.39**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	1.20	x	1	=	**6.72**	cfs
Q_{10} =	0.90	x	6.98	x	1.20	x	1	=	**7.52**	cfs
Q_{25} =	0.90	x	8.08	x	1.20	x	1.1	=	**9.58**	cfs
Q_{50} =	0.90	x	8.93	x	1.20	x	1.2	=	**11.54**	cfs
Q_{100} =	0.90	x	9.81	x	1.20	x	1.25	=	**13.21**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Checked By: _____ Date: _____

Location: **Site 120e**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.65	0.5841
Grass	0.25	0.45	0.1117
Woods	0.15	2.38	0.3576
	Σ	**3.48**	1.0534

$C_{ave} = \frac{1.0534}{3.48} = 0.30$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.90	0.8091
Grass	0.25	0.45	0.1117
Woods	0.15	2.38	0.3576
	Σ	**3.73**	1.2784

$C_{ave} = \frac{1.2784}{3.73} = 0.34$

T_c =	11.32	min.								
I_{05} =	5.33	in / hr								
I_{10} =	5.94	in / hr								
I_{25} =	6.84	in / hr								
I_{50} =	7.52	in / hr								
I_{100} =	8.22	in / hr								

Pre Construction Runoff:

Q_{05} =	0.30	x	5.33	x	3.48	x	1	=	**5.61**	cfs
Q_{10} =	0.30	x	5.94	x	3.48	x	1	=	**6.26**	cfs
Q_{25} =	0.30	x	6.84	x	3.48	x	1.1	=	**7.93**	cfs
Q_{50} =	0.30	x	7.52	x	3.48	x	1.2	=	**9.50**	cfs
Q_{100} =	0.30	x	8.22	x	3.48	x	1.25	=	**10.83**	cfs

Post Construction Runoff:

Q_{05} =	0.34	x	5.33	x	3.73	x	1	=	**6.81**	cfs
Q_{10} =	0.34	x	5.94	x	3.73	x	1	=	**7.60**	cfs
Q_{25} =	0.34	x	6.84	x	3.73	x	1.1	=	**9.62**	cfs
Q_{50} =	0.34	x	7.52	x	3.73	x	1.2	=	**11.53**	cfs
Q_{100} =	0.34	x	8.22	x	3.73	x	1.25	=	**13.14**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 120a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Grass				
2	Manning's roughness coeff., n (table 3-1)			**0.150**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.204**	+		=	**0.204**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**460**				
9	Watercourse slope, s		ft/ft	**0.0370**				
10	Average velocity, V (figure 3-1)		ft/s	**3.10**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.041**	+		=	**0.041**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.245**
							min	**14.69**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 120b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**50**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.338**	+		=	**0.338**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)							
8	Flow length, L		ft					
9	Watercourse slope, s		ft/ft					
10	Average velocity, V (figure 3-1)		ft/s					
11	$T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**6**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**2.13**	**0.00**			
13	Wetted perimeter, p_w		ft	**6.62**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.32**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0100**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**1.16**	**#DIV/0!**			
18	Flow length, L		ft	**500**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.119**	+	**0.000**	=	**0.119**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.458**
							min	**27.46**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 120c Checked _____ Date _____

Circle one: Present Developed
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)	----------			Woods				
2 Manning's roughness coeff., n (table 3-1)	----------			**0.800**				
3 Flow length, L (total L < or = 100)	----------		ft	**100**				
4 Two-yr 24-hr rainfall, P_2	----------		in	**3.58**				
5 Land slope, s	----------		ft/ft	**0.0200**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)	----------			unpaved				
8 Flow length, L	----------		ft	**350**				
9 Watercourse slope, s	----------		ft/ft	**0.0486**				
10 Average velocity, V (figure 3-1)	----------		ft/s	**3.56**				
11 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**0.027**	+		=	**0.027**
Channel Flow			Segment ID					
Front Slope, (_ : 1)	----------							
Back Slope, (_ : 1)	----------							
Bottom Width	----------		ft					
Flow Depth	----------		ft					
12 Cross sectional flow area, a	----------		ft^2	**0.00**		**0.00**		
13 Wetted perimeter, p_w	----------		ft	**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	----------	ft	**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s	----------		ft/ft					
16 Manning's roughness coeff., n	----------							
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18 Flow length, L	----------		ft					
19 $T_t = L / (3600\ V)$	Compute T_t	----------	hr	**0.000**	+	**0.000**	=	**0.000**
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------				hr	**0.616**
							min	**36.99**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 120e Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)		Segment ID					
1 Surface Desciption (table 3-1)	----------		Grass				
2 Manning's roughness coeff., n (table 3-1)	----------		**0.150**				
3 Flow length, L (total L < or = 100)	----------	ft	**100**				
4 Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5 Land slope, s	----------	ft/ft	**0.0200**				
6 $T_t = 0.007 (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.154**	+		=	**0.154**

Shallow Concentrated Flow		Segment ID					
7 Surface Desciption (paved or unpaved)	----------		unpaved				
8 Flow length, L	----------	ft	**430**				
9 Watercourse slope, s	----------	ft/ft	**0.0465**				
10 Average velocity, V (figure 3-1)	----------	ft/s	**3.48**				
11 $T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.034**	+		=	**0.034**

Channel Flow		Segment ID					
Front Slope, (_ : 1)	----------						
Back Slope, (_ : 1)	----------						
Bottom Width	----------	ft					
Flow Depth	----------	ft					
12 Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13 Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s	----------	ft/ft					
16 Manning's roughness coeff., n	----------						
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18 Flow length, L	----------	ft					
19 $T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.189**
						min	**11.32**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-120		Outlet	OP	555.77	555.77	0.77	0.00	0.00	37.28	0.00	12.25	0.32	0.00
CB-120e		Other	C.B. TYPE 112	559.17	559.17	3.57	0.36	37.22	37.22	21.85	12.25	0.32	4.62
CB-120d		Other	C.B. TYPE 112	560.03	560.03	3.20	0.04	37.11	37.11	16.03	8.77	0.33	4.63
CB-120c		Other	C.B. TYPE 112	561.04	561.04	3.22	0.34	36.99	36.99	10.02	6.90	0.26	4.64
CB-120b		Other	C.B. TYPE 112	561.41	561.41	2.61	0.32	27.46	27.46	9.34	5.01	0.29	5.42
DN-120a		Other	DUMMY JOINT	567.27	567.27	0.00	0.00	14.69	14.69	4.02	2.25	0.21	7.01

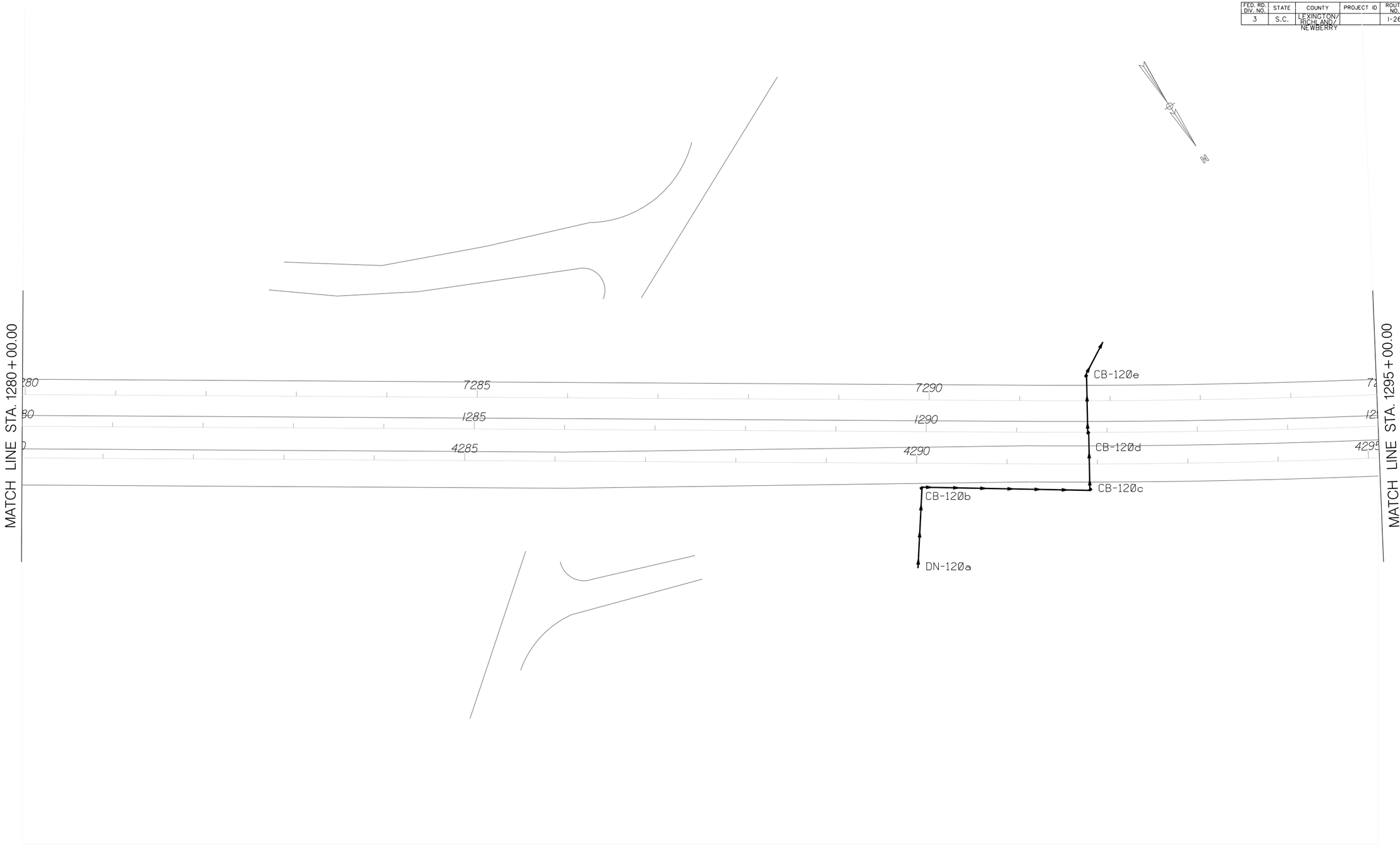
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-89	CB-120e	OF-120	Circular	Concrete	1	2.00	41	1.46	21.85	31.80	1.28	10.29	557.60	557.64	557.00	556.37	555.60	555.00	6.95	9.53	2.00	1.37
NP-88	CB-120d	CB-120e	Circular	Concrete	1	2.00	61	1.57	16.03	33.00	1.03	9.87	558.83	558.34	557.87	556.95	556.83	555.87	6.28	9.29	1.51	1.08
NP-87	CB-120c	CB-120d	Circular	Concrete	1	2.00	61	1.60	10.02	33.36	0.78	8.82	559.82	559.32	558.84	557.65	557.82	556.84	3.96	8.39	1.50	0.81
NP-86	CB-120b	CB-120c	Circular	Concrete	1	1.50	184	0.48	9.34	8.51	1.50	5.42	560.30	560.88	559.41	559.32	558.80	557.91	5.29	5.41	1.50	1.41
NP-85	DN-120a	CB-120b	Circular	Concrete	1	1.50	88	8.71	4.02	36.13	0.35	12.80	568.77	568.41	561.12	559.97	567.27	559.62	2.80	12.74	1.14	0.35

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-120e	11.32	9.62	7.60	0.30	3.48	0.30	3.48	0.00	0.00
CB-120d	5.00	11.75	9.03	0.58	1.87	0.58	1.87	0.00	0.00
CB-120c	36.99	2.03	4.64	0.19	1.89	0.19	1.89	0.00	0.00
CB-120b	27.46	6.24	5.42	0.35	2.76	0.35	2.76	0.00	0.00
DN-120a	14.69	4.02	7.01	0.21	2.25	0.21	2.25	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	53



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

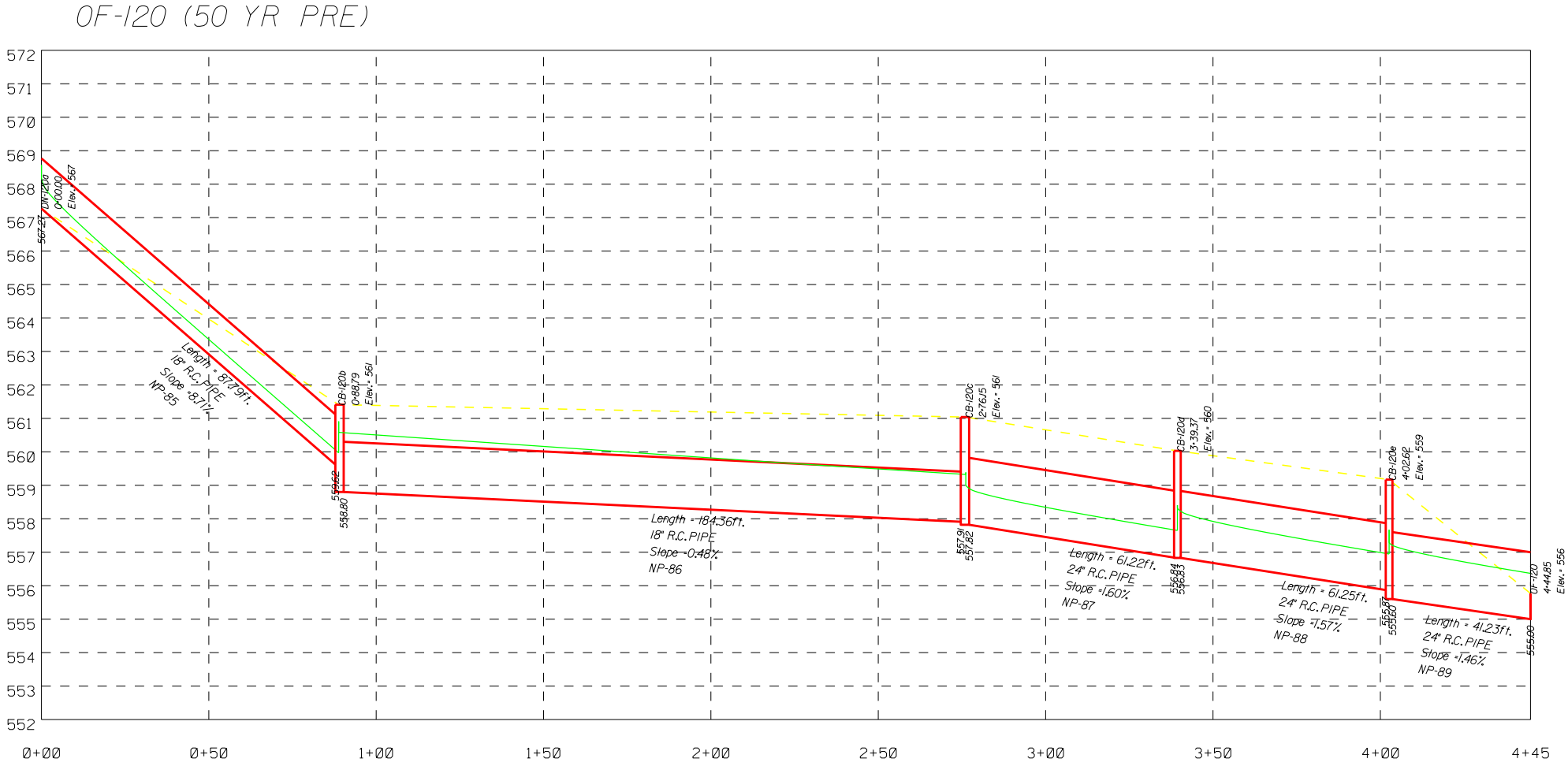
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1280+00.00 TO STA. 1295+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-120 (50 YR PRE)
572
571
570
569
568
567
566
565
564
563
562
561
560
559
558
557
556
555
554
553
552
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+45
DW-120a
0+00.00
Elev.= 567
567.27
Length = 87.79ft.
18" R.C. PIPE
Slope =8.71%
NP-85
CB-120b
0+88.79
Elev.= 561
559.62
558.80
Length = 184.36ft.
18" R.C. PIPE
Slope =0.48%
NP-86
CB-120c
2+76.15
Elev.= 561
557.91
557.82
Length = 61.22ft.
24" R.C. PIPE
Slope =1.60%
NP-87
CB-120d
3+39.37
Elev.= 560
556.84
556.35
Length = 61.25ft.
24" R.C. PIPE
Slope =1.57%
NP-88
CB-120e
4+02.62
Elev.= 559
556.81
555.80
Length = 41.23ft.
24" R.C. PIPE
Slope =1.46%
NP-89
OF-120
4+44.85
Elev.= 556
555.60

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-120	Outlet	OP	555.77	555.77	0.77	0.00	0.00	37.28	0.00	12.16	0.37	0.00
CB-120e	Other	C.B. TYPE 112	559.17	559.17	3.57	0.42	37.21	37.21	24.72	12.16	0.37	4.62
CB-120d	Other	C.B. TYPE 112	560.03	560.03	3.20	0.04	37.10	37.10	17.65	8.43	0.38	4.63
CB-120c	Other	C.B. TYPE 112	561.04	561.04	3.22	0.39	36.99	36.99	11.67	7.23	0.29	4.64
CB-120b	Other	C.B. TYPE 112	561.41	561.41	2.61	0.44	27.46	27.46	10.92	5.28	0.32	5.42
DN-120a	Other	DUMMY JOINT	567.27	567.27	0.00	0.00	14.69	14.69	4.02	2.25	0.21	7.01

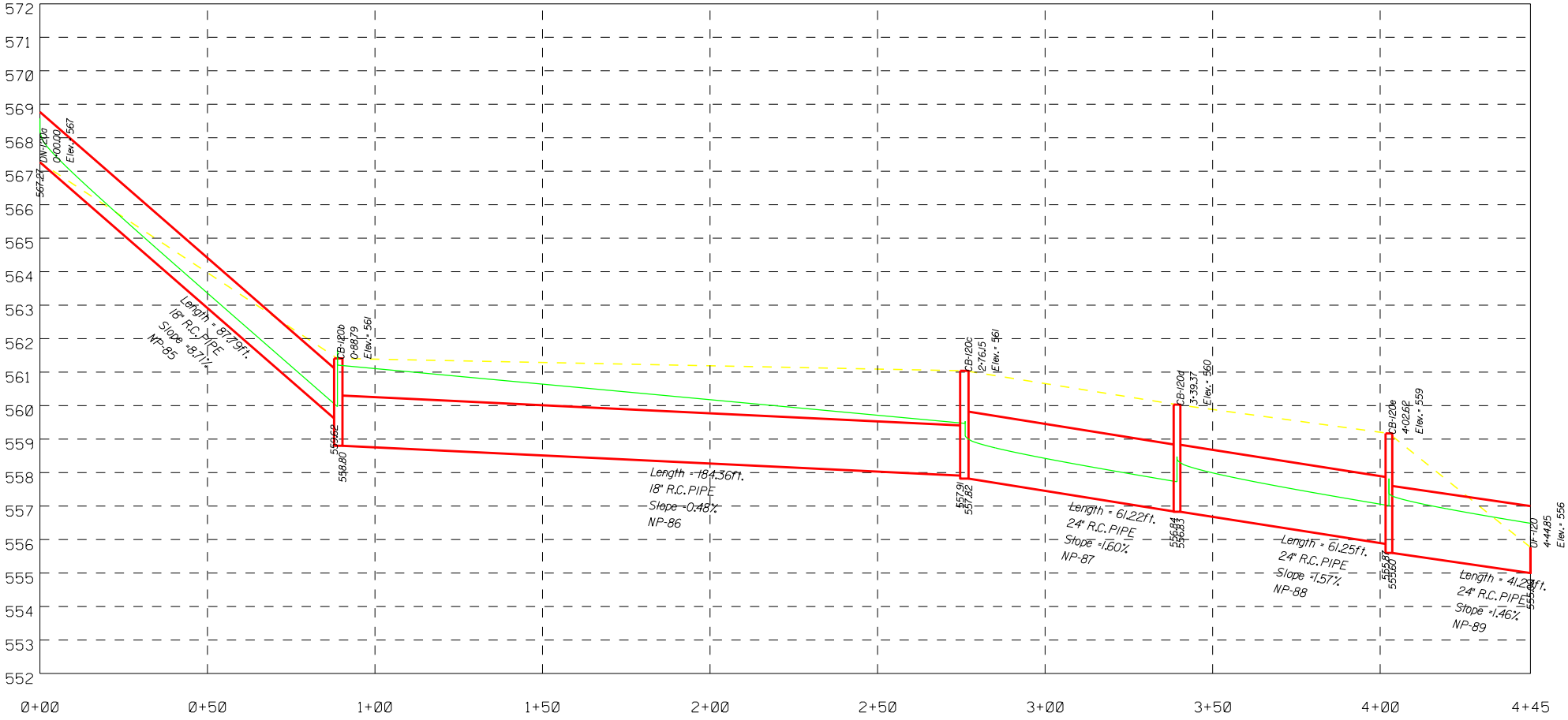
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-89	CB-120e	OF-120	Circular	Concrete	1	2.00	41	1.46	24.72	31.80	1.40	10.52	557.60	557.79	557.00	556.49	555.60	555.00	7.87	9.87	2.00	1.49
NP-88	CB-120d	CB-120e	Circular	Concrete	1	2.00	61	1.57	17.65	33.00	1.09	10.09	558.83	558.42	557.87	557.01	556.83	555.87	6.61	9.50	1.59	1.14
NP-87	CB-120c	CB-120d	Circular	Concrete	1	2.00	61	1.60	11.67	33.36	0.85	9.17	559.82	559.47	558.84	557.73	557.82	556.84	4.21	8.69	1.65	0.89
NP-86	CB-120b	CB-120c	Circular	Concrete	1	1.50	184	0.48	10.92	8.51	1.50	6.34	560.30	561.63	559.41	559.47	558.80	557.91	6.18	6.18	1.50	1.50
NP-85	DN-120a	CB-120b	Circular	Concrete	1	1.50	88	8.71	4.02	36.13	0.35	12.80	568.77	568.41	561.12	559.97	567.27	559.62	2.80	12.74	1.14	0.35

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-120e	11.32	11.67	7.60	0.34	3.73	0.34	3.73	0.00	0.00
CB-120d	5.00	11.70	9.03	0.90	1.20	0.90	1.20	0.00	0.00
CB-120c	36.99	2.33	4.64	0.21	1.95	0.21	1.95	0.00	0.00
CB-120b	27.46	7.82	5.42	0.40	3.03	0.40	3.03	0.00	0.00
DN-120a	14.69	4.02	7.01	0.21	2.25	0.21	2.25	0.00	0.00

OF-120 (50 YR POST)



CULVERT 121

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 121a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.69	0.6209
Grass	0.25	0.27	0.0669
Woods	0.15	0.35	0.0525
	Σ	**1.31**	0.7403

$C_{ave} = \frac{0.7403}{1.31} = 0.57$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.98	0.8794
Grass	0.25	0.27	0.0669
Woods	0.15	0.35	0.0525
	Σ	**1.59**	0.9988

$C_{ave} = \frac{0.9988}{1.59} = 0.63$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.57	x	6.23	x	1.31	x	1	=	**4.61**	cfs
Q_{10} =	0.57	x	6.98	x	1.31	x	1	=	**5.17**	cfs
Q_{25} =	0.57	x	8.08	x	1.31	x	1.1	=	**6.58**	cfs
Q_{50} =	0.57	x	8.93	x	1.31	x	1.2	=	**7.93**	cfs
Q_{100} =	0.57	x	9.81	x	1.31	x	1.25	=	**9.08**	cfs

Post Construction Runoff:

Q_{05} =	0.63	x	6.23	x	1.59	x	1	=	**6.22**	cfs
Q_{10} =	0.63	x	6.98	x	1.59	x	1	=	**6.97**	cfs
Q_{25} =	0.63	x	8.08	x	1.59	x	1.1	=	**8.88**	cfs
Q_{50} =	0.63	x	8.93	x	1.59	x	1.2	=	**10.70**	cfs
Q_{100} =	0.63	x	9.81	x	1.59	x	1.25	=	**12.25**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 121b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.69	0.6249
Grass	0.25	0.57	0.1436
Woods	0.15	0.00	0.0000
	Σ	**1.27**	0.7685

$C_{ave} = \frac{0.7685}{1.27} =$ **0.61**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.98	0.8834
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.98**	0.8834

$C_{ave} = \frac{0.8834}{0.98} =$ **0.90**

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.61	x	6.23	x	1.27	x	1	=	**4.79**	cfs
Q_{10} =	0.61	x	6.98	x	1.27	x	1	=	**5.36**	cfs
Q_{25} =	0.61	x	8.08	x	1.27	x	1.1	=	**6.83**	cfs
Q_{50} =	0.61	x	8.93	x	1.27	x	1.2	=	**8.23**	cfs
Q_{100} =	0.61	x	9.81	x	1.27	x	1.25	=	**9.42**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.98	x	1	=	**5.50**	cfs
Q_{10} =	0.90	x	6.98	x	0.98	x	1	=	**6.16**	cfs
Q_{25} =	0.90	x	8.08	x	0.98	x	1.1	=	**7.85**	cfs
Q_{50} =	0.90	x	8.93	x	0.98	x	1.2	=	**9.46**	cfs
Q_{100} =	0.90	x	9.81	x	0.98	x	1.25	=	**10.83**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-121		Outlet	OP	538.81	538.81	0.00	0.77	0.00	5.35	0.00	2.58	0.58	0.00
CB-121b		Other	C.B. TYPE 112	543.02	543.02	3.05	0.04	5.19	5.19	16.23	2.58	0.58	8.98
CB-121a		Other	C.B. TYPE 112	543.74	543.74	3.12	0.00	5.00	5.00	8.03	1.31	0.57	9.03

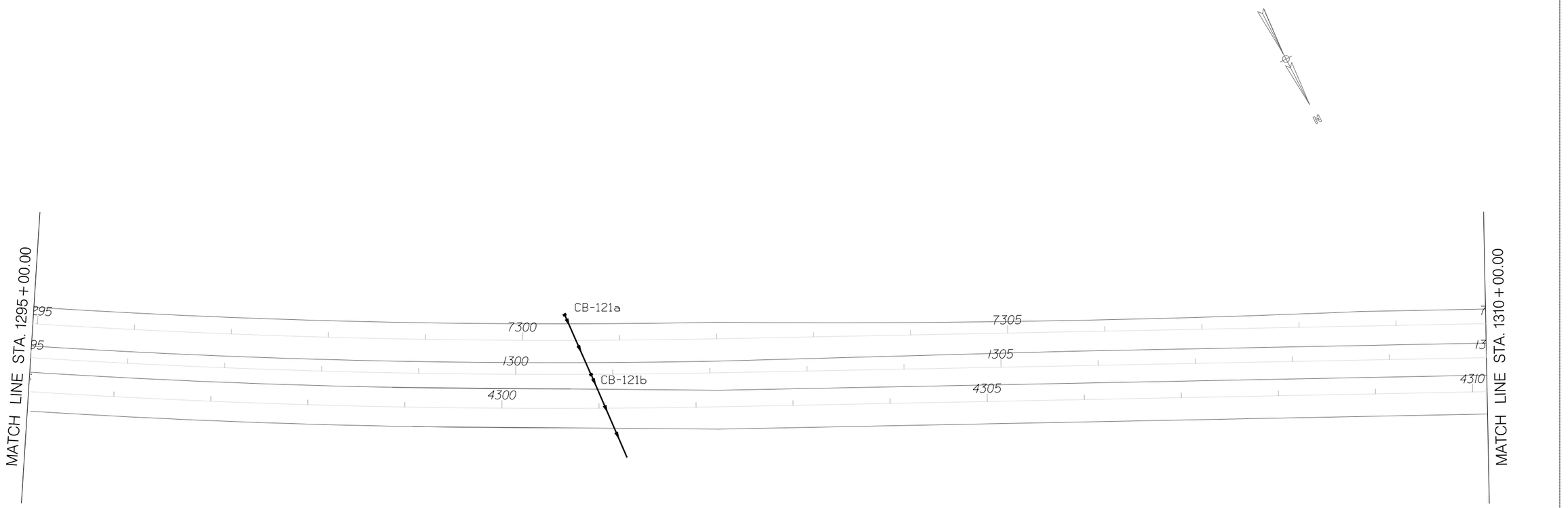
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-58	CB-121b	OF-121	Circular	Concrete	1	1.50	92	1.26	16.23	13.74	1.50	9.42	541.47	542.21	540.31	540.24	539.97	538.81	9.19	9.35	1.50	1.43
NP-57	CB-121a	CB-121b	Circular	Concrete	1	1.50	65	0.66	8.03	9.94	1.08	5.90	542.12	542.55	541.69	542.21	540.62	540.19	4.54	4.54	1.50	1.50

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-121b	5.00	8.30	9.03	0.60	1.27	0.60	1.27	0.00	0.00
CB-121a	5.00	8.03	9.03	0.57	1.31	0.57	1.31	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	54



$$$$$$$$$$filename$$$$$$$$$$
$$$$date$$$$

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

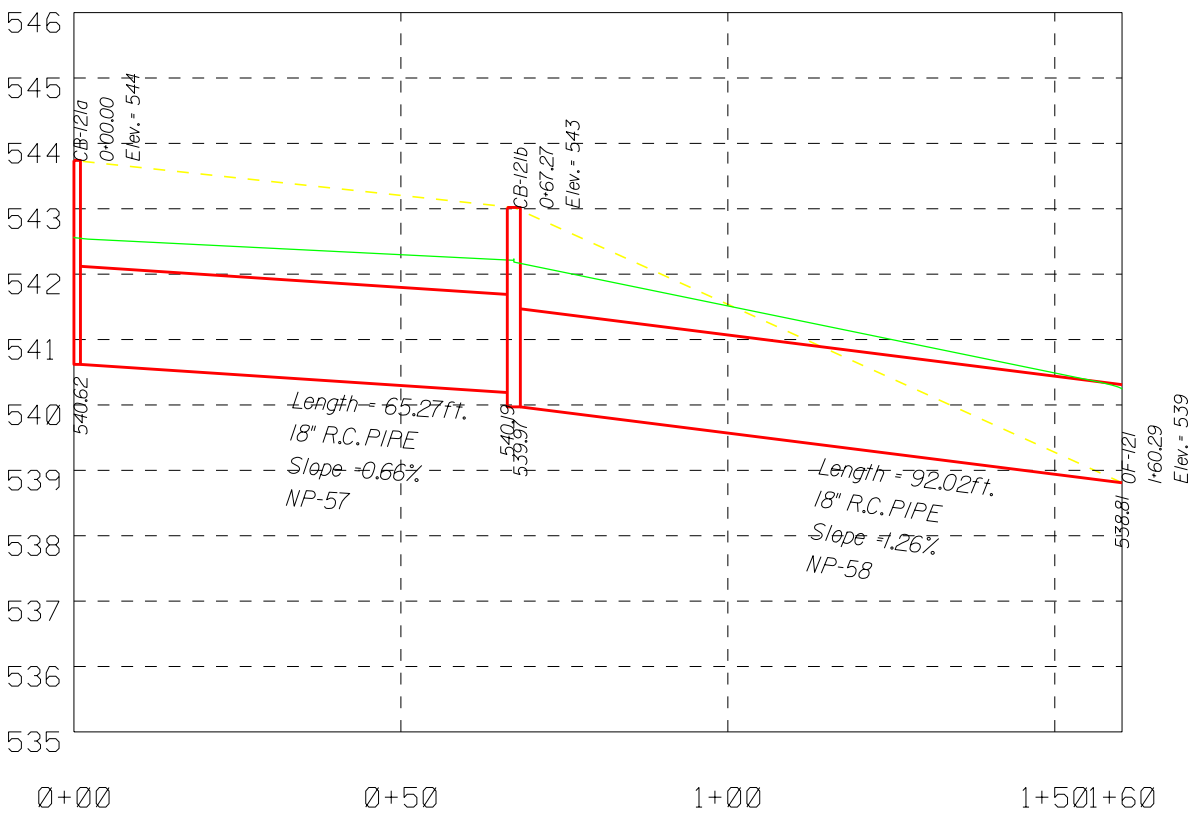
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1295+00.00 TO STA. 1310+00.00

OF-121 (50 YR PRE)



SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

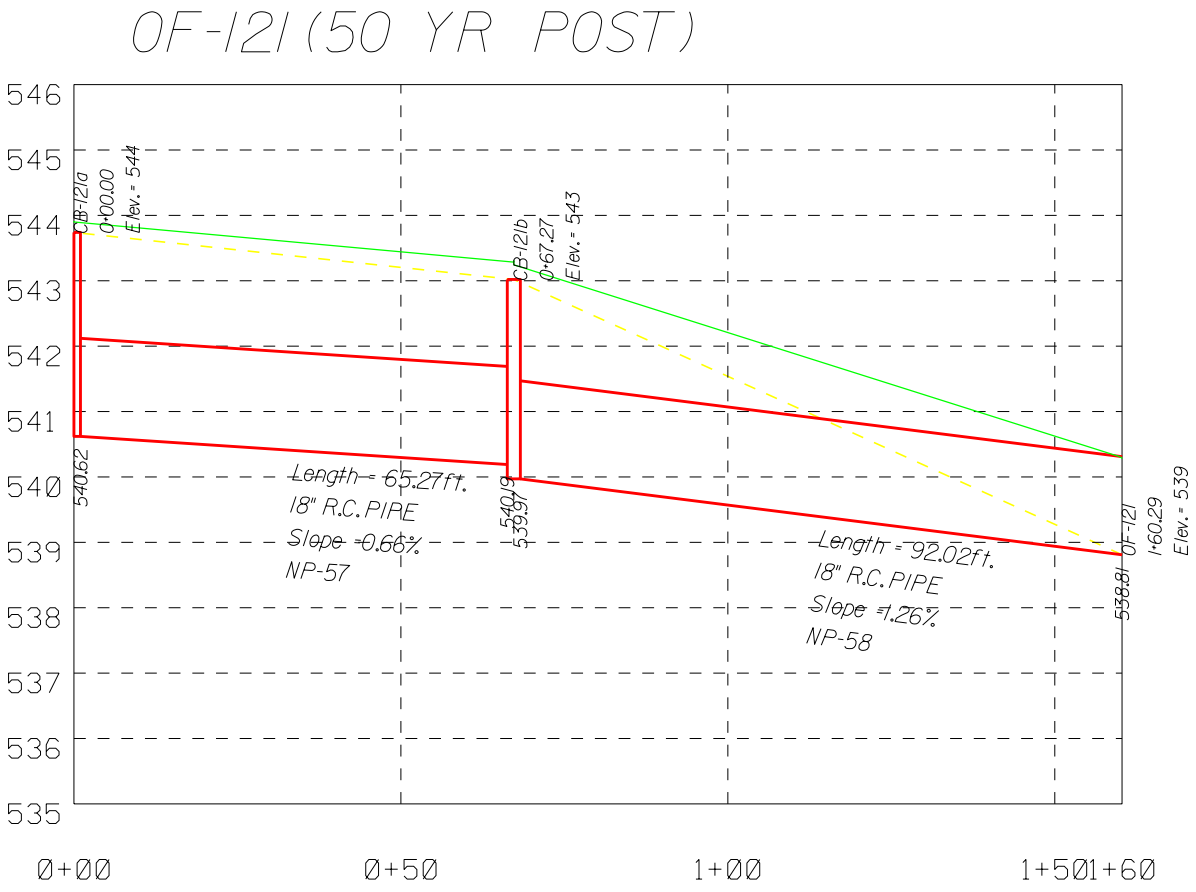
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-121	Outlet	OP	538.81	538.81	0.00	0.77	0.00	5.31	0.00	2.57	0.73	0.00
CB-121b	Other	C.B. TYPE 112	543.02	543.02	3.05	0.05	5.18	5.18	20.20	2.57	0.73	8.98
CB-121a	Other	C.B. TYPE 112	543.74	543.74	3.12	0.00	5.00	5.00	10.76	1.59	0.62	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-58	CB-121b	OF-121	Circular	Concrete	1	1.50	92	1.26	20.20	13.74	1.50	11.73	541.47	543.29	540.31	540.28	539.97	538.81	11.43	11.49	1.50	1.47
NP-57	CB-121a	CB-121b	Circular	Concrete	1	1.50	65	0.66	10.76	9.94	1.50	6.25	542.12	543.89	541.69	543.29	540.62	540.19	6.09	6.09	1.50	1.50

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-121b	5.00	9.55	9.03	0.90	0.98	0.90	0.98	0.00	0.00
CB-121a	5.00	10.76	9.03	0.62	1.59	0.62	1.59	0.00	0.00


OF-121 (50 YR POST)
546
545
544
543
542
541
540
539
538
537
536
535
0+00
0+50
1+00
1+50
1+60
CB-121a
0+00.00
Elev. = 544
CB-121b
0+67.27
Elev. = 543
OF-121
1+60.29
Elev. = 539
540.62
540.19
539.97
538.81
Length = 65.27ft.
18" R.C. PIPE
Slope =0.66%
NP-57
Length = 92.02ft.
18" R.C. PIPE
Slope =1.26%
NP-58

CULVERT 122

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 122**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.94	1.7471
Grass	0.25	2.04	0.5091
Woods	0.15	13.99	2.0982
	Σ	**17.97**	4.3544

$C_{ave} = \frac{4.3544}{17.97} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.81	2.5281
Grass	0.25	1.17	0.2921
Woods	0.15	13.99	2.0982
	Σ	**17.97**	4.9184

$C_{ave} = \frac{4.9184}{17.97} = 0.27$

T_c =	50.03	min.								
I_{05} =	2.81	in / hr								
I_{10} =	3.10	in / hr								
I_{25} =	3.52	in / hr								
I_{50} =	3.84	in / hr								
I_{100} =	4.15	in / hr								

Pre Construction Runoff:

Q_{05} =	0.24	**x**	2.81	**x**	17.97	**x**	1	=	**12.25**	cfs
Q_{10} =	0.24	**x**	3.10	**x**	17.97	**x**	1	=	**13.52**	cfs
Q_{25} =	0.24	**x**	3.52	**x**	17.97	**x**	1.1	=	**16.88**	cfs
Q_{50} =	0.24	**x**	3.84	**x**	17.97	**x**	1.2	=	**20.04**	cfs
Q_{100} =	0.24	**x**	4.15	**x**	17.97	**x**	1.25	=	**22.60**	cfs

Post Construction Runoff:

Q_{05} =	0.27	**x**	2.81	**x**	17.97	**x**	1	=	**13.84**	cfs
Q_{10} =	0.27	**x**	3.10	**x**	17.97	**x**	1	=	**15.27**	cfs
Q_{25} =	0.27	**x**	3.52	**x**	17.97	**x**	1.1	=	**19.07**	cfs
Q_{50} =	0.27	**x**	3.84	**x**	17.97	**x**	1.2	=	**22.64**	cfs
Q_{100} =	0.27	**x**	4.15	**x**	17.97	**x**	1.25	=	**25.52**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 122	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**775**				
9	Watercourse slope, s	----------	ft/ft	**0.0560**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.82**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.056**	+		=	**0.056**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.834**
							min	**50.03**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 16.88 cfs

Design Flow: 20.04 cfs

Maximum Flow: 22.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1305+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
521.89	16.88	16.88	0.00	1
521.95	17.45	17.45	0.00	1
522.02	18.02	18.02	0.00	1
522.08	18.60	18.60	0.00	1
522.15	19.17	19.17	0.00	1
522.22	19.74	19.74	0.00	1
522.26	20.04	20.04	0.00	1
522.37	20.88	20.88	0.00	1
522.45	21.46	21.46	0.00	1
522.52	22.03	22.03	0.00	1
522.61	22.60	22.60	0.00	1
527.00	42.85	42.85	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
16.88	16.88	521.89	2.262	0.0*	5-S2n	0.803	1.479	0.803	0.980	13.832	4.353
17.45	17.45	521.95	2.324	0.0*	5-S2n	0.818	1.504	0.818	0.996	13.957	4.391
18.02	18.02	522.02	2.388	0.0*	5-S2n	0.833	1.527	0.833	1.012	14.068	4.429
18.60	18.60	522.08	2.454	0.0*	5-S2n	0.847	1.550	0.895	1.027	13.213	4.465
19.17	19.17	522.15	2.522	0.0*	5-S2n	0.862	1.573	0.900	1.042	13.510	4.501
19.74	19.74	522.22	2.592	0.0*	5-S2n	0.877	1.595	0.905	1.057	13.818	4.537
20.04	20.04	522.26	2.630	0.0*	5-S2n	0.884	1.606	0.908	1.065	13.979	4.555
20.88	20.88	522.37	2.739	0.0*	5-S2n	0.905	1.636	0.905	1.087	14.622	4.604
21.46	21.46	522.45	2.816	0.0*	5-S2n	0.919	1.656	0.919	1.101	14.724	4.637
22.03	22.03	522.52	2.895	0.0*	5-S2n	0.933	1.675	0.933	1.115	14.819	4.669
22.60	22.60	522.61	2.976	0.0*	5-S2n	0.947	1.693	0.947	1.129	14.917	4.700

* Full Flow Headwater elevation is below inlet invert.

****

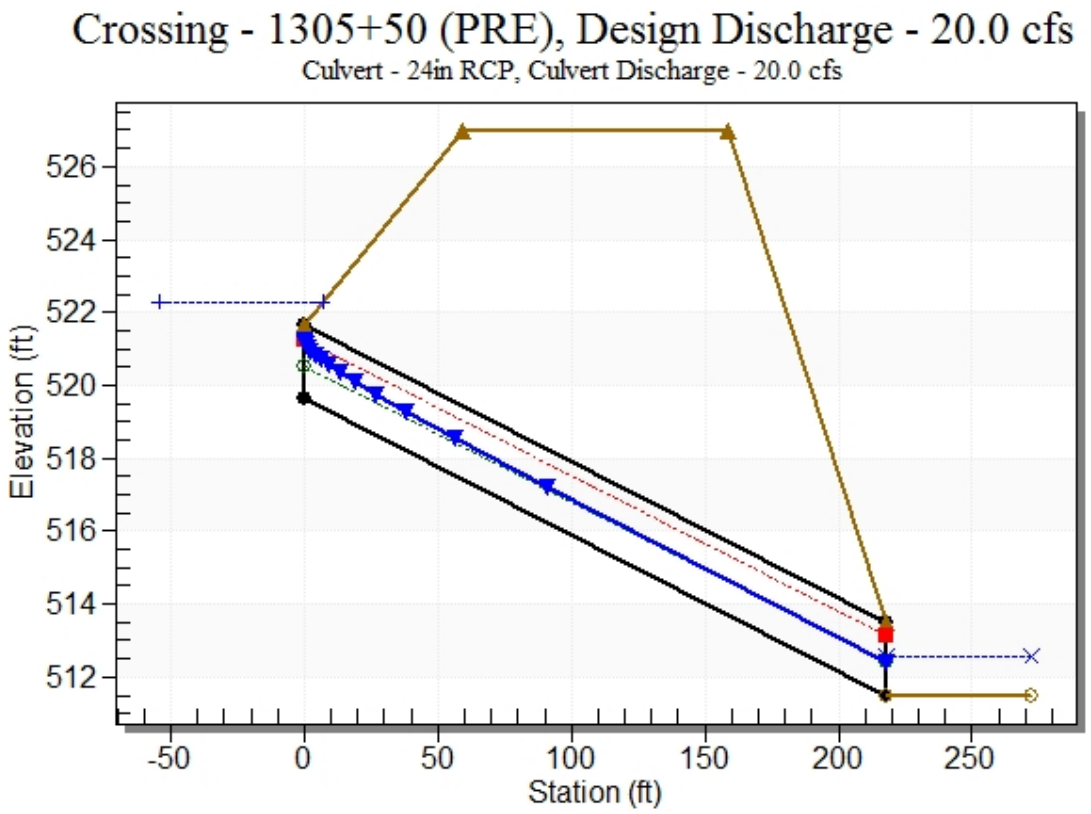
Straight Culvert

Inlet Elevation (invert): 519.63 ft, Outlet Elevation (invert): 511.50 ft

Culvert Length: 218.15 ft, Culvert Slope: 0.0373

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 519.63 ft

Outlet Station: 218.00 ft

Outlet Elevation: 511.50 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1305+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
16.88	512.48	0.98	4.35	3.67	0.95
17.45	512.50	1.00	4.39	3.73	0.95
18.02	512.51	1.01	4.43	3.79	0.95
18.60	512.53	1.03	4.47	3.85	0.95
19.17	512.54	1.04	4.50	3.90	0.95
19.74	512.56	1.06	4.54	3.96	0.96
20.04	512.57	1.07	4.55	3.99	0.96
20.88	512.59	1.09	4.60	4.07	0.96
21.46	512.60	1.10	4.64	4.12	0.96
22.03	512.62	1.12	4.67	4.18	0.96
22.60	512.63	1.13	4.70	4.23	0.96

Tailwater Channel Data - 1305+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 511.50 ft

Roadway Data for Crossing: 1305+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 527.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 19.07 cfs

Design Flow: 22.64 cfs

Maximum Flow: 25.52 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1305+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
522.14	19.07	19.07	0.00	1
522.22	19.72	19.72	0.00	1
522.30	20.36	20.36	0.00	1
522.39	21.00	21.00	0.00	1
522.47	21.65	21.65	0.00	1
522.56	22.30	22.30	0.00	1
522.61	22.64	22.64	0.00	1
522.75	23.59	23.59	0.00	1
522.85	24.23	24.23	0.00	1
522.95	24.88	24.88	0.00	1
523.06	25.52	25.52	0.00	1
527.00	42.85	42.85	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
19.07	19.07	522.14	2.511	0.0*	5-S2n	0.860	1.569	0.900	1.040	13.457	4.495
19.72	19.72	522.22	2.589	0.0*	5-S2n	0.876	1.594	0.905	1.057	13.805	4.535
20.36	20.36	522.30	2.671	0.0*	5-S2n	0.892	1.617	0.892	1.073	14.525	4.574
21.00	21.00	522.39	2.755	0.0*	5-S2n	0.908	1.640	0.908	1.090	14.644	4.612
21.65	21.65	522.47	2.842	0.0*	5-S2n	0.924	1.662	0.924	1.106	14.752	4.648
22.30	22.30	522.56	2.932	0.0*	5-S2n	0.940	1.683	0.940	1.122	14.865	4.683
22.64	22.64	522.61	2.982	0.0*	5-S2n	0.948	1.694	0.948	1.130	14.924	4.703
23.59	23.59	522.75	3.121	0.0*	5-S2n	0.971	1.723	0.971	1.153	15.078	4.753
24.23	24.23	522.85	3.221	0.0*	5-S2n	0.987	1.741	1.040	1.168	14.200	4.787
24.88	24.88	522.95	3.323	0.0*	5-S2n	1.002	1.758	1.056	1.182	14.310	4.820
25.52	25.52	523.06	3.428	0.0*	5-S2n	1.018	1.774	1.072	1.197	14.410	4.852

* Full Flow Headwater elevation is below inlet invert.

****

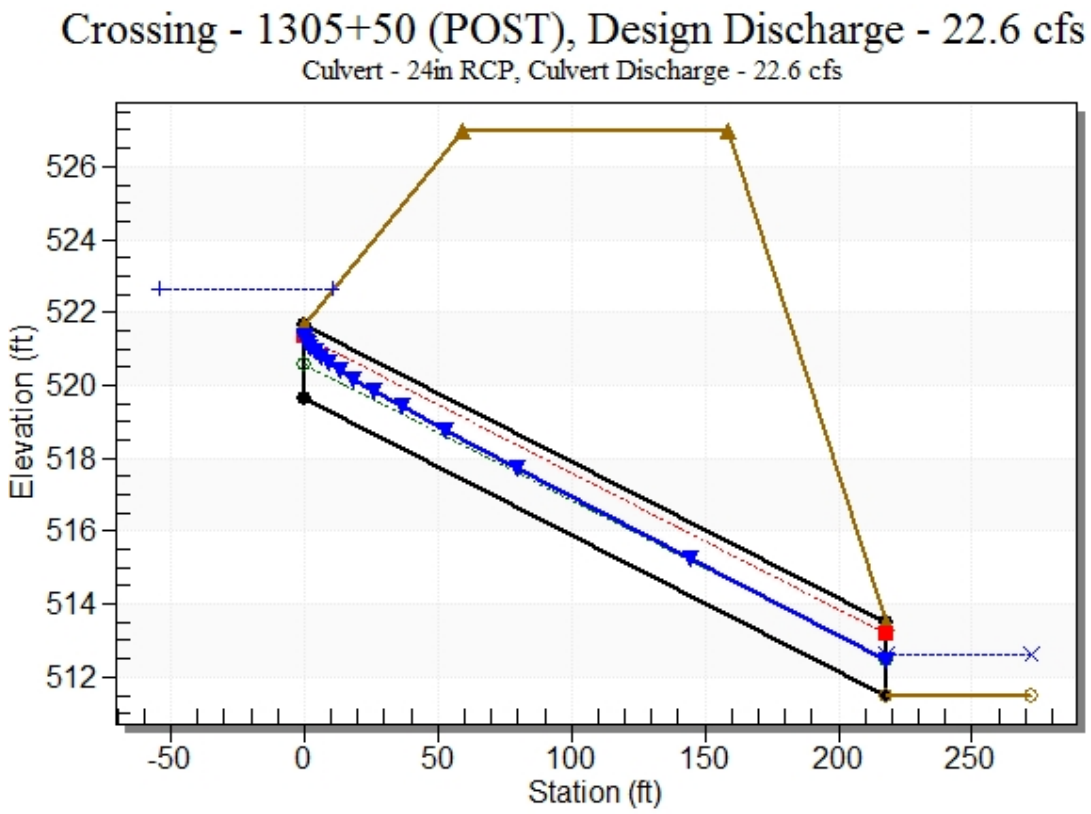
Straight Culvert

Inlet Elevation (invert): 519.63 ft, Outlet Elevation (invert): 511.50 ft

Culvert Length: 218.15 ft, Culvert Slope: 0.0373

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 519.63 ft

Outlet Station: 218.00 ft

Outlet Elevation: 511.50 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1305+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
19.07	512.54	1.04	4.49	3.89	0.95
19.72	512.56	1.06	4.54	3.96	0.96
20.36	512.57	1.07	4.57	4.02	0.96
21.00	512.59	1.09	4.61	4.08	0.96
21.65	512.61	1.11	4.65	4.14	0.96
22.30	512.62	1.12	4.68	4.20	0.96
22.64	512.63	1.13	4.70	4.23	0.96
23.59	512.65	1.15	4.75	4.32	0.97
24.23	512.67	1.17	4.79	4.37	0.97
24.88	512.68	1.18	4.82	4.43	0.97
25.52	512.70	1.20	4.85	4.48	0.97

Tailwater Channel Data - 1305+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 511.50 ft

Roadway Data for Crossing: 1305+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 527.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 123

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 123**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	7.14	6.4226
Grass	0.25	9.83	2.4566
Woods	0.15	60.37	9.0559
	Σ	**77.34**	17.9351

$C_{ave} = \frac{17.9351}{77.34} = 0.23$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	9.26	8.3348
Grass	0.25	7.70	1.9254
Woods	0.15	60.37	9.0559
	Σ	**77.34**	19.3161

$C_{ave} = \frac{19.3161}{77.34} = 0.25$

T_c =	48.31	min.								
I_{05} =	2.87	in / hr								
I_{10} =	3.17	in / hr								
I_{25} =	3.60	in / hr								
I_{50} =	3.92	in / hr								
I_{100} =	4.24	in / hr								

Pre Construction Runoff:

Q_{05} =	0.23	x	2.87	x	77.34	x	1	=	**51.54**	cfs
Q_{10} =	0.23	x	3.17	x	77.34	x	1	=	**56.89**	cfs
Q_{25} =	0.23	x	3.60	x	77.34	x	1.1	=	**71.06**	cfs
Q_{50} =	0.23	x	3.92	x	77.34	x	1.2	=	**84.37**	cfs
Q_{100} =	0.23	x	4.24	x	77.34	x	1.25	=	**95.16**	cfs

Post Construction Runoff:

Q_{05} =	0.25	x	2.87	x	77.34	x	1	=	**55.51**	cfs
Q_{10} =	0.25	x	3.17	x	77.34	x	1	=	**61.28**	cfs
Q_{25} =	0.25	x	3.60	x	77.34	x	1.1	=	**76.53**	cfs
Q_{50} =	0.25	x	3.92	x	77.34	x	1.2	=	**90.87**	cfs
Q_{100} =	0.25	x	4.24	x	77.34	x	1.25	=	**102.49**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 123	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**2100**				
9	Watercourse slope, s		ft/ft	**0.0280**				
10	Average velocity, V (figure 3-1)		ft/s	**2.70**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.216**	+		=	**0.216**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.805**
							min	**48.31**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 71.06 cfs

Design Flow: 84.37 cfs

Maximum Flow: 95.16 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1311+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
489.06	71.06	71.06	0.00	1
489.14	73.47	73.47	0.00	1
489.22	75.88	75.88	0.00	1
489.30	78.29	78.29	0.00	1
489.38	80.70	80.70	0.00	1
489.47	83.11	83.11	0.00	1
489.51	84.37	84.37	0.00	1
489.63	87.93	87.93	0.00	1
489.72	90.34	90.34	0.00	1
489.81	92.75	92.75	0.00	1
489.90	95.16	95.16	0.00	1
505.00	284.61	284.61	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
71.06	71.06	489.06	3.722	0.885	1-S2n	1.720	2.544	1.821	1.767	12.335	5.338
73.47	73.47	489.14	3.801	1.000	1-S2n	1.753	2.588	1.856	1.797	12.448	5.385
75.88	75.88	489.22	3.881	1.120	1-S2n	1.785	2.634	1.888	1.826	12.576	5.432
78.29	78.29	489.30	3.961	1.239	1-S2n	1.818	2.677	1.925	1.854	12.660	5.478
80.70	80.70	489.38	4.043	1.359	5-S2n	1.850	2.719	1.962	1.882	12.735	5.521
83.11	83.11	489.47	4.126	1.480	5-S2n	1.881	2.760	1.998	1.910	12.817	5.565
84.37	84.37	489.51	4.169	1.545	5-S2n	1.898	2.781	2.016	1.924	12.862	5.587
87.93	87.93	489.63	4.295	1.728	5-S2n	1.945	2.839	2.067	1.964	12.990	5.649
90.34	90.34	489.72	4.382	1.855	5-S2n	1.976	2.878	2.101	1.990	13.077	5.689
92.75	92.75	489.81	4.470	1.983	5-S2n	2.007	2.916	2.135	2.016	13.165	5.729
95.16	95.16	489.90	4.561	2.113	5-S2n	2.038	2.953	2.168	2.041	13.250	5.768

****

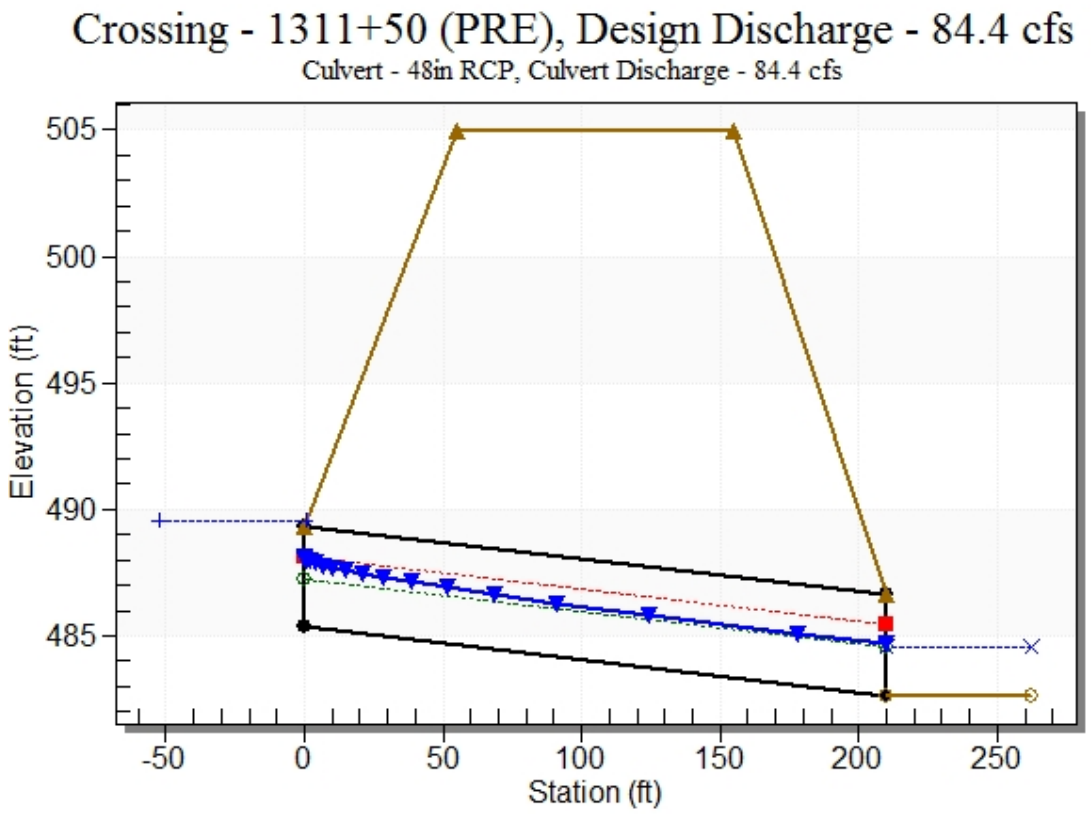
Straight Culvert

Inlet Elevation (invert): 485.34 ft, Outlet Elevation (invert): 482.65 ft

Culvert Length: 210.02 ft, Culvert Slope: 0.0128

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 485.34 ft

Outlet Station: 210.00 ft

Outlet Elevation: 482.65 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1311+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
71.06	484.42	1.77	5.34	4.41	0.86
73.47	484.45	1.80	5.39	4.48	0.86
75.88	484.48	1.83	5.43	4.56	0.86
78.29	484.50	1.85	5.48	4.63	0.86
80.70	484.53	1.88	5.52	4.70	0.86
83.11	484.56	1.91	5.57	4.77	0.87
84.37	484.57	1.92	5.59	4.80	0.87
87.93	484.61	1.96	5.65	4.90	0.87
90.34	484.64	1.99	5.69	4.97	0.87
92.75	484.67	2.02	5.73	5.03	0.87
95.16	484.69	2.04	5.77	5.09	0.87

Tailwater Channel Data - 1311+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 482.65 ft

Roadway Data for Crossing: 1311+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 505.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 76.53 cfs

Design Flow: 90.87 cfs

Maximum Flow: 102.49 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1311+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
489.24	76.53	76.53	0.00	1
489.33	79.13	79.13	0.00	1
489.42	81.72	81.72	0.00	1
489.51	84.32	84.32	0.00	1
489.60	86.91	86.91	0.00	1
489.69	89.51	89.51	0.00	1
489.74	90.87	90.87	0.00	1
489.88	94.70	94.70	0.00	1
489.98	97.30	97.30	0.00	1
490.08	99.89	99.89	0.00	1
490.19	102.49	102.49	0.00	1
505.00	284.61	284.61	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
76.53	76.53	489.24	3.902	1.152	1-S2n	1.794	2.646	1.897	1.833	12.607	5.444
79.13	79.13	489.33	3.990	1.280	1-S2n	1.829	2.691	1.938	1.864	12.685	5.493
81.72	81.72	489.42	4.078	1.410	5-S2n	1.863	2.736	1.977	1.894	12.769	5.540
84.32	84.32	489.51	4.168	1.542	5-S2n	1.897	2.780	2.015	1.924	12.860	5.586
86.91	86.91	489.60	4.259	1.676	5-S2n	1.931	2.823	2.053	1.952	12.953	5.631
89.51	89.51	489.69	4.352	1.811	5-S2n	1.965	2.865	2.089	1.981	13.047	5.675
90.87	90.87	489.74	4.401	1.883	5-S2n	1.983	2.887	2.108	1.996	13.097	5.698
94.70	94.70	489.88	4.543	2.088	5-S2n	2.032	2.946	2.162	2.036	13.234	5.761
97.30	97.30	489.98	4.642	2.229	5-S2n	2.066	2.986	2.198	2.063	13.323	5.802
99.89	99.89	490.08	4.744	2.860	5-S2n	2.099	3.025	2.233	2.090	13.413	5.842
102.49	102.49	490.19	4.847	2.987	5-S2n	2.132	3.062	2.269	2.116	13.497	5.882

****

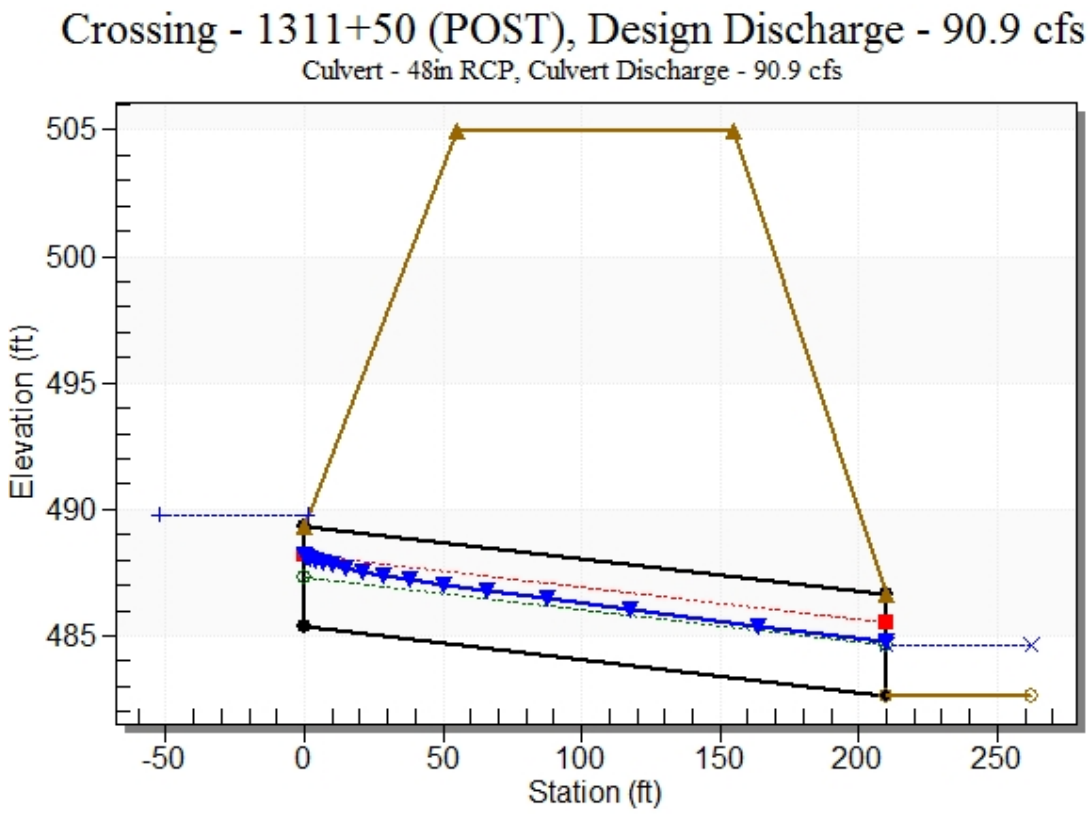
Straight Culvert

Inlet Elevation (invert): 485.34 ft, Outlet Elevation (invert): 482.65 ft

Culvert Length: 210.02 ft, Culvert Slope: 0.0128

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 485.34 ft

Outlet Station: 210.00 ft

Outlet Elevation: 482.65 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1311+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
76.53	484.48	1.83	5.44	4.58	0.86
79.13	484.51	1.86	5.49	4.65	0.86
81.72	484.54	1.89	5.54	4.73	0.86
84.32	484.57	1.92	5.59	4.80	0.87
86.91	484.60	1.95	5.63	4.87	0.87
89.51	484.63	1.98	5.68	4.94	0.87
90.87	484.65	2.00	5.70	4.98	0.87
94.70	484.69	2.04	5.76	5.08	0.87
97.30	484.71	2.06	5.80	5.15	0.87
99.89	484.74	2.09	5.84	5.22	0.88
102.49	484.77	2.12	5.88	5.28	0.88

Tailwater Channel Data - 1311+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 482.65 ft

Roadway Data for Crossing: 1311+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 505.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 124

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 124**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.64	0.5797
Grass	0.25	0.45	0.1117
Woods	0.15	0.85	0.1274
	Σ	**1.94**	0.8188

$C_{ave} = \frac{0.8188}{1.94} = 0.42$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.77	0.6932
Grass	0.25	0.18	0.0452
Woods	0.15	0.85	0.1274
	Σ	**1.80**	0.8658

$C_{ave} = \frac{0.8658}{1.80} = 0.48$

T_c =	38.01	min.
I_{05} =	3.30	in / hr
I_{10} =	3.65	in / hr
I_{25} =	4.15	in / hr
I_{50} =	4.52	in / hr
I_{100} =	4.90	in / hr

Pre Construction Runoff:

Q_{05} =	0.42	x	3.30	x	1.94	x	1	=	**2.70**	cfs
Q_{10} =	0.42	x	3.65	x	1.94	x	1	=	**2.99**	cfs
Q_{25} =	0.42	x	4.15	x	1.94	x	1.1	=	**3.74**	cfs
Q_{50} =	0.42	x	4.52	x	1.94	x	1.2	=	**4.44**	cfs
Q_{100} =	0.42	x	4.90	x	1.94	x	1.25	=	**5.02**	cfs

Post Construction Runoff:

Q_{05} =	0.48	x	3.30	x	1.80	x	1	=	**2.86**	cfs
Q_{10} =	0.48	x	3.65	x	1.80	x	1	=	**3.16**	cfs
Q_{25} =	0.48	x	4.15	x	1.80	x	1.1	=	**3.95**	cfs
Q_{50} =	0.48	x	4.52	x	1.80	x	1.2	=	**4.70**	cfs
Q_{100} =	0.48	x	4.90	x	1.80	x	1.25	=	**5.31**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 124	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**180**				
9	Watercourse slope, s		ft/ft	**0.2100**				
10	Average velocity, V (figure 3-1)		ft/s	**7.39**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.007**	+		=	**0.007**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**			
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0150**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**1.48**	**#DIV/0!**			
18	Flow length, L		ft	**200**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.038**	+	**0.000**	=	**0.038**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.633**
							min	**38.01**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.74 cfs

Design Flow: 4.44 cfs

Maximum Flow: 5.02 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1316+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
493.16	3.74	3.74	0.00	1
493.18	3.87	3.87	0.00	1
493.21	4.00	4.00	0.00	1
493.23	4.12	4.12	0.00	1
493.25	4.25	4.25	0.00	1
493.27	4.38	4.38	0.00	1
493.28	4.44	4.44	0.00	1
493.32	4.64	4.64	0.00	1
493.34	4.76	4.76	0.00	1
493.36	4.89	4.89	0.00	1
493.38	5.02	5.02	0.00	1
495.08	12.17	12.17	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.74	3.74	493.16	1.082	0.0*	1-S2n	0.620	0.739	0.638	0.416	5.047	3.175
3.87	3.87	493.18	1.105	0.0*	1-S2n	0.631	0.752	0.651	0.424	5.085	3.207
4.00	4.00	493.21	1.127	0.027	1-S2n	0.643	0.765	0.664	0.431	5.125	3.238
4.12	4.12	493.23	1.149	0.058	1-S2n	0.655	0.777	0.655	0.439	5.385	3.267
4.25	4.25	493.25	1.171	0.089	1-S2n	0.666	0.789	0.666	0.446	5.425	3.297
4.38	4.38	493.27	1.192	0.120	1-S2n	0.677	0.801	0.677	0.453	5.468	3.325
4.44	4.44	493.28	1.202	0.135	1-S2n	0.683	0.807	0.683	0.457	5.487	3.339
4.64	4.64	493.32	1.235	0.184	1-S2n	0.700	0.824	0.700	0.467	5.549	3.381
4.76	4.76	493.34	1.256	0.216	1-S2n	0.711	0.835	0.711	0.474	5.586	3.408
4.89	4.89	493.36	1.277	0.249	1-S2n	0.722	0.846	0.722	0.481	5.623	3.434
5.02	5.02	493.38	1.298	0.283	1-S2n	0.733	0.857	0.733	0.488	5.660	3.459

* Full Flow Headwater elevation is below inlet invert.

****

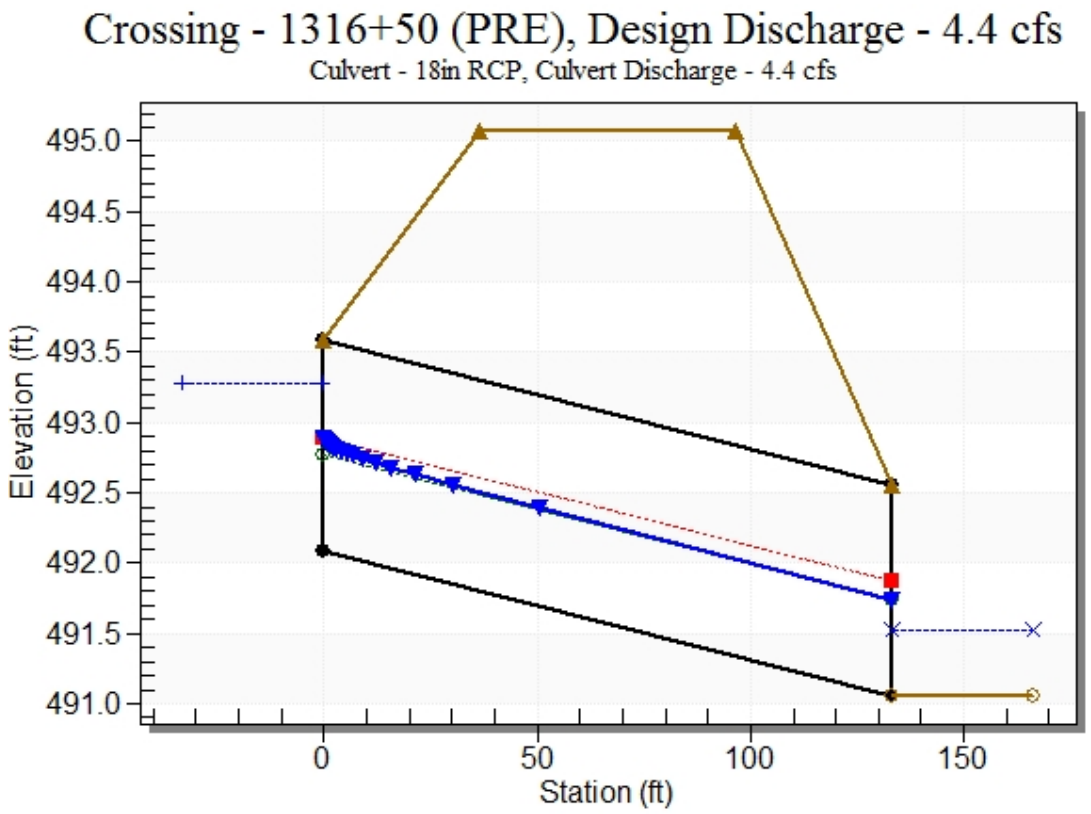
Straight Culvert

Inlet Elevation (invert): 492.08 ft, Outlet Elevation (invert): 491.06 ft

Culvert Length: 133.00 ft, Culvert Slope: 0.0077

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 492.08 ft

Outlet Station: 133.00 ft

Outlet Elevation: 491.06 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1316+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.74	491.48	0.42	3.18	2.08	0.99
3.87	491.48	0.42	3.21	2.11	0.99
4.00	491.49	0.43	3.24	2.15	0.99
4.12	491.50	0.44	3.27	2.19	0.99
4.25	491.51	0.45	3.30	2.23	1.00
4.38	491.51	0.45	3.33	2.26	1.00
4.44	491.52	0.46	3.34	2.28	1.00
4.64	491.53	0.47	3.38	2.33	1.00
4.76	491.53	0.47	3.41	2.37	1.00
4.89	491.54	0.48	3.43	2.40	1.00
5.02	491.55	0.49	3.46	2.43	1.01

Tailwater Channel Data - 1316+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 491.06 ft

Roadway Data for Crossing: 1316+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 495.08 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.95 cfs

Design Flow: 4.7 cfs

Maximum Flow: 5.31 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1316+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
493.20	3.95	3.95	0.00	1
493.22	4.09	4.09	0.00	1
493.25	4.22	4.22	0.00	1
493.27	4.36	4.36	0.00	1
493.29	4.49	4.49	0.00	1
493.31	4.63	4.63	0.00	1
493.33	4.70	4.70	0.00	1
493.36	4.90	4.90	0.00	1
493.38	5.04	5.04	0.00	1
493.40	5.17	5.17	0.00	1
493.43	5.31	5.31	0.00	1
495.08	12.18	12.18	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.95	3.95	493.20	1.119	0.0*	1-S2n	0.639	0.760	0.659	0.429	5.109	3.226
4.09	4.09	493.22	1.143	0.048	1-S2n	0.651	0.773	0.651	0.436	5.371	3.258
4.22	4.22	493.25	1.166	0.081	1-S2n	0.663	0.786	0.663	0.444	5.420	3.290
4.36	4.36	493.27	1.189	0.115	1-S2n	0.675	0.799	0.675	0.452	5.461	3.321
4.49	4.49	493.29	1.212	0.148	1-S2n	0.687	0.812	0.687	0.460	5.504	3.350
4.63	4.63	493.31	1.234	0.182	1-S2n	0.699	0.824	0.699	0.467	5.547	3.380
4.70	4.70	493.33	1.246	0.200	1-S2n	0.705	0.830	0.705	0.471	5.566	3.394
4.90	4.90	493.36	1.279	0.252	1-S2n	0.723	0.847	0.723	0.481	5.626	3.436
5.04	5.04	493.38	1.301	0.287	1-S2n	0.735	0.859	0.735	0.489	5.665	3.463
5.17	5.17	493.40	1.324	0.323	1-S2n	0.746	0.870	0.746	0.496	5.702	3.490
5.31	5.31	493.43	1.346	0.363	1-S2n	0.758	0.885	0.758	0.503	5.738	3.516

* Full Flow Headwater elevation is below inlet invert.

****

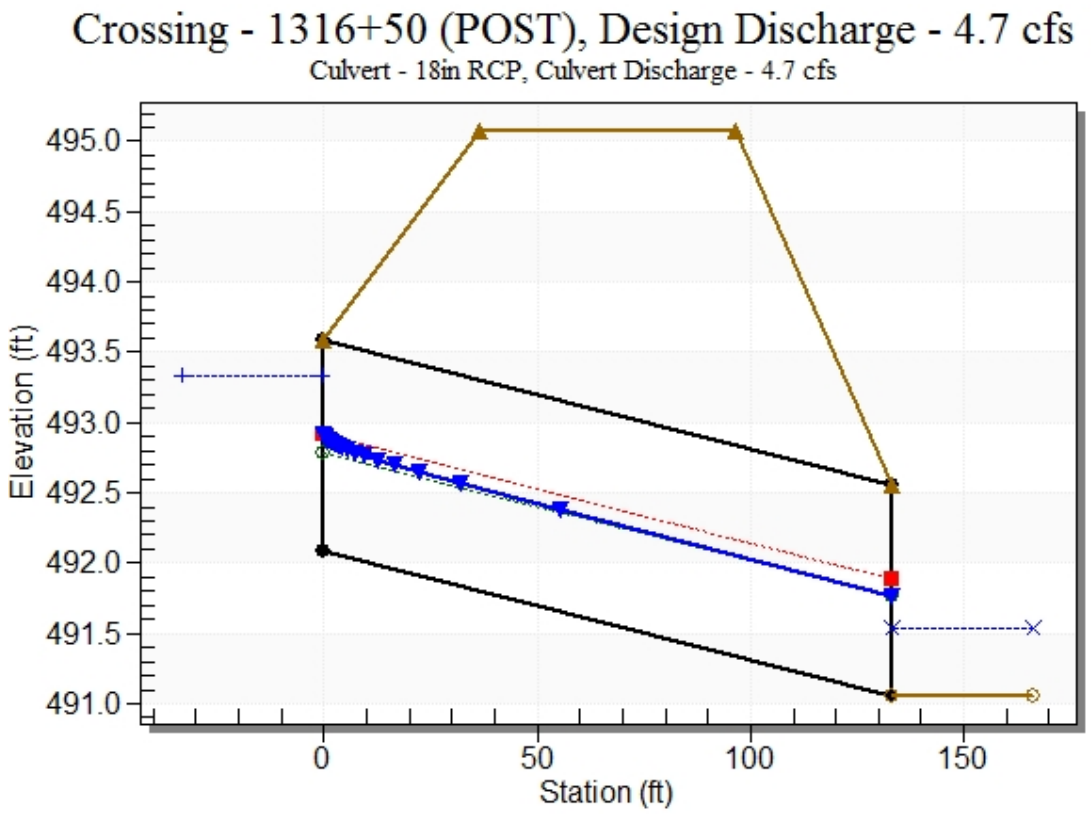
Straight Culvert

Inlet Elevation (invert): 492.08 ft, Outlet Elevation (invert): 491.06 ft

Culvert Length: 133.00 ft, Culvert Slope: 0.0077

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 492.08 ft

Outlet Station: 133.00 ft

Outlet Elevation: 491.06 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1316+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.95	491.49	0.43	3.23	2.14	0.99
4.09	491.50	0.44	3.26	2.18	0.99
4.22	491.50	0.44	3.29	2.22	0.99
4.36	491.51	0.45	3.32	2.26	1.00
4.49	491.52	0.46	3.35	2.29	1.00
4.63	491.53	0.47	3.38	2.33	1.00
4.70	491.53	0.47	3.39	2.35	1.00
4.90	491.54	0.48	3.44	2.40	1.00
5.04	491.55	0.49	3.46	2.44	1.01
5.17	491.56	0.50	3.49	2.47	1.01
5.31	491.56	0.50	3.52	2.51	1.01

Tailwater Channel Data - 1316+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 491.06 ft

Roadway Data for Crossing: 1316+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 495.08 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

CULVERT 125

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 125**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.21	1.9860
Grass	0.25	6.49	1.6234
Woods	0.15	36.73	5.5101
	Σ	**45.43**	9.1195

$C_{ave} = \frac{9.1195}{45.43} = 0.20$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.34	2.1030
Grass	0.25	6.49	1.6234
Woods	0.15	36.73	5.5101
	Σ	**45.56**	9.2365

$C_{ave} = \frac{9.2365}{45.56} = 0.20$

T_c =	43.02	min.								
I_{05} =	3.08	in / hr								
I_{10} =	3.40	in / hr								
I_{25} =	3.86	in / hr								
I_{50} =	4.21	in / hr								
I_{100} =	4.56	in / hr								

Pre Construction Runoff:

Q_{05} =	0.20	**x**	3.08	**x**	45.43	**x**	1	=	**28.06**	cfs
Q_{10} =	0.20	**x**	3.40	**x**	45.43	**x**	1	=	**31.00**	cfs
Q_{25} =	0.20	**x**	3.86	**x**	45.43	**x**	1.1	=	**38.75**	cfs
Q_{50} =	0.20	**x**	4.21	**x**	45.43	**x**	1.2	=	**46.05**	cfs
Q_{100} =	0.20	**x**	4.56	**x**	45.43	**x**	1.25	=	**51.96**	cfs

Post Construction Runoff:

Q_{05} =	0.20	**x**	3.08	**x**	45.56	**x**	1	=	**28.42**	cfs
Q_{10} =	0.20	**x**	3.40	**x**	45.56	**x**	1	=	**31.40**	cfs
Q_{25} =	0.20	**x**	3.86	**x**	45.56	**x**	1.1	=	**39.25**	cfs
Q_{50} =	0.20	**x**	4.21	**x**	45.56	**x**	1.2	=	**46.64**	cfs
Q_{100} =	0.20	**x**	4.56	**x**	45.56	**x**	1.25	=	**52.63**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 125	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**2546**				
9	Watercourse slope, s		ft/ft	**0.0450**				
10	Average velocity, V (figure 3-1)		ft/s	**3.42**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.207**	+		=	**0.207**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**			
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0150**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**1.48**	**#DIV/0!**			
18	Flow length, L		ft	**340**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.064**	+	**0.000**	=	**0.064**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.717**
							min	**43.02**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 38.75 cfs

Design Flow: 46.05 cfs

Maximum Flow: 51.96 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1319+75 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
465.35	38.75	38.75	0.00	1
465.40	40.07	40.07	0.00	1
465.45	41.39	41.39	0.00	1
465.50	42.71	42.71	0.00	1
465.55	44.03	44.03	0.00	1
465.60	45.36	45.36	0.00	1
465.62	46.05	46.05	0.00	1
465.69	48.00	48.00	0.00	1
465.74	49.32	49.32	0.00	1
465.78	50.64	50.64	0.00	1
465.83	51.96	51.96	0.00	1
492.00	354.72	354.72	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.75	38.75	465.35	2.529	0.0*	1-S2n	0.856	1.857	0.856	1.398	18.971	4.078
40.07	40.07	465.40	2.580	0.0*	1-S2n	0.871	1.890	0.911	1.422	17.942	4.115
41.39	41.39	465.45	2.630	0.0*	1-S2n	0.885	1.922	0.885	1.446	19.285	4.152
42.71	42.71	465.50	2.680	0.0*	1-S2n	0.899	1.954	0.951	1.470	17.998	4.188
44.03	44.03	465.55	2.729	0.0*	1-S2n	0.914	1.985	0.956	1.493	18.426	4.223
45.36	45.36	465.60	2.777	0.0*	1-S2n	0.928	2.015	0.928	1.515	19.789	4.257
46.05	46.05	465.62	2.802	0.0*	1-S2n	0.935	2.031	0.935	1.527	19.890	4.274
48.00	48.00	465.69	2.871	0.0*	1-S2n	0.954	2.075	1.003	1.559	18.743	4.323
49.32	49.32	465.74	2.918	0.0*	1-S2n	0.967	2.103	1.005	1.581	19.209	4.355
50.64	50.64	465.78	2.963	0.0*	1-S2n	0.980	2.132	0.980	1.602	20.442	4.386
51.96	51.96	465.83	3.009	0.0*	1-S2n	0.993	2.159	1.048	1.623	19.097	4.417

* Full Flow Headwater elevation is below inlet invert.

****

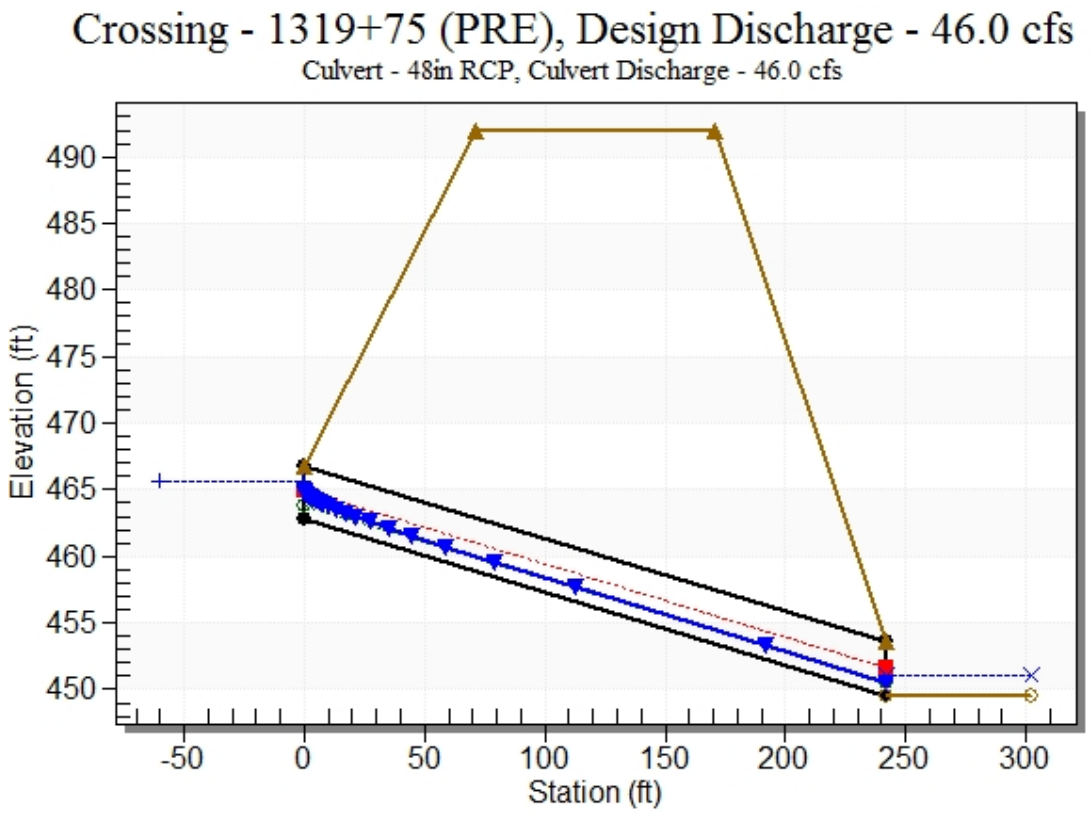
Straight Culvert

Inlet Elevation (invert): 462.82 ft, Outlet Elevation (invert): 449.57 ft

Culvert Length: 242.36 ft, Culvert Slope: 0.0548

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 462.82 ft

Outlet Station: 242.00 ft

Outlet Elevation: 449.57 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1319+75 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
38.75	450.97	1.40	4.08	2.62	0.72
40.07	450.99	1.42	4.12	2.66	0.72
41.39	451.02	1.45	4.15	2.71	0.72
42.71	451.04	1.47	4.19	2.75	0.73
44.03	451.06	1.49	4.22	2.79	0.73
45.36	451.09	1.52	4.26	2.84	0.73
46.05	451.10	1.53	4.27	2.86	0.73
48.00	451.13	1.56	4.32	2.92	0.73
49.32	451.15	1.58	4.36	2.96	0.73
50.64	451.17	1.60	4.39	3.00	0.73
51.96	451.19	1.62	4.42	3.04	0.74

Tailwater Channel Data - 1319+75 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 449.57 ft

Roadway Data for Crossing: 1319+75 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 492.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 39.25 cfs

Design Flow: 46.64 cfs

Maximum Flow: 52.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1319+75 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	48in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
465.37	39.25	39.25	0.00	1
465.42	40.59	40.59	0.00	1
465.47	41.93	41.93	0.00	1
465.52	43.26	43.26	0.00	1
465.57	44.60	44.60	0.00	1
465.62	45.94	45.94	0.00	1
465.64	46.64	46.64	0.00	1
465.71	48.62	48.62	0.00	1
465.76	49.95	49.95	0.00	1
465.81	51.29	51.29	0.00	1
465.85	52.63	52.63	0.00	1
492.00	354.72	354.72	0.00	Overtopping

Table 2 - Culvert Summary Table: 48in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
39.25	39.25	465.37	2.548	0.0*	1-S2n	0.862	1.869	0.911	1.407	17.567	4.092
40.59	40.59	465.42	2.600	0.0*	1-S2n	0.876	1.903	0.908	1.432	18.236	4.130
41.93	41.93	465.47	2.650	0.0*	1-S2n	0.891	1.935	0.891	1.456	19.355	4.167
43.26	43.26	465.52	2.700	0.0*	1-S2n	0.905	1.967	0.955	1.479	18.143	4.203
44.60	44.60	465.57	2.750	0.0*	1-S2n	0.920	1.998	0.956	1.503	18.683	4.238
45.94	45.94	465.62	2.798	0.0*	1-S2n	0.933	2.029	0.933	1.525	19.874	4.272
46.64	46.64	465.64	2.823	0.0*	1-S2n	0.940	2.044	0.994	1.537	18.461	4.290
48.62	48.62	465.71	2.893	0.0*	1-S2n	0.960	2.088	1.005	1.570	18.943	4.338
49.95	49.95	465.76	2.940	0.0*	1-S2n	0.973	2.117	0.973	1.591	20.418	4.370
51.29	51.29	465.81	2.986	0.0*	1-S2n	0.986	2.145	1.042	1.613	19.010	4.401
52.63	52.63	465.85	3.032	0.0*	1-S2n	0.999	2.173	1.053	1.634	19.230	4.432

* Full Flow Headwater elevation is below inlet invert.

****

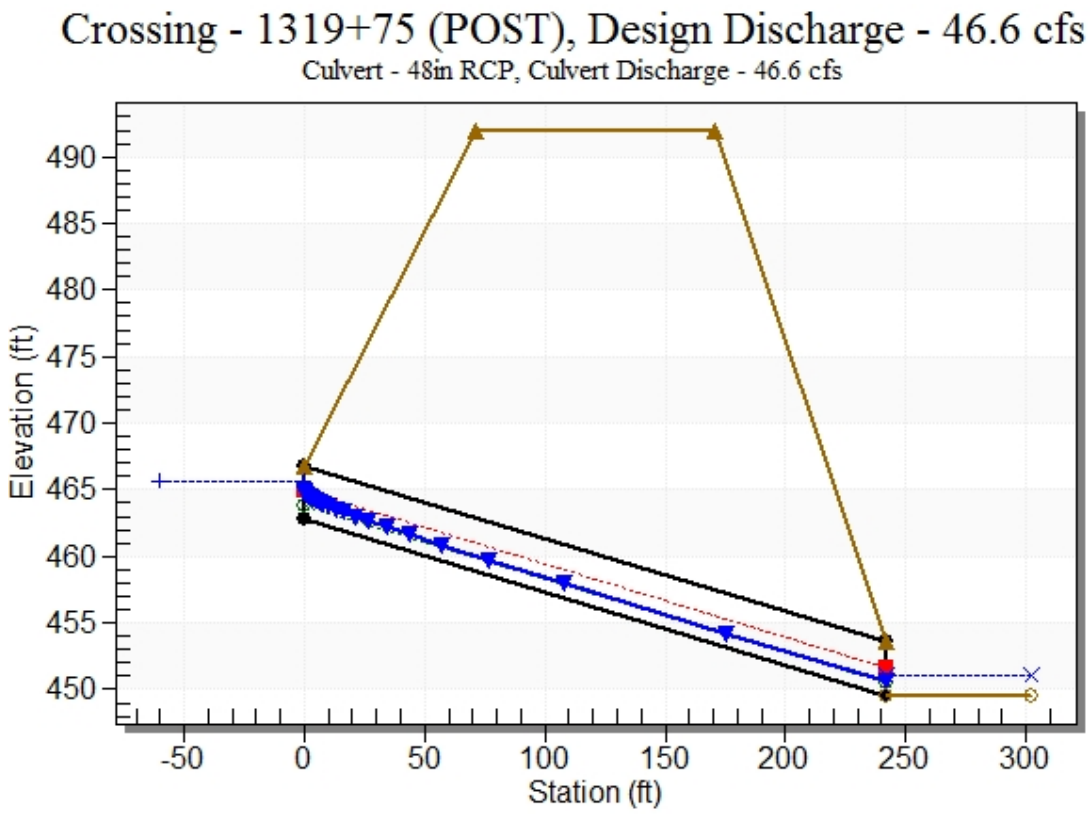
Straight Culvert

Inlet Elevation (invert): 462.82 ft, Outlet Elevation (invert): 449.57 ft

Culvert Length: 242.36 ft, Culvert Slope: 0.0548

****

Water Surface Profile Plot for Culvert: 48in RCP



Site Data - 48in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 462.82 ft

Outlet Station: 242.00 ft

Outlet Elevation: 449.57 ft

Number of Barrels: 1

Culvert Data Summary - 48in RCP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1319+75 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
39.25	450.98	1.41	4.09	2.63	0.72
40.59	451.00	1.43	4.13	2.68	0.72
41.93	451.03	1.46	4.17	2.73	0.73
43.26	451.05	1.48	4.20	2.77	0.73
44.60	451.07	1.50	4.24	2.81	0.73
45.94	451.10	1.53	4.27	2.86	0.73
46.64	451.11	1.54	4.29	2.88	0.73
48.62	451.14	1.57	4.34	2.94	0.73
49.95	451.16	1.59	4.37	2.98	0.73
51.29	451.18	1.61	4.40	3.02	0.73
52.63	451.20	1.63	4.43	3.06	0.74

Tailwater Channel Data - 1319+75 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 449.57 ft

Roadway Data for Crossing: 1319+75 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 492.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 126

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 126**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.38	0.3387
Grass	0.25	0.25	0.0620
Woods	0.15	0.00	0.0000
	Σ	**0.62**	0.4006

$C_{ave} = \frac{0.4006}{0.62} = 0.64$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3313
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.37**	0.3313

$C_{ave} = \frac{0.3313}{0.37} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.64	**x**	6.23	**x**	0.62	**x**	1	=	**2.50**	cfs
Q_{10} =	0.64	**x**	6.98	**x**	0.62	**x**	1	=	**2.80**	cfs
Q_{25} =	0.64	**x**	8.08	**x**	0.62	**x**	1.1	=	**3.56**	cfs
Q_{50} =	0.64	**x**	8.93	**x**	0.62	**x**	1.2	=	**4.29**	cfs
Q_{100} =	0.64	**x**	9.81	**x**	0.62	**x**	1.25	=	**4.91**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.37	**x**	1	=	**2.06**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.37	**x**	1	=	**2.31**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.37	**x**	1.1	=	**2.95**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.37	**x**	1.2	=	**3.55**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.37	**x**	1.25	=	**4.06**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.56 cfs

Design Flow: 4.29 cfs

Maximum Flow: 4.91 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1321+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
487.29	3.56	3.56	0.00	1
487.32	3.70	3.70	0.00	1
487.35	3.83	3.83	0.00	1
487.38	3.96	3.96	0.00	1
487.41	4.10	4.10	0.00	1
487.44	4.24	4.24	0.00	1
487.45	4.29	4.29	0.00	1
487.50	4.50	4.50	0.00	1
487.53	4.64	4.64	0.00	1
487.57	4.78	4.78	0.00	1
487.60	4.91	4.91	0.00	1
488.57	7.85	7.85	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.56	3.56	487.29	1.017	0.0*	1-S2n	0.264	0.759	0.260	0.405	18.719	3.129
3.70	3.70	487.32	1.047	0.0*	1-S2n	0.269	0.773	0.269	0.413	18.635	3.164
3.83	3.83	487.35	1.076	0.0*	1-S2n	0.274	0.787	0.274	0.421	18.870	3.198
3.96	3.96	487.38	1.106	0.0*	1-S2n	0.279	0.801	0.279	0.429	18.824	3.230
4.10	4.10	487.41	1.136	0.0*	1-S2n	0.283	0.815	0.283	0.437	19.017	3.262
4.24	4.24	487.44	1.167	0.0*	1-S2n	0.288	0.828	0.319	0.445	16.588	3.293
4.29	4.29	487.45	1.180	0.0*	1-S2n	0.290	0.837	0.290	0.448	19.291	3.306
4.50	4.50	487.50	1.230	0.0*	1-S2n	0.297	0.858	0.297	0.460	19.627	3.353
4.64	4.64	487.53	1.263	0.0*	5-S2n	0.301	0.871	0.301	0.467	19.828	3.382
4.78	4.78	487.57	1.296	0.0*	5-S2n	0.306	0.883	0.306	0.475	20.021	3.410
4.91	4.91	487.60	1.330	0.0*	5-S2n	0.310	0.895	0.310	0.482	19.994	3.438

* Full Flow Headwater elevation is below inlet invert.

****

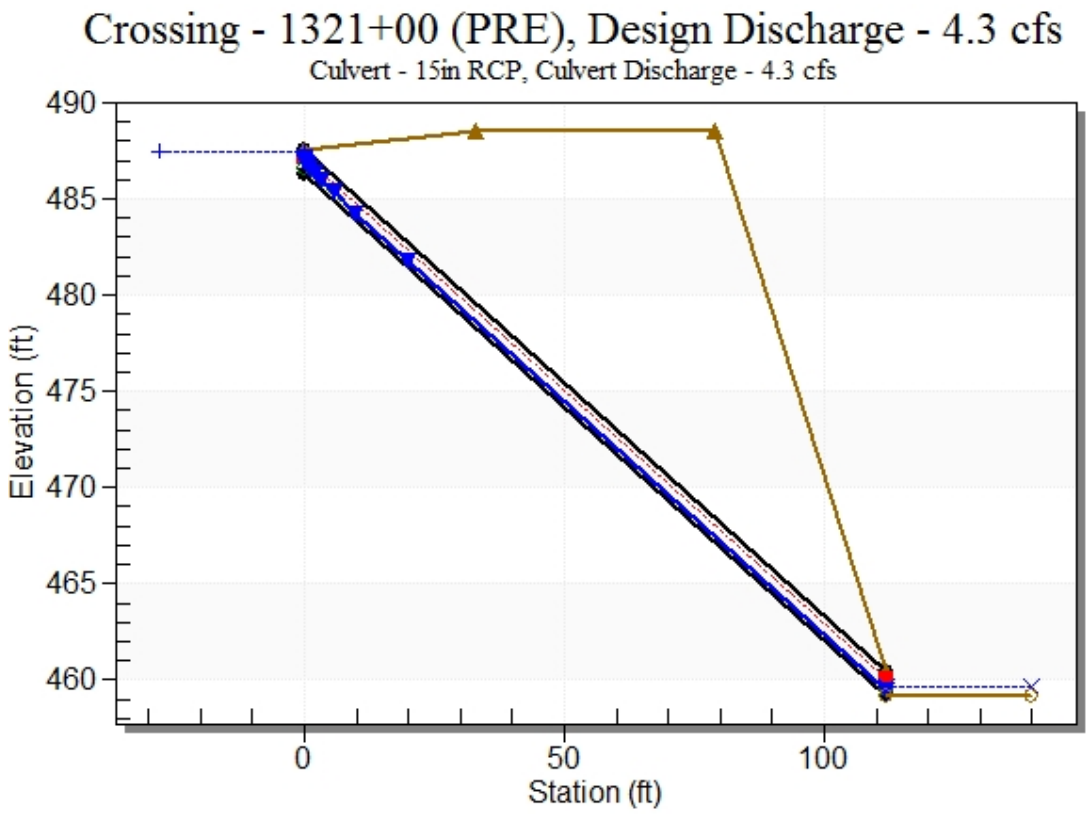
Straight Culvert

Inlet Elevation (invert): 486.27 ft, Outlet Elevation (invert): 459.21 ft

Culvert Length: 115.22 ft, Culvert Slope: 0.2416

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 486.27 ft

Outlet Station: 112.00 ft

Outlet Elevation: 459.21 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1321+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.56	459.61	0.40	3.13	2.02	0.98
3.70	459.62	0.41	3.16	2.06	0.99
3.83	459.63	0.42	3.20	2.10	0.99
3.96	459.64	0.43	3.23	2.14	0.99
4.10	459.65	0.44	3.26	2.18	0.99
4.24	459.65	0.44	3.29	2.22	0.99
4.29	459.66	0.45	3.31	2.24	1.00
4.50	459.67	0.46	3.35	2.30	1.00
4.64	459.68	0.47	3.38	2.33	1.00
4.78	459.68	0.47	3.41	2.37	1.00
4.91	459.69	0.48	3.44	2.41	1.00

Tailwater Channel Data - 1321+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 459.21 ft

Roadway Data for Crossing: 1321+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 488.57 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.95 cfs

Design Flow: 3.55 cfs

Maximum Flow: 4.06 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1321+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
487.16	2.95	2.95	0.00	1
487.18	3.06	3.06	0.00	1
487.20	3.17	3.17	0.00	1
487.23	3.28	3.28	0.00	1
487.25	3.39	3.39	0.00	1
487.28	3.50	3.50	0.00	1
487.29	3.55	3.55	0.00	1
487.32	3.73	3.73	0.00	1
487.35	3.84	3.84	0.00	1
487.37	3.95	3.95	0.00	1
487.40	4.06	4.06	0.00	1
488.57	7.85	7.85	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.95	2.95	487.16	0.885	0.0*	1-S2n	0.240	0.688	0.240	0.365	17.593	2.958
3.06	3.06	487.18	0.910	0.0*	1-S2n	0.245	0.701	0.245	0.373	17.486	2.992
3.17	3.17	487.20	0.934	0.0*	1-S2n	0.249	0.713	0.249	0.380	17.683	3.023
3.28	3.28	487.23	0.958	0.0*	1-S2n	0.254	0.725	0.254	0.387	17.871	3.055
3.39	3.39	487.25	0.981	0.0*	1-S2n	0.258	0.737	0.258	0.394	18.069	3.085
3.50	3.50	487.28	1.005	0.0*	1-S2n	0.262	0.753	0.283	0.401	16.284	3.115
3.55	3.55	487.29	1.015	0.0*	1-S2n	0.264	0.758	0.265	0.404	18.279	3.126
3.73	3.73	487.32	1.054	0.0*	1-S2n	0.270	0.777	0.270	0.415	18.692	3.172
3.84	3.84	487.35	1.078	0.0*	1-S2n	0.274	0.788	0.274	0.422	18.884	3.200
3.95	3.95	487.37	1.103	0.0*	1-S2n	0.278	0.799	0.278	0.428	18.800	3.226
4.06	4.06	487.40	1.127	0.0*	1-S2n	0.282	0.811	0.282	0.435	18.961	3.252

* Full Flow Headwater elevation is below inlet invert.

****

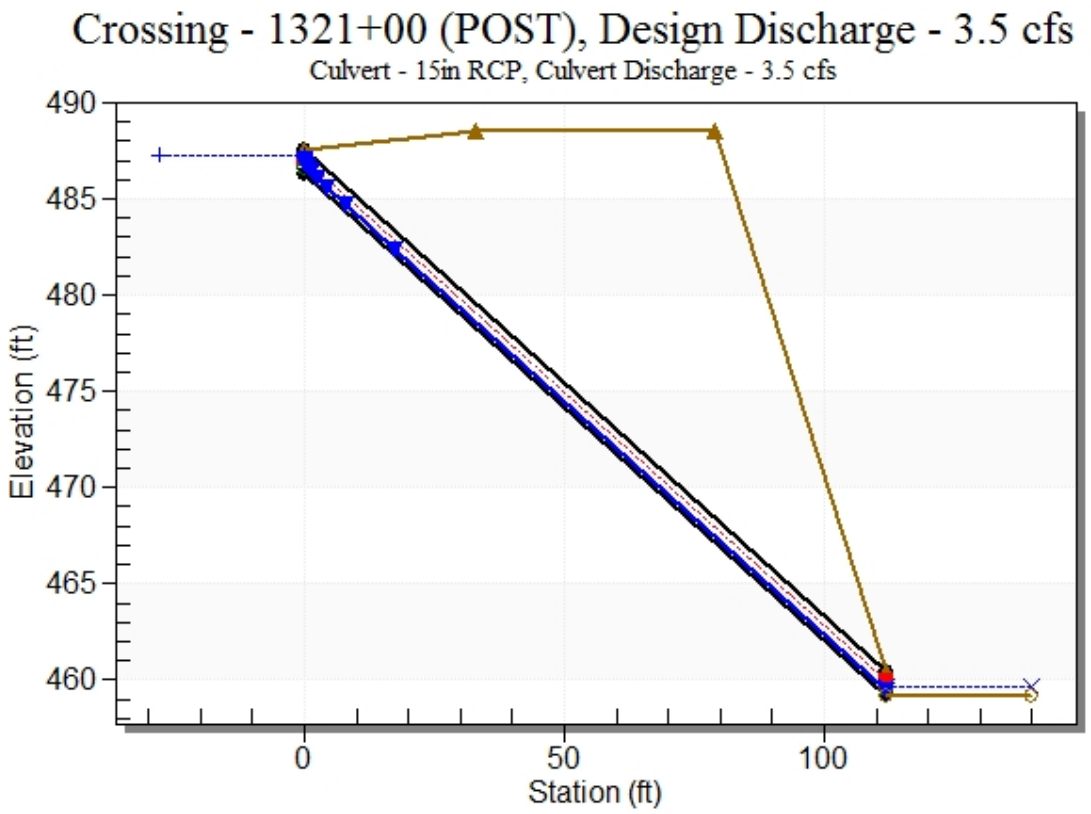
Straight Culvert

Inlet Elevation (invert): 486.27 ft, Outlet Elevation (invert): 459.21 ft

Culvert Length: 115.22 ft, Culvert Slope: 0.2416

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 486.27 ft

Outlet Station: 112.00 ft

Outlet Elevation: 459.21 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1321+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.95	459.58	0.37	2.96	1.82	0.97
3.06	459.58	0.37	2.99	1.86	0.97
3.17	459.59	0.38	3.02	1.90	0.98
3.28	459.60	0.39	3.05	1.93	0.98
3.39	459.60	0.39	3.09	1.97	0.98
3.50	459.61	0.40	3.11	2.00	0.98
3.55	459.61	0.40	3.13	2.02	0.98
3.73	459.63	0.42	3.17	2.07	0.99
3.84	459.63	0.42	3.20	2.11	0.99
3.95	459.64	0.43	3.23	2.14	0.99
4.06	459.64	0.43	3.25	2.17	0.99

Tailwater Channel Data - 1321+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 459.21 ft

Roadway Data for Crossing: 1321+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 488.57 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 127

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 127**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.14	0.1229
Grass	0.25	0.08	0.0192
Woods	0.15	2.86	0.4286
	Σ	**3.07**	0.5707

$C_{ave} = \frac{0.5707}{3.07} = 0.19$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.20	0.1769
Grass	0.25	0.08	0.0192
Woods	0.15	2.86	0.4286
	Σ	**3.13**	0.6247

$C_{ave} = \frac{0.6247}{3.13} = 0.20$

T_c =	25.47	min.
I_{05} =	4.02	in / hr
I_{10} =	4.46	in / hr
I_{25} =	5.09	in / hr
I_{50} =	5.56	in / hr
I_{100} =	6.05	in / hr

Pre Construction Runoff:

Q_{05} =	0.19	x	4.02	x	3.07	x	1	=	**2.29**	cfs
Q_{10} =	0.19	x	4.46	x	3.07	x	1	=	**2.54**	cfs
Q_{25} =	0.19	x	5.09	x	3.07	x	1.1	=	**3.20**	cfs
Q_{50} =	0.19	x	5.56	x	3.07	x	1.2	=	**3.81**	cfs
Q_{100} =	0.19	x	6.05	x	3.07	x	1.25	=	**4.31**	cfs

Post Construction Runoff:

Q_{05} =	0.20	x	4.02	x	3.13	x	1	=	**2.51**	cfs
Q_{10} =	0.20	x	4.46	x	3.13	x	1	=	**2.78**	cfs
Q_{25} =	0.20	x	5.09	x	3.13	x	1.1	=	**3.50**	cfs
Q_{50} =	0.20	x	5.56	x	3.13	x	1.2	=	**4.17**	cfs
Q_{100} =	0.20	x	6.05	x	3.13	x	1.25	=	**4.72**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 127	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**365**				
9	Watercourse slope, s		ft/ft	**0.1500**				
10	Average velocity, V (figure 3-1)		ft/s	**6.25**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.016**	+		=	**0.016**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.425**
							min	**25.47**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.2 cfs

Design Flow: 3.81 cfs

Maximum Flow: 4.31 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1323+25 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
480.90	3.20	3.20	0.00	1
480.92	3.31	3.31	0.00	1
480.93	3.42	3.42	0.00	1
480.94	3.53	3.53	0.00	1
480.96	3.64	3.64	0.00	1
480.97	3.75	3.75	0.00	1
480.98	3.81	3.81	0.00	1
481.00	3.98	3.98	0.00	1
481.01	4.09	4.09	0.00	1
481.02	4.20	4.20	0.00	1
481.04	4.31	4.31	0.00	1
487.00	41.51	41.51	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.20	3.20	480.90	0.773	0.0*	1-S2n	0.258	0.622	0.258	0.461	12.996	2.374
3.31	3.31	480.92	0.787	0.0*	1-S2n	0.262	0.634	0.262	0.470	13.168	2.398
3.42	3.42	480.93	0.801	0.0*	1-S2n	0.266	0.645	0.266	0.478	13.333	2.421
3.53	3.53	480.94	0.814	0.0*	1-S2n	0.270	0.652	0.270	0.486	13.492	2.443
3.64	3.64	480.96	0.828	0.0*	1-S2n	0.274	0.663	0.274	0.495	13.644	2.465
3.75	3.75	480.97	0.841	0.0*	1-S2n	0.278	0.674	0.278	0.503	13.790	2.486
3.81	3.81	480.98	0.847	0.0*	1-S2n	0.280	0.679	0.280	0.507	13.861	2.496
3.98	3.98	481.00	0.867	0.0*	1-S2n	0.285	0.695	0.285	0.518	14.067	2.528
4.09	4.09	481.01	0.880	0.0*	1-S2n	0.289	0.706	0.289	0.526	14.197	2.547
4.20	4.20	481.02	0.893	0.0*	1-S2n	0.293	0.716	0.293	0.533	14.324	2.567
4.31	4.31	481.04	0.906	0.0*	1-S2n	0.297	0.726	0.297	0.541	14.445	2.586

* Full Flow Headwater elevation is below inlet invert.

****

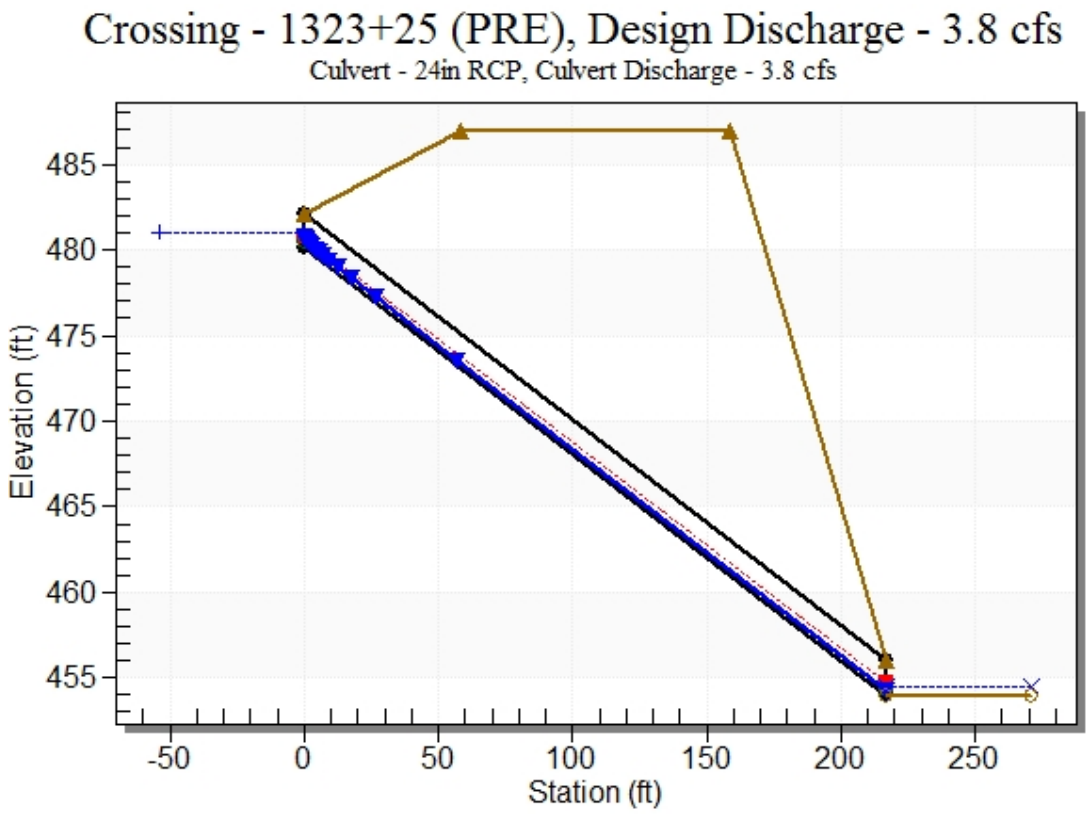
Straight Culvert

Inlet Elevation (invert): 480.13 ft, Outlet Elevation (invert): 453.99 ft

Culvert Length: 218.57 ft, Culvert Slope: 0.1205

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 480.13 ft

Outlet Station: 217.00 ft

Outlet Elevation: 453.99 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1323+25 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.20	454.45	0.46	2.37	1.15	0.71
3.31	454.46	0.47	2.40	1.17	0.71
3.42	454.47	0.48	2.42	1.19	0.71
3.53	454.48	0.49	2.44	1.21	0.71
3.64	454.48	0.49	2.46	1.23	0.71
3.75	454.49	0.50	2.49	1.25	0.71
3.81	454.50	0.51	2.50	1.26	0.71
3.98	454.51	0.52	2.53	1.29	0.72
4.09	454.52	0.53	2.55	1.31	0.72
4.20	454.52	0.53	2.57	1.33	0.72
4.31	454.53	0.54	2.59	1.35	0.72

Tailwater Channel Data - 1323+25 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 453.99 ft

Roadway Data for Crossing: 1323+25 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 487.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.5 cfs

Design Flow: 4.17 cfs

Maximum Flow: 4.72 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1323+25 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
480.94	3.50	3.50	0.00	1
480.96	3.62	3.62	0.00	1
480.97	3.74	3.74	0.00	1
480.98	3.87	3.87	0.00	1
481.00	3.99	3.99	0.00	1
481.01	4.11	4.11	0.00	1
481.02	4.17	4.17	0.00	1
481.04	4.35	4.35	0.00	1
481.05	4.48	4.48	0.00	1
481.07	4.60	4.60	0.00	1
481.08	4.72	4.72	0.00	1
487.00	41.50	41.50	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.50	3.50	480.94	0.810	0.0*	1-S2n	0.269	0.649	0.269	0.484	13.445	2.437
3.62	3.62	480.96	0.825	0.0*	1-S2n	0.273	0.661	0.273	0.493	13.614	2.460
3.74	3.74	480.97	0.839	0.0*	1-S2n	0.277	0.673	0.277	0.502	13.776	2.484
3.87	3.87	480.98	0.854	0.0*	1-S2n	0.281	0.685	0.281	0.510	13.931	2.507
3.99	3.99	481.00	0.869	0.0*	1-S2n	0.286	0.696	0.286	0.519	14.080	2.529
4.11	4.11	481.01	0.883	0.0*	1-S2n	0.290	0.708	0.290	0.527	14.223	2.551
4.17	4.17	481.02	0.890	0.0*	1-S2n	0.292	0.713	0.292	0.531	14.291	2.562
4.35	4.35	481.04	0.911	0.0*	1-S2n	0.299	0.730	0.299	0.544	14.492	2.593
4.48	4.48	481.05	0.924	0.0*	1-S2n	0.303	0.741	0.303	0.552	14.620	2.614
4.60	4.60	481.07	0.938	0.0*	1-S2n	0.307	0.752	0.307	0.560	14.462	2.634
4.72	4.72	481.08	0.951	0.0*	1-S2n	0.311	0.762	0.311	0.568	14.601	2.653

* Full Flow Headwater elevation is below inlet invert.

****

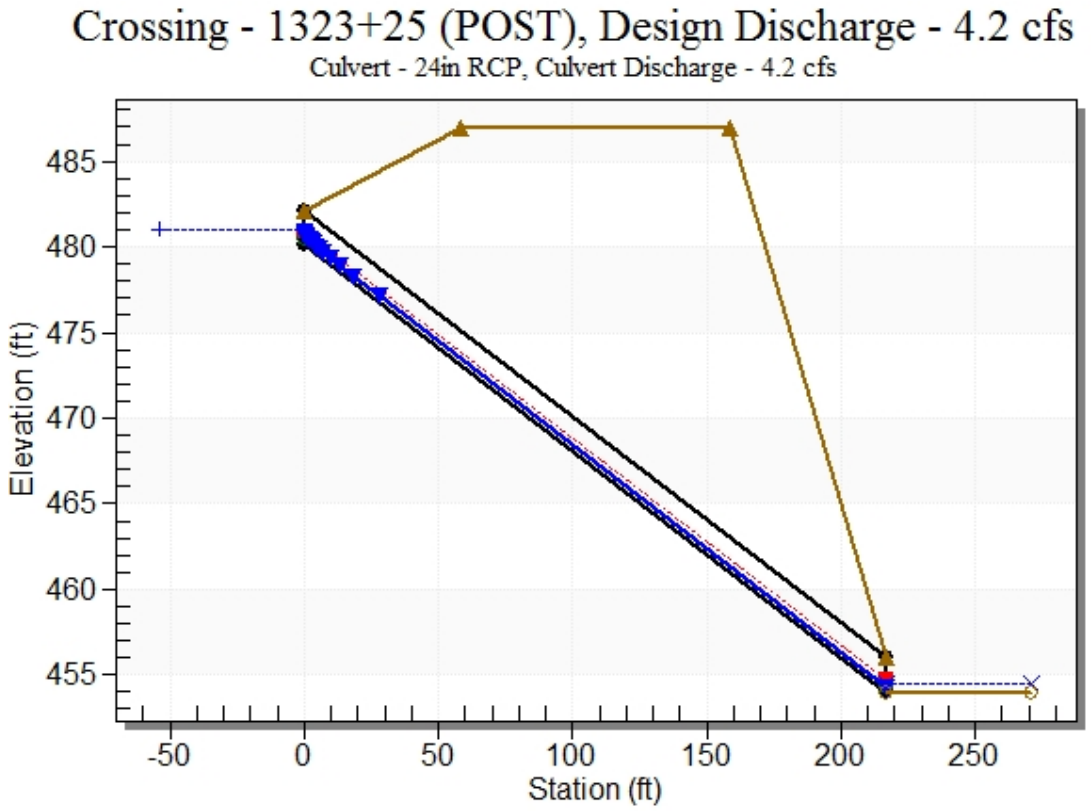
Straight Culvert

Inlet Elevation (invert): 480.13 ft, Outlet Elevation (invert): 453.99 ft

Culvert Length: 218.57 ft, Culvert Slope: 0.1205

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 480.13 ft

Outlet Station: 217.00 ft

Outlet Elevation: 453.99 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1323+25 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.50	454.47	0.48	2.44	1.21	0.71
3.62	454.48	0.49	2.46	1.23	0.71
3.74	454.49	0.50	2.48	1.25	0.71
3.87	454.50	0.51	2.51	1.27	0.72
3.99	454.51	0.52	2.53	1.30	0.72
4.11	454.52	0.53	2.55	1.32	0.72
4.17	454.52	0.53	2.56	1.33	0.72
4.35	454.53	0.54	2.59	1.36	0.72
4.48	454.54	0.55	2.61	1.38	0.72
4.60	454.55	0.56	2.63	1.40	0.72
4.72	454.56	0.57	2.65	1.42	0.72

Tailwater Channel Data - 1323+25 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 453.99 ft

Roadway Data for Crossing: 1323+25 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 487.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 128

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700 Huger Street
Columbia, South Carolina 29201
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 128a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.68	0.6158
Grass	0.25	0.48	0.1205
Woods	0.15	0.00	0.0000
	Σ	**1.17**	0.7363

$C_{ave} = \frac{0.7363}{1.17} = 0.63$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.71	0.6356
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.71**	0.6356

$C_{ave} = \frac{0.6356}{0.71} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.63	x	6.23	x	1.17	x	1	=	**4.59**	cfs
Q_{10} =	0.63	x	6.98	x	1.17	x	1	=	**5.14**	cfs
Q_{25} =	0.63	x	8.08	x	1.17	x	1.1	=	**6.55**	cfs
Q_{50} =	0.63	x	8.93	x	1.17	x	1.2	=	**7.89**	cfs
Q_{100} =	0.63	x	9.81	x	1.17	x	1.25	=	**9.03**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.71	x	1	=	**3.96**	cfs
Q_{10} =	0.90	x	6.98	x	0.71	x	1	=	**4.44**	cfs
Q_{25} =	0.90	x	8.08	x	0.71	x	1.1	=	**5.65**	cfs
Q_{50} =	0.90	x	8.93	x	0.71	x	1.2	=	**6.81**	cfs
Q_{100} =	0.90	x	9.81	x	0.71	x	1.25	=	**7.79**	cfs

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700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 128b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.26	0.2369
Grass	0.25	0.15	0.0367
Woods	0.15	0.45	0.0682
	Σ	**0.86**	0.3417

$C_{ave} = \frac{0.3417}{0.86} = 0.40$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4439
Grass	0.25	0.15	0.0367
Woods	0.15	0.45	0.0682
	Σ	**1.09**	0.5487

$C_{ave} = \frac{0.5487}{1.09} = 0.50$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.40	x	6.23	x	0.86	x	1	=	**2.13**	cfs
Q_{10} =	0.40	x	6.98	x	0.86	x	1	=	**2.38**	cfs
Q_{25} =	0.40	x	8.08	x	0.86	x	1.1	=	**3.04**	cfs
Q_{50} =	0.40	x	8.93	x	0.86	x	1.2	=	**3.66**	cfs
Q_{100} =	0.40	x	9.81	x	0.86	x	1.25	=	**4.19**	cfs

Post Construction Runoff:

Q_{05} =	0.50	x	6.23	x	1.09	x	1	=	**3.42**	cfs
Q_{10} =	0.50	x	6.98	x	1.09	x	1	=	**3.83**	cfs
Q_{25} =	0.50	x	8.08	x	1.09	x	1.1	=	**4.88**	cfs
Q_{50} =	0.50	x	8.93	x	1.09	x	1.2	=	**5.88**	cfs
Q_{100} =	0.50	x	9.81	x	1.09	x	1.25	=	**6.73**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-128		Outlet	OP	467.83	467.83	0.00	0.77	0.00	5.20	0.00	2.03	0.53	0.00
CB-128b		Other	C.B. TYPE 112	475.05	475.05	3.92	0.98	5.15	5.15	11.55	2.03	0.53	8.99
CB-128a		Other	C.B. TYPE 112	475.62	475.62	3.55	0.00	5.00	5.00	7.93	1.17	0.63	9.03

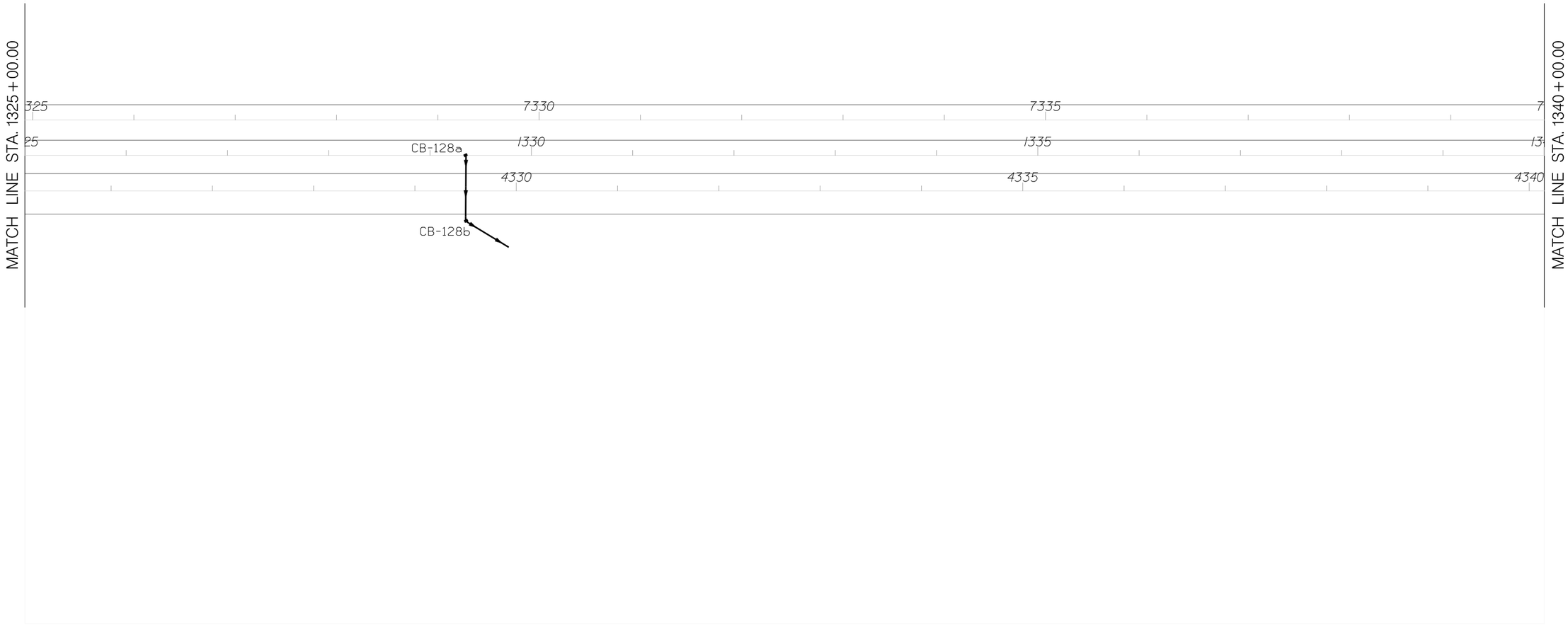
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-60	CB-128b	OF-128	Circular	Concrete	1	1.25	49	6.77	11.55	19.59	0.72	15.70	472.38	473.39	469.08	468.61	471.13	467.83	9.41	14.30	1.25	0.78
NP-59	CB-128a	CB-128b	Circular	Concrete	1	1.25	63	1.27	7.93	8.48	1.03	7.35	473.32	474.55	472.52	473.39	472.07	471.27	6.46	6.46	1.25	1.25

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-128b	5.00	3.67	9.03	0.39	0.86	0.39	0.86	0.00	0.00
CB-128a	5.00	7.93	9.03	0.63	1.17	0.63	1.16	0.00	0.01

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	56



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$$$$date$$$$

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

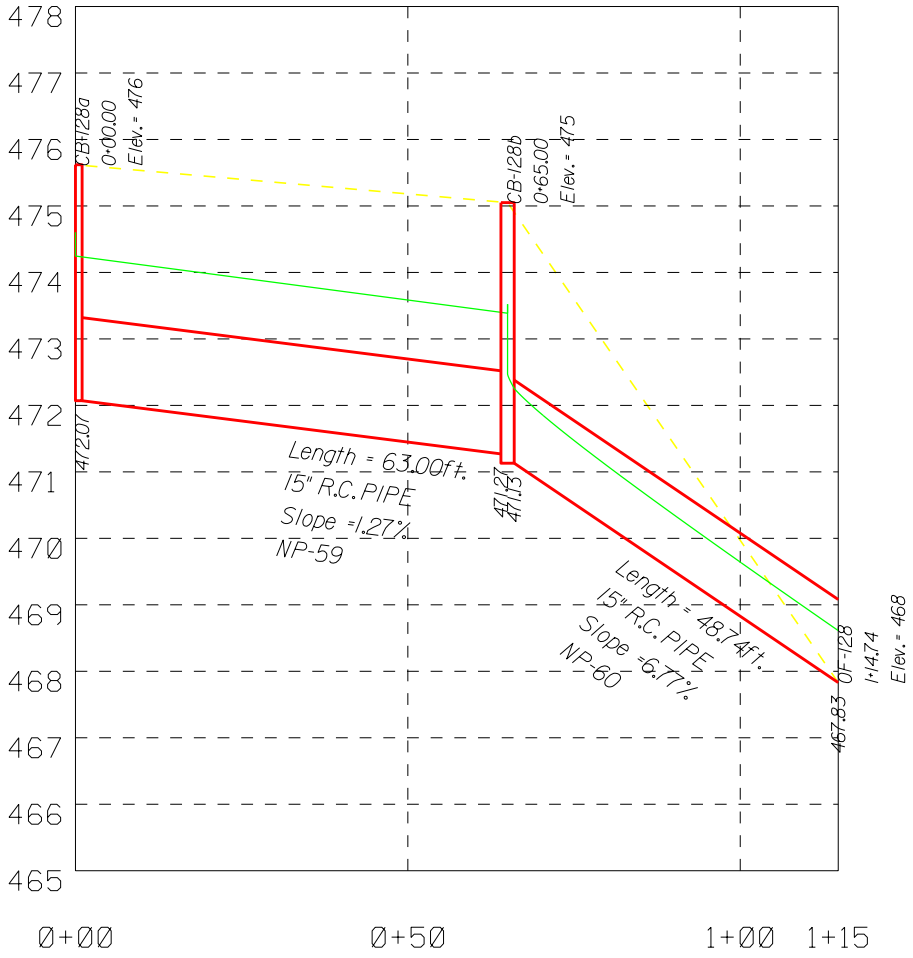
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1325+00.00 TO STA. 1340+00.00

OF-128 (50 YR PRE)



SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-128	Outlet	OP	467.83	467.83	0.00	0.77	0.00	5.20	0.00	1.80	0.66	0.00
CB-128b	Other	C.B. TYPE 112	475.05	475.05	3.92	1.22	5.15	5.15	12.78	1.80	0.66	8.99
CB-128a	Other	C.B. TYPE 112	475.62	475.62	3.55	0.00	5.00	5.00	6.92	0.71	0.90	9.03

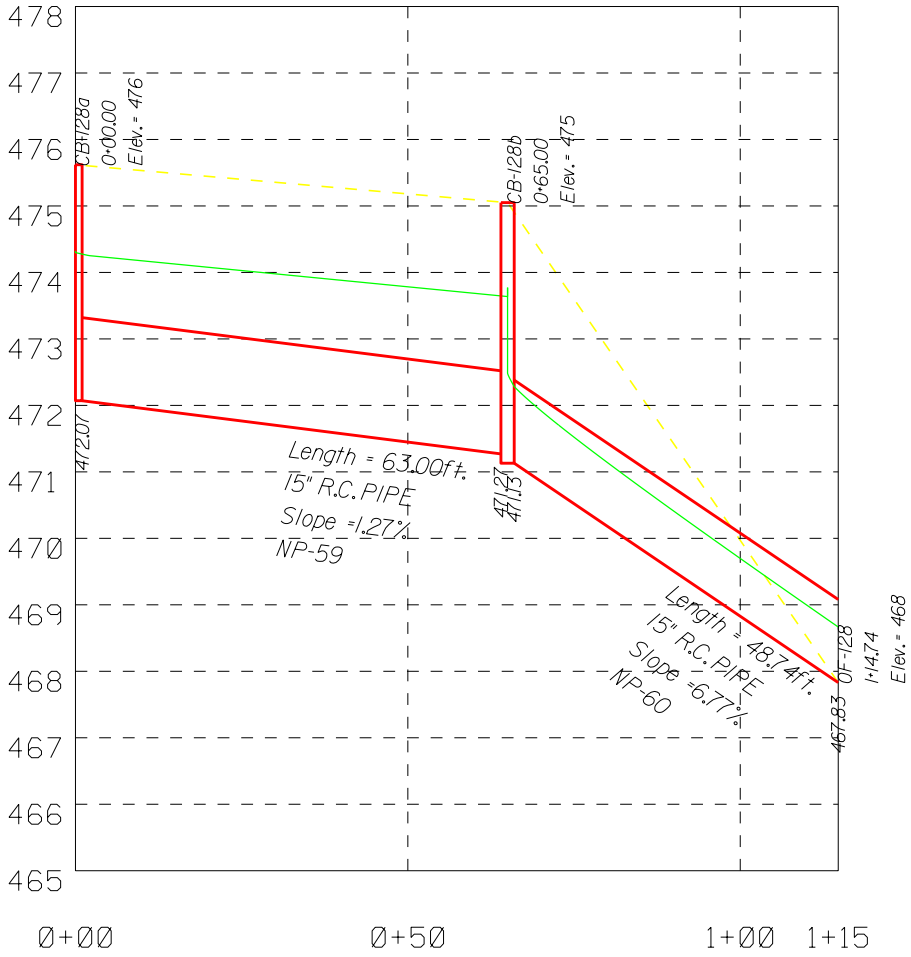
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-60	CB-128b	OF-128	Circular	Concrete	1	1.25	49	6.77	12.78	19.59	0.77	16.06	472.38	473.64	469.08	468.67	471.13	467.83	10.41	14.64	1.25	0.84
NP-59	CB-128a	CB-128b	Circular	Concrete	1	1.25	63	1.27	6.92	8.48	0.91	7.25	473.32	474.27	472.52	473.64	472.07	471.27	5.64	5.64	1.25	1.25

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-128b	5.00	5.91	9.03	0.50	1.09	0.50	1.09	0.00	0.00
CB-128a	5.00	6.92	9.03	0.90	0.71	0.90	0.71	0.00	0.00

OF-128 (50 YR POST)



CULVERT 129

Hydrograph Report

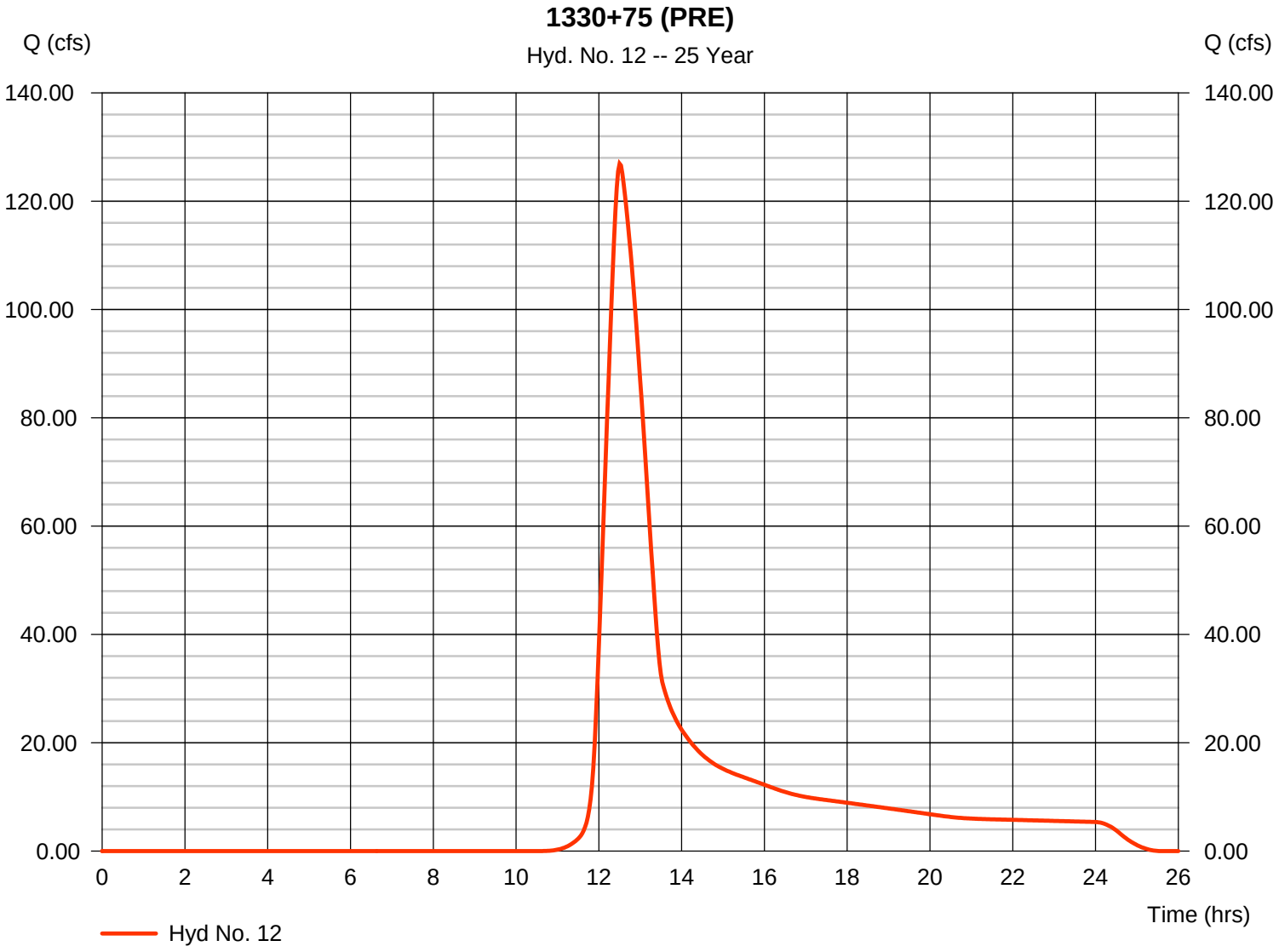
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 12

1330+75 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	126.91 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.50 hrs
Time interval	=	2 min	Hyd. volume	=	874,412 cuft
Drainage area	=	108.380 ac	Curve number	=	61*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	59.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



Hydrograph Report

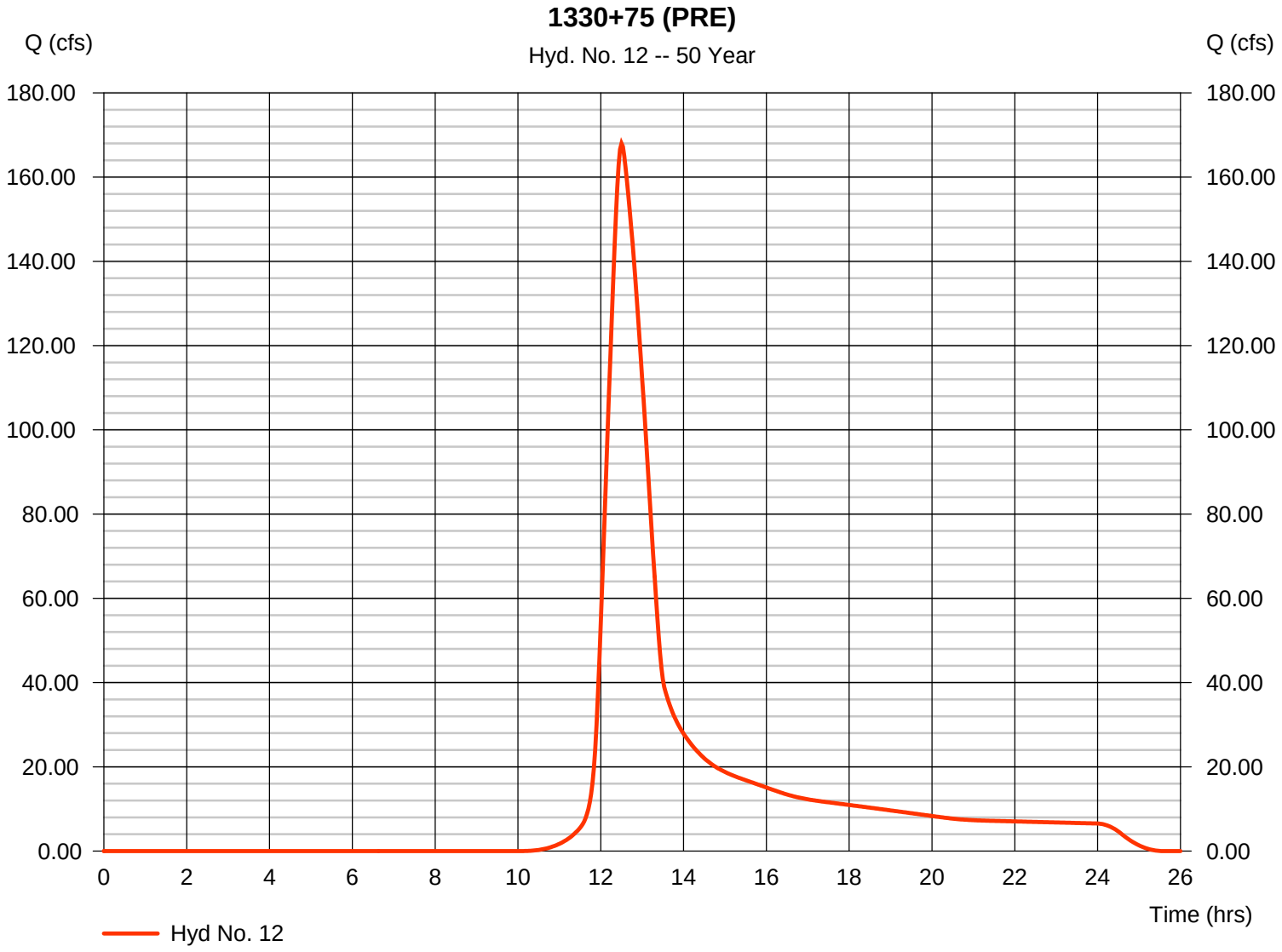
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 12

1330+75 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 168.00 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.50 hrs
Time interval	= 2 min	Hyd. volume	= 1,128,751 cuft
Drainage area	= 108.380 ac	Curve number	= 61*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 59.00 min
Total precip.	= 7.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



Hydrograph Report

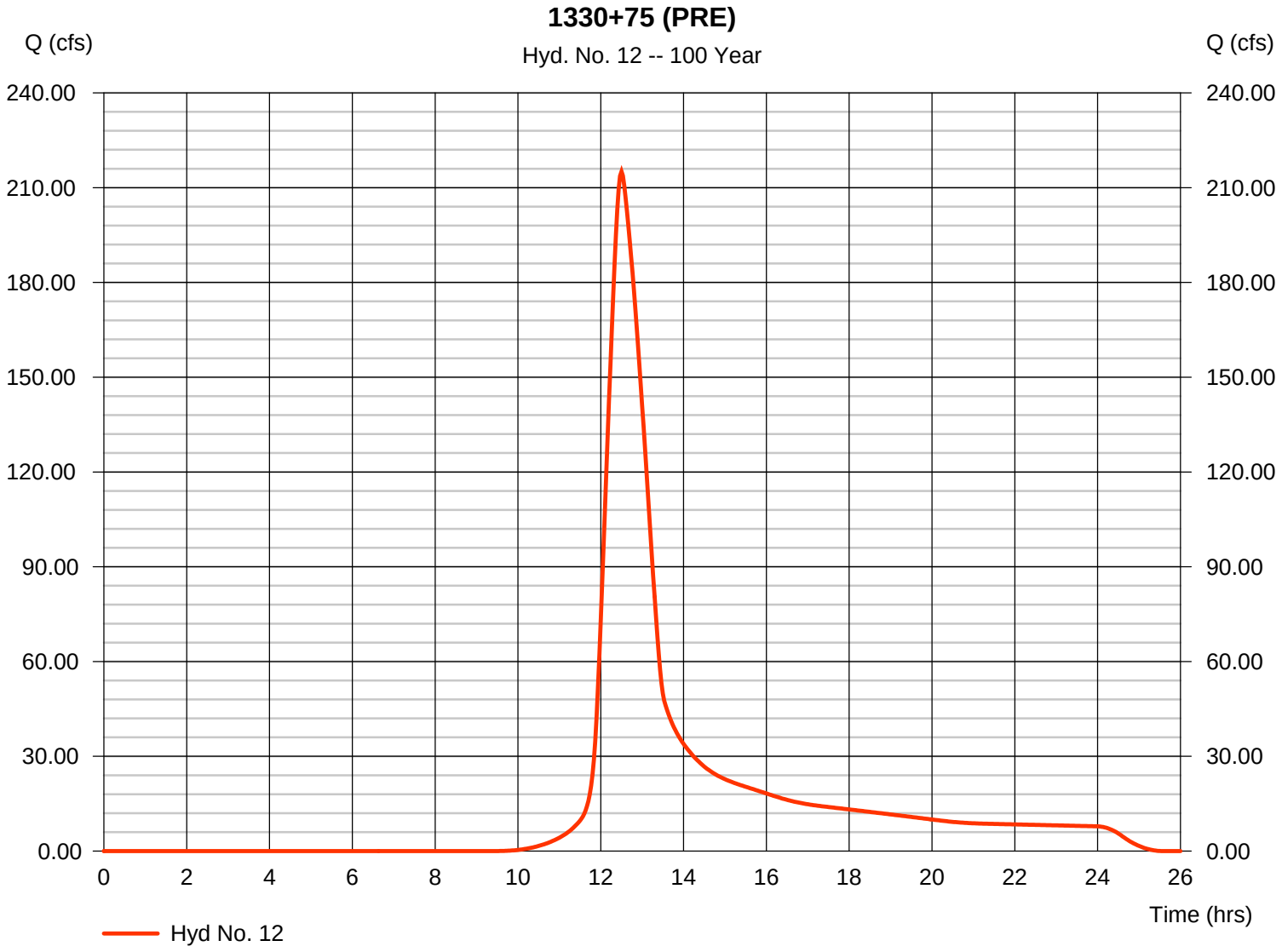
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 12

1330+75 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	215.11 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.50 hrs
Time interval	=	2 min	Hyd. volume	=	1,421,523 cuft
Drainage area	=	108.380 ac	Curve number	=	61*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	59.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



Hydrograph Report

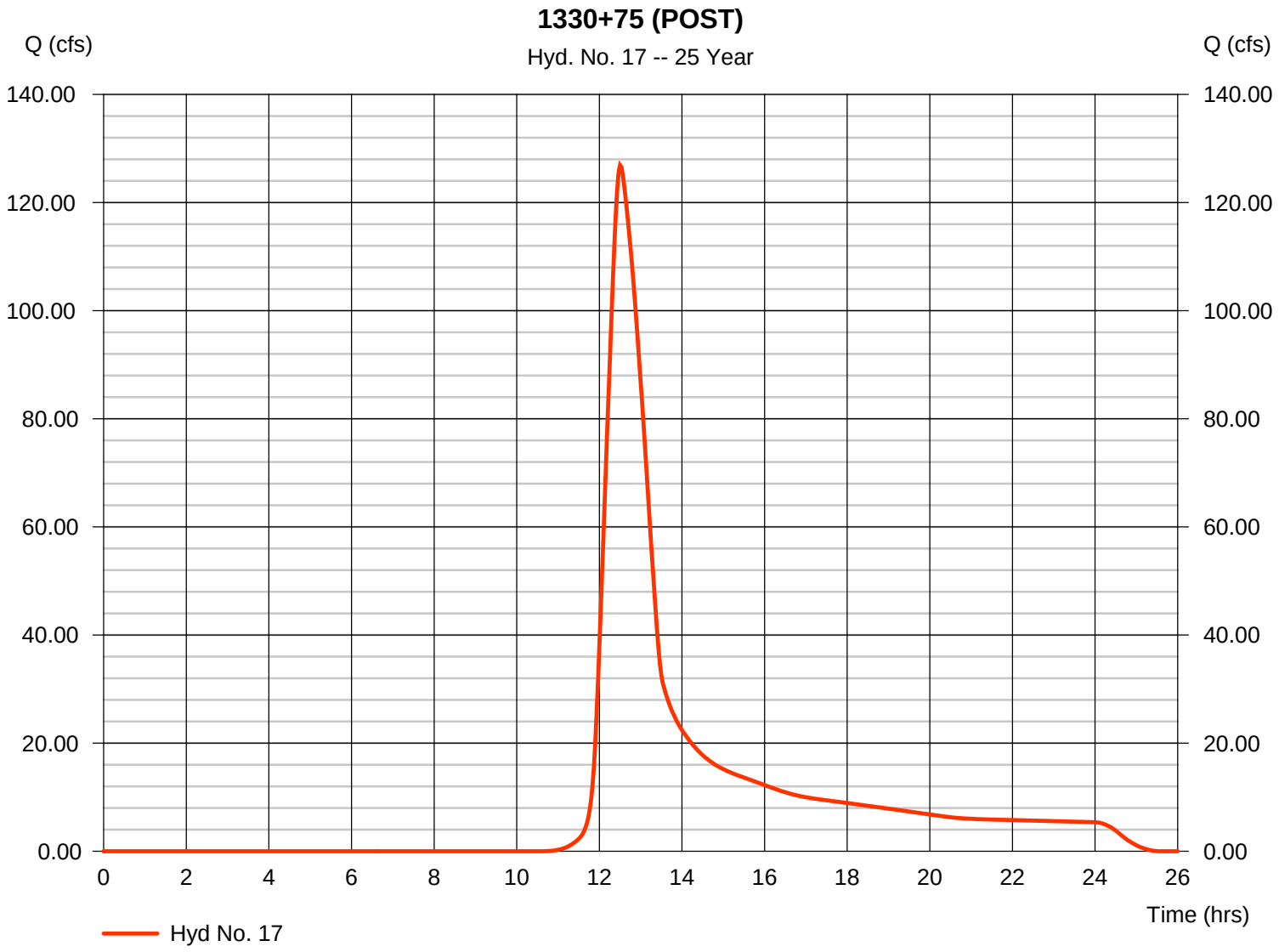
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 17

1330+75 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	126.91 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.50 hrs
Time interval	=	2 min	Hyd. volume	=	874,412 cuft
Drainage area	=	108.380 ac	Curve number	=	61*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	59.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



Hydrograph Report

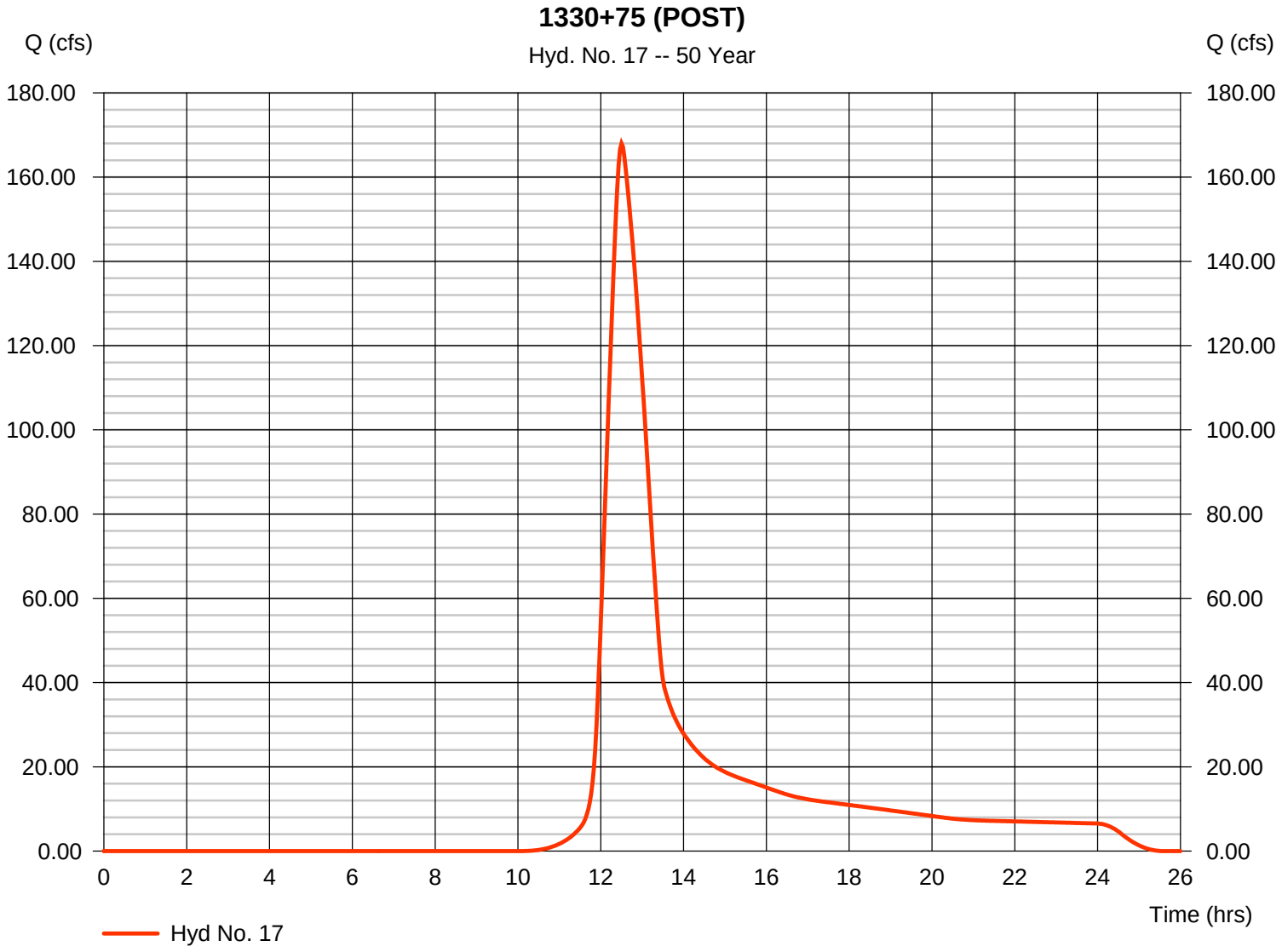
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 17

1330+75 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	168.00 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.50 hrs
Time interval	=	2 min	Hyd. volume	=	1,128,751 cuft
Drainage area	=	108.380 ac	Curve number	=	61*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	59.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



Hydrograph Report

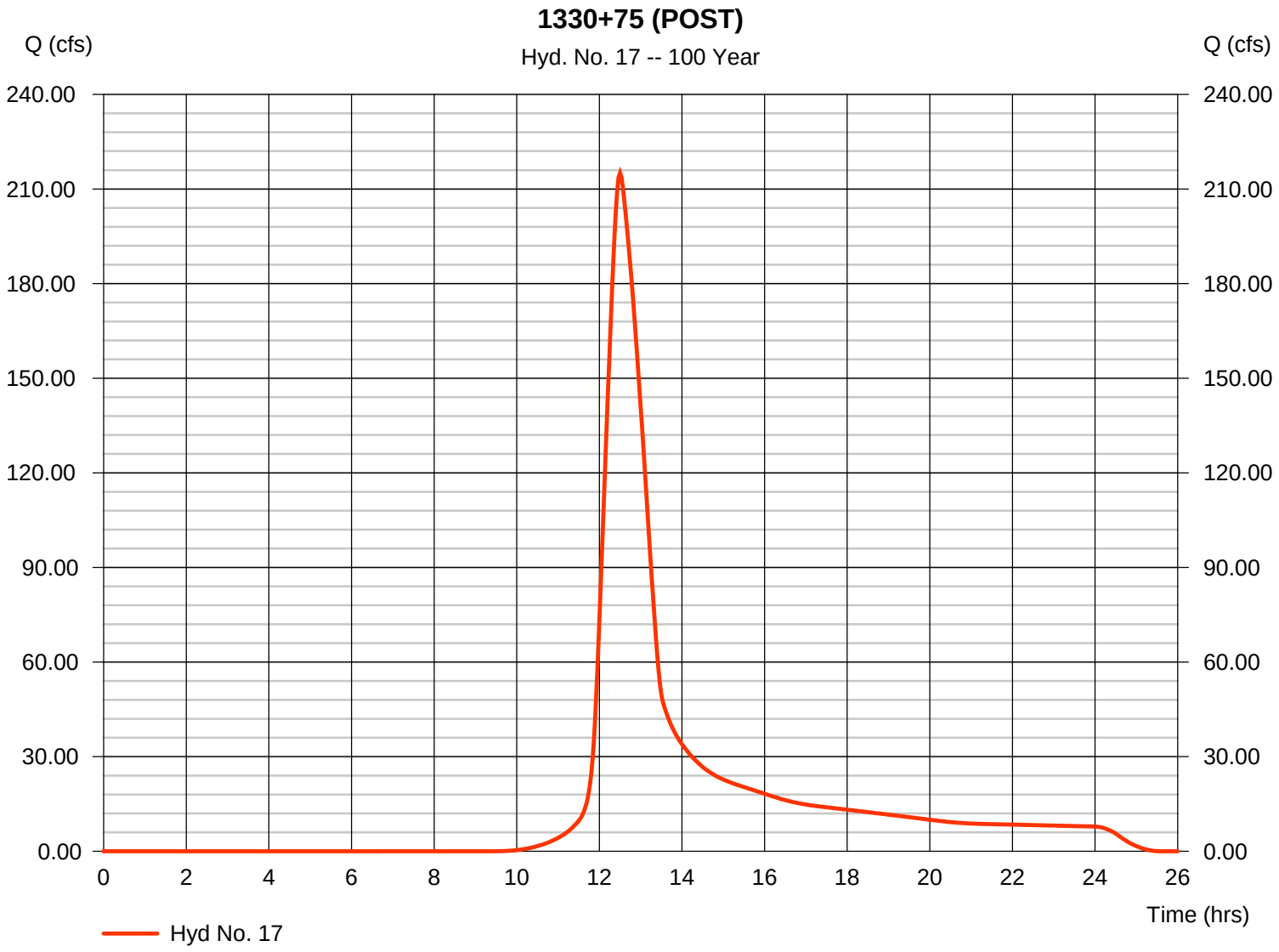
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 17

1330+75 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	215.11 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.50 hrs
Time interval	=	2 min	Hyd. volume	=	1,421,523 cuft
Drainage area	=	108.380 ac	Curve number	=	61*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	59.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.000 x 61) + (1.000 x 74) + (0.980 x 98) + (63.820 x 55) + (39.580 x 70)] / 108.380



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 126.91 cfs

Design Flow: 168 cfs

Maximum Flow: 215.11 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1330+75 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	4x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
439.30	126.91	126.91	0.00	1
439.52	135.73	135.73	0.00	1
439.74	144.55	144.55	0.00	1
439.95	153.37	153.37	0.00	1
440.16	162.19	162.19	0.00	1
440.30	168.00	168.00	0.00	1
440.58	179.83	179.83	0.00	1
440.78	188.65	188.65	0.00	1
440.99	197.47	197.47	0.00	1
441.19	206.29	206.29	0.00	1
441.40	215.11	215.11	0.00	1
475.00	856.87	856.87	0.00	Overtopping

Table 2 - Culvert Summary Table: 4x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
126.91	126.91	439.30	4.843	0.0*	1-S2n	1.707	3.150	1.824	2.347	17.395	6.221
135.73	135.73	439.52	5.064	0.0*	1-S2n	1.793	3.295	1.922	2.423	17.659	6.331
144.55	144.55	439.74	5.280	0.0*	1-S2n	1.880	3.436	2.018	2.497	17.907	6.436
153.37	153.37	439.95	5.493	0.0*	1-S2n	1.965	3.574	2.113	2.569	18.145	6.535
162.19	162.19	440.16	5.703	0.0*	1-S2n	2.049	3.710	2.207	2.637	18.376	6.630
168.00	168.00	440.30	5.839	0.0*	1-S2n	2.105	3.798	2.271	2.682	18.496	6.691
179.83	179.83	440.58	6.116	0.0*	5-S2n	2.216	3.974	2.396	2.769	18.760	6.810
188.65	188.65	440.78	6.321	0.002	5-S2n	2.299	4.103	2.489	2.832	18.946	6.894
197.47	197.47	440.99	6.525	0.317	5-S2n	2.381	4.230	2.580	2.893	19.138	6.976
206.29	206.29	441.19	6.730	0.639	5-S2n	2.463	4.355	2.673	2.952	19.290	7.055
215.11	215.11	441.40	6.935	0.968	5-S2n	2.544	4.478	2.765	3.010	19.451	7.131

* Full Flow Headwater elevation is below inlet invert.

****

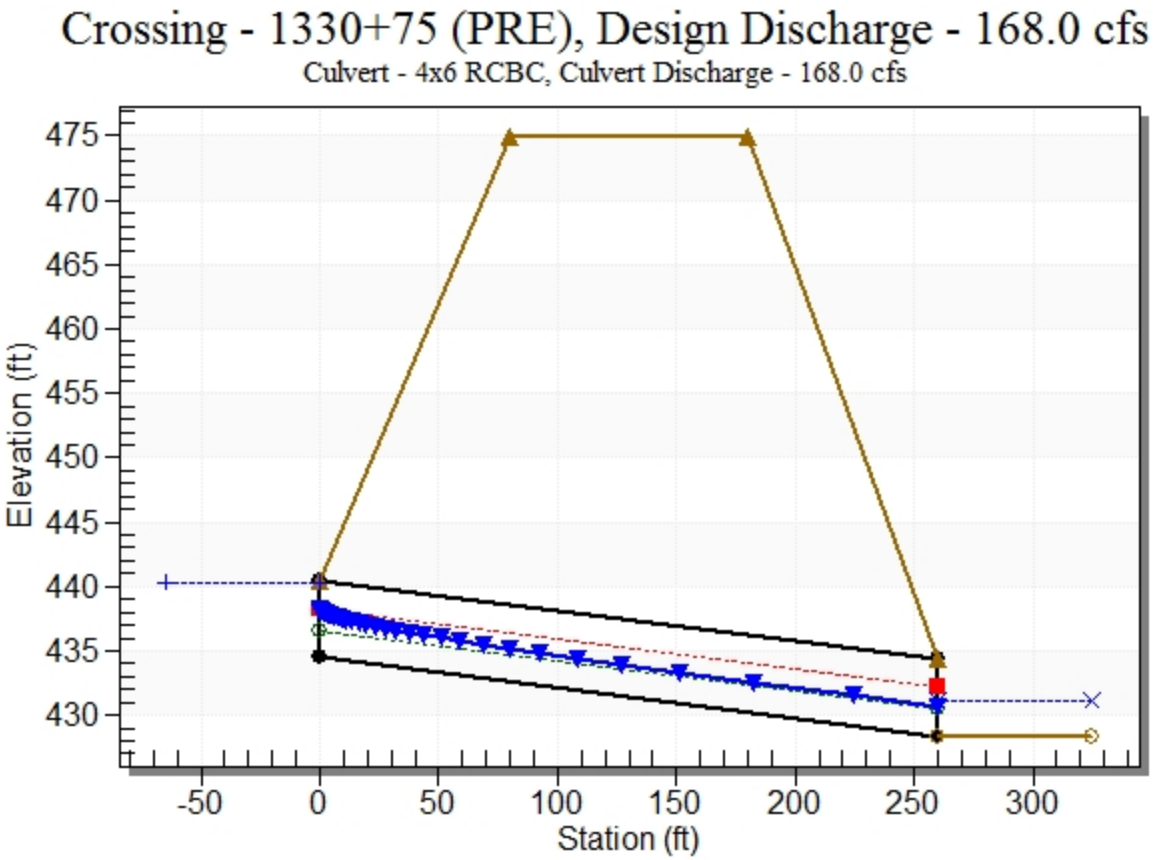
Straight Culvert

Inlet Elevation (invert): 434.46 ft, Outlet Elevation (invert): 428.39 ft

Culvert Length: 260.07 ft, Culvert Slope: 0.0233

****

Water Surface Profile Plot for Culvert: 4x6 RCBC



Site Data - 4x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 434.46 ft

Outlet Station: 260.00 ft

Outlet Elevation: 428.39 ft

Number of Barrels: 1

Culvert Data Summary - 4x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 4.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1330+75 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
126.91	430.74	2.35	6.22	5.86	0.89
135.73	430.81	2.42	6.33	6.05	0.89
144.55	430.89	2.50	6.44	6.23	0.90
153.37	430.96	2.57	6.53	6.41	0.90
162.19	431.03	2.64	6.63	6.58	0.90
168.00	431.07	2.68	6.69	6.69	0.90
179.83	431.16	2.77	6.81	6.91	0.91
188.65	431.22	2.83	6.89	7.07	0.91
197.47	431.28	2.89	6.98	7.22	0.91
206.29	431.34	2.95	7.06	7.37	0.91
215.11	431.40	3.01	7.13	7.51	0.92

Tailwater Channel Data - 1330+75 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 428.39 ft

Roadway Data for Crossing: 1330+75 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 475.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 126.91 cfs

Design Flow: 168 cfs

Maximum Flow: 215.11 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1330+75 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	4x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
439.30	126.91	126.91	0.00	1
439.52	135.73	135.73	0.00	1
439.74	144.55	144.55	0.00	1
439.95	153.37	153.37	0.00	1
440.16	162.19	162.19	0.00	1
440.30	168.00	168.00	0.00	1
440.58	179.83	179.83	0.00	1
440.78	188.65	188.65	0.00	1
440.99	197.47	197.47	0.00	1
441.19	206.29	206.29	0.00	1
441.40	215.11	215.11	0.00	1
475.00	856.87	856.87	0.00	Overtopping

Table 2 - Culvert Summary Table: 4x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
126.91	126.91	439.30	4.843	0.0*	1-S2n	1.707	3.150	1.824	2.347	17.395	6.221
135.73	135.73	439.52	5.064	0.0*	1-S2n	1.793	3.295	1.922	2.423	17.659	6.331
144.55	144.55	439.74	5.280	0.0*	1-S2n	1.880	3.436	2.018	2.497	17.907	6.436
153.37	153.37	439.95	5.493	0.0*	1-S2n	1.965	3.574	2.113	2.569	18.145	6.535
162.19	162.19	440.16	5.703	0.0*	1-S2n	2.049	3.710	2.207	2.637	18.376	6.630
168.00	168.00	440.30	5.839	0.0*	1-S2n	2.105	3.798	2.271	2.682	18.496	6.691
179.83	179.83	440.58	6.116	0.0*	5-S2n	2.216	3.974	2.396	2.769	18.760	6.810
188.65	188.65	440.78	6.321	0.002	5-S2n	2.299	4.103	2.489	2.832	18.946	6.894
197.47	197.47	440.99	6.525	0.317	5-S2n	2.381	4.230	2.580	2.893	19.138	6.976
206.29	206.29	441.19	6.730	0.639	5-S2n	2.463	4.355	2.673	2.952	19.290	7.055
215.11	215.11	441.40	6.935	0.968	5-S2n	2.544	4.478	2.765	3.010	19.451	7.131

* Full Flow Headwater elevation is below inlet invert.

****

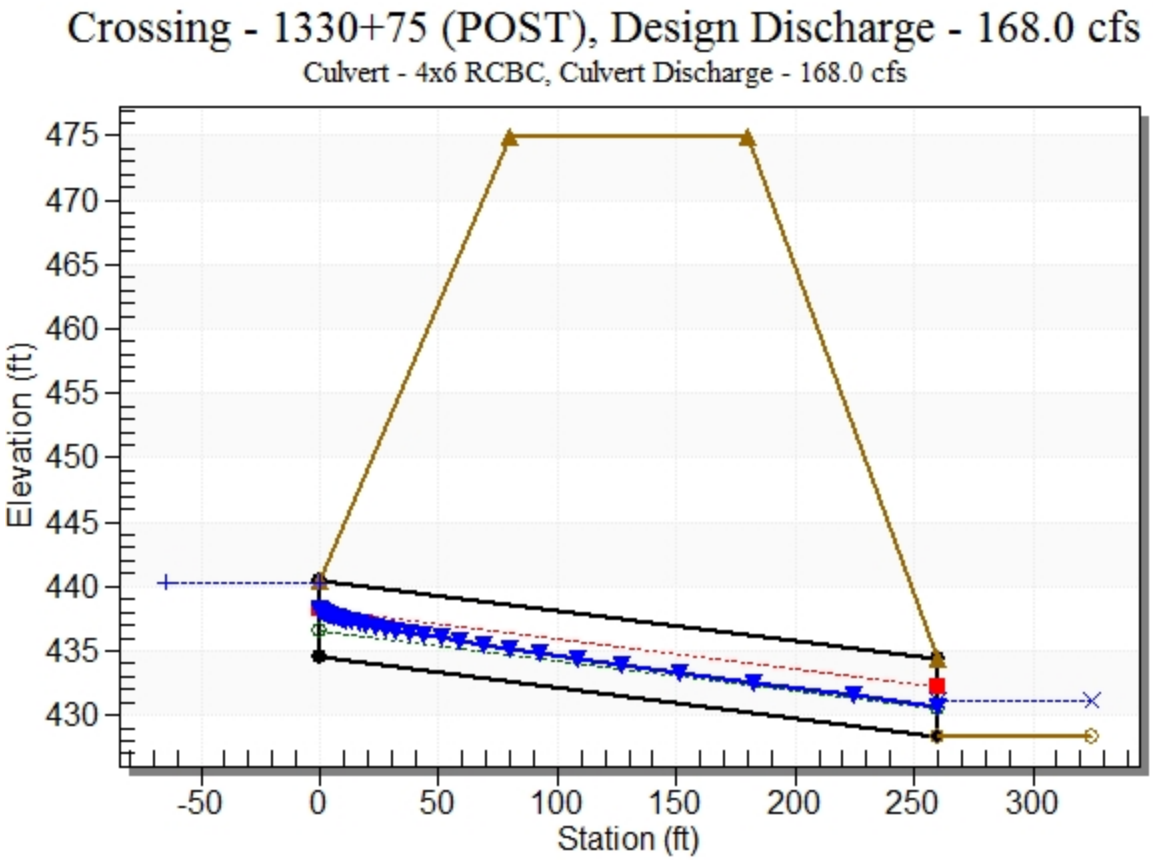
Straight Culvert

Inlet Elevation (invert): 434.46 ft, Outlet Elevation (invert): 428.39 ft

Culvert Length: 260.07 ft, Culvert Slope: 0.0233

****

Water Surface Profile Plot for Culvert: 4x6 RCBC



Site Data - 4x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 434.46 ft

Outlet Station: 260.00 ft

Outlet Elevation: 428.39 ft

Number of Barrels: 1

Culvert Data Summary - 4x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 4.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1330+75 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
126.91	430.74	2.35	6.22	5.86	0.89
135.73	430.81	2.42	6.33	6.05	0.89
144.55	430.89	2.50	6.44	6.23	0.90
153.37	430.96	2.57	6.53	6.41	0.90
162.19	431.03	2.64	6.63	6.58	0.90
168.00	431.07	2.68	6.69	6.69	0.90
179.83	431.16	2.77	6.81	6.91	0.91
188.65	431.22	2.83	6.89	7.07	0.91
197.47	431.28	2.89	6.98	7.22	0.91
206.29	431.34	2.95	7.06	7.37	0.91
215.11	431.40	3.01	7.13	7.51	0.92

Tailwater Channel Data - 1330+75 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 428.39 ft

Roadway Data for Crossing: 1330+75 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 475.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 130

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 130**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.69	0.6184
Grass	0.25	0.61	0.1525
Woods	0.15	0.00	0.0000
	Σ	**1.30**	0.7709

$C_{ave} = \frac{0.7709}{1.30} =$ **0.59**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.76	0.6817
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.76**	0.6817

$C_{ave} = \frac{0.6817}{0.76} =$ **0.90**

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	1.30	x	1	=	**4.80**	cfs
Q_{10} =	0.59	x	6.98	x	1.30	x	1	=	**5.38**	cfs
Q_{25} =	0.59	x	8.08	x	1.30	x	1.1	=	**6.85**	cfs
Q_{50} =	0.59	x	8.93	x	1.30	x	1.2	=	**8.26**	cfs
Q_{100} =	0.59	x	9.81	x	1.30	x	1.25	=	**9.45**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.76	x	1	=	**4.25**	cfs
Q_{10} =	0.90	x	6.98	x	0.76	x	1	=	**4.76**	cfs
Q_{25} =	0.90	x	8.08	x	0.76	x	1.1	=	**6.06**	cfs
Q_{50} =	0.90	x	8.93	x	0.76	x	1.2	=	**7.30**	cfs
Q_{100} =	0.90	x	9.81	x	0.76	x	1.25	=	**8.36**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.85 cfs

Design Flow: 8.26 cfs

Maximum Flow: 9.45 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1332+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
471.85	6.85	6.85	0.00	1
471.94	7.11	7.11	0.00	1
472.04	7.37	7.37	0.00	1
472.14	7.63	7.63	0.00	1
472.25	7.89	7.89	0.00	1
472.36	8.15	8.15	0.00	1
472.41	8.26	8.26	0.00	1
472.59	8.67	8.67	0.00	1
472.71	8.93	8.93	0.00	1
472.84	9.19	9.19	0.00	1
472.97	9.45	9.45	0.00	1
474.00	11.31	11.31	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.85	6.85	471.85	1.927	0.0*	5-S2n	0.376	1.048	0.376	0.689	21.299	2.943
7.11	7.11	471.94	2.022	0.0*	5-S2n	0.384	1.064	0.384	0.702	21.529	2.973
7.37	7.37	472.04	2.121	0.0*	5-S2n	0.391	1.080	0.391	0.715	21.777	3.003
7.63	7.63	472.14	2.223	0.0*	5-S2n	0.398	1.095	0.407	0.728	21.263	3.031
7.89	7.89	472.25	2.330	0.0*	5-S2n	0.405	1.109	0.405	0.741	22.144	3.059
8.15	8.15	472.36	2.440	0.0*	5-S2n	0.412	1.122	0.412	0.753	22.351	3.087
8.26	8.26	472.41	2.488	0.0*	5-S2n	0.415	1.127	0.415	0.758	22.436	3.098
8.67	8.67	472.59	2.673	0.0*	5-S2n	0.426	1.144	0.426	0.777	22.773	3.139
8.93	8.93	472.71	2.795	0.0*	5-S2n	0.432	1.153	0.432	0.789	22.979	3.164
9.19	9.19	472.84	2.921	0.0*	5-S2n	0.439	1.160	0.439	0.800	23.093	3.189
9.45	9.45	472.97	3.050	0.0*	5-S2n	0.446	1.166	0.446	0.812	23.274	3.213

* Full Flow Headwater elevation is below inlet invert.

****

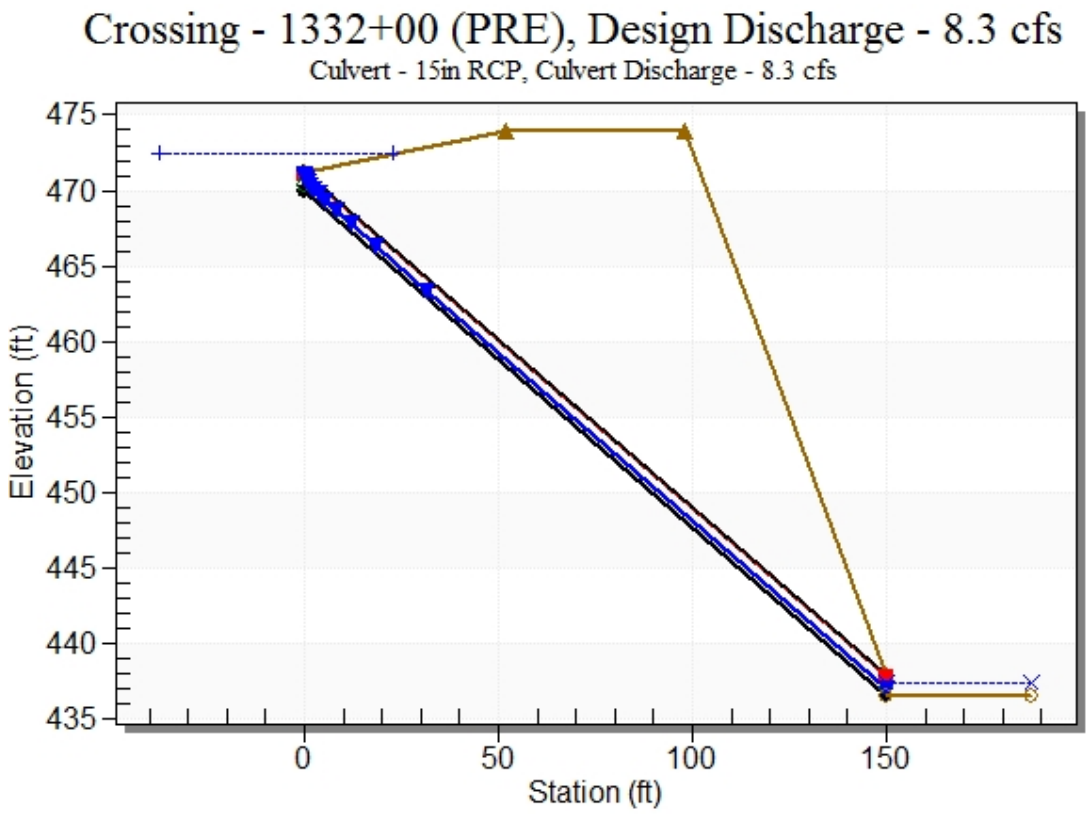
Straight Culvert

Inlet Elevation (invert): 469.92 ft, Outlet Elevation (invert): 436.60 ft

Culvert Length: 153.66 ft, Culvert Slope: 0.2221

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 469.92 ft

Outlet Station: 150.00 ft

Outlet Elevation: 436.60 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1332+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.85	437.29	0.69	2.94	1.72	0.74
7.11	437.30	0.70	2.97	1.75	0.74
7.37	437.32	0.72	3.00	1.79	0.74
7.63	437.33	0.73	3.03	1.82	0.75
7.89	437.34	0.74	3.06	1.85	0.75
8.15	437.35	0.75	3.09	1.88	0.75
8.26	437.36	0.76	3.10	1.89	0.75
8.67	437.38	0.78	3.14	1.94	0.75
8.93	437.39	0.79	3.16	1.97	0.75
9.19	437.40	0.80	3.19	2.00	0.75
9.45	437.41	0.81	3.21	2.03	0.76

Tailwater Channel Data - 1332+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 436.60 ft

Roadway Data for Crossing: 1332+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 474.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.06 cfs

Design Flow: 7.3 cfs

Maximum Flow: 8.36 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1332+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
471.58	6.06	6.06	0.00	1
471.66	6.29	6.29	0.00	1
471.73	6.52	6.52	0.00	1
471.81	6.75	6.75	0.00	1
471.89	6.98	6.98	0.00	1
471.98	7.21	7.21	0.00	1
472.01	7.30	7.30	0.00	1
472.16	7.67	7.67	0.00	1
472.25	7.90	7.90	0.00	1
472.35	8.13	8.13	0.00	1
472.45	8.36	8.36	0.00	1
474.00	11.31	11.31	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.06	6.06	471.58	1.664	0.0*	5-S2n	0.353	0.991	0.353	0.647	20.601	2.845
6.29	6.29	471.66	1.737	0.0*	5-S2n	0.360	1.008	0.360	0.659	20.858	2.875
6.52	6.52	471.73	1.813	0.0*	5-S2n	0.367	1.025	0.367	0.672	21.103	2.903
6.75	6.75	471.81	1.892	0.0*	5-S2n	0.373	1.041	0.373	0.684	21.207	2.931
6.98	6.98	471.89	1.974	0.0*	5-S2n	0.380	1.056	0.380	0.696	21.416	2.959
7.21	7.21	471.98	2.059	0.0*	5-S2n	0.386	1.071	0.386	0.707	21.623	2.985
7.30	7.30	472.01	2.094	0.0*	5-S2n	0.389	1.076	0.389	0.712	21.710	2.995
7.67	7.67	472.16	2.239	0.0*	5-S2n	0.399	1.097	0.403	0.730	21.628	3.036
7.90	7.90	472.25	2.334	0.0*	5-S2n	0.405	1.109	0.405	0.741	22.153	3.060
8.13	8.13	472.35	2.432	0.0*	5-S2n	0.411	1.121	0.411	0.752	22.336	3.084
8.36	8.36	472.45	2.532	0.0*	5-S2n	0.418	1.131	0.418	0.763	22.515	3.108

* Full Flow Headwater elevation is below inlet invert.

****

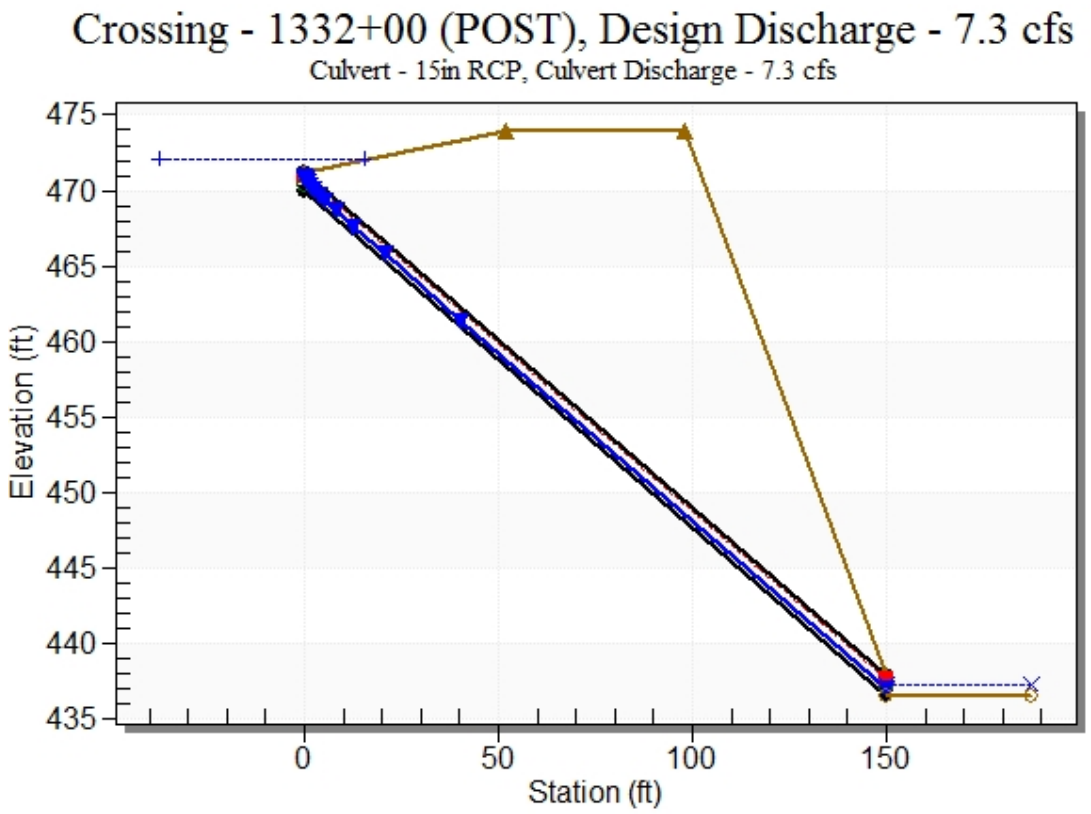
Straight Culvert

Inlet Elevation (invert): 469.92 ft, Outlet Elevation (invert): 436.60 ft

Culvert Length: 153.66 ft, Culvert Slope: 0.2221

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 469.92 ft

Outlet Station: 150.00 ft

Outlet Elevation: 436.60 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1332+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.06	437.25	0.65	2.85	1.61	0.74
6.29	437.26	0.66	2.87	1.65	0.74
6.52	437.27	0.67	2.90	1.68	0.74
6.75	437.28	0.68	2.93	1.71	0.74
6.98	437.30	0.70	2.96	1.74	0.74
7.21	437.31	0.71	2.98	1.77	0.74
7.30	437.31	0.71	3.00	1.78	0.74
7.67	437.33	0.73	3.04	1.82	0.75
7.90	437.34	0.74	3.06	1.85	0.75
8.13	437.35	0.75	3.08	1.88	0.75
8.36	437.36	0.76	3.11	1.90	0.75

Tailwater Channel Data - 1332+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 436.60 ft

Roadway Data for Crossing: 1332+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 474.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 131

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 131a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3288
Grass	0.25	0.95	0.2368
Woods	0.15	1.30	0.1948
	Σ	**2.61**	0.7604

$C_{ave} = \frac{0.7604}{2.61} = 0.29$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.53	0.4728
Grass	0.25	0.95	0.2368
Woods	0.15	1.30	0.1948
	Σ	**2.77**	0.9044

$C_{ave} = \frac{0.9044}{2.77} = 0.33$

T_c =	27.80	min.
I_{05} =	3.86	in / hr
I_{10} =	4.28	in / hr
I_{25} =	4.88	in / hr
I_{50} =	5.33	in / hr
I_{100} =	5.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.29	x	3.86	x	2.61	x	1	=	**2.94**	cfs
Q_{10} =	0.29	x	4.28	x	2.61	x	1	=	**3.25**	cfs
Q_{25} =	0.29	x	4.88	x	2.61	x	1.1	=	**4.08**	cfs
Q_{50} =	0.29	x	5.33	x	2.61	x	1.2	=	**4.87**	cfs
Q_{100} =	0.29	x	5.80	x	2.61	x	1.25	=	**5.51**	cfs

Post Construction Runoff:

Q_{05} =	0.33	x	3.86	x	2.77	x	1	=	**3.49**	cfs
Q_{10} =	0.33	x	4.28	x	2.77	x	1	=	**3.87**	cfs
Q_{25} =	0.33	x	4.88	x	2.77	x	1.1	=	**4.86**	cfs
Q_{50} =	0.33	x	5.33	x	2.77	x	1.2	=	**5.79**	cfs
Q_{100} =	0.33	x	5.80	x	2.77	x	1.25	=	**6.55**	cfs

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Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 131b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3893
Grass	0.25	0.38	0.0941
Woods	0.15	0.00	0.0000
	Σ	**0.81**	0.4833

$C_{ave} = \frac{0.4833}{0.81} = 0.60$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4399
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.49**	0.4399

$C_{ave} = \frac{0.4399}{0.49} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.60	x	6.23	x	0.81	x	1	=	**3.01**	cfs
Q_{10} =	0.60	x	6.98	x	0.81	x	1	=	**3.37**	cfs
Q_{25} =	0.60	x	8.08	x	0.81	x	1.1	=	**4.30**	cfs
Q_{50} =	0.60	x	8.93	x	0.81	x	1.2	=	**5.18**	cfs
Q_{100} =	0.60	x	9.81	x	0.81	x	1.25	=	**5.93**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.49	x	1	=	**2.74**	cfs
Q_{10} =	0.90	x	6.98	x	0.49	x	1	=	**3.07**	cfs
Q_{25} =	0.90	x	8.08	x	0.49	x	1.1	=	**3.91**	cfs
Q_{50} =	0.90	x	8.93	x	0.49	x	1.2	=	**4.71**	cfs
Q_{100} =	0.90	x	9.81	x	0.49	x	1.25	=	**5.39**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 131c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3938
Grass	0.25	0.25	0.0626
Woods	0.15	2.66	0.3986
	Σ	**3.35**	0.8550

$C_{ave} = \frac{0.8550}{3.35} = 0.26$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.60	0.5378
Grass	0.25	0.25	0.0626
Woods	0.15	2.66	0.3986
	Σ	**3.51**	0.9990

$C_{ave} = \frac{0.9990}{3.51} = 0.29$

T_c =	31.04	min.
I_{05} =	3.66	in / hr
I_{10} =	4.06	in / hr
I_{25} =	4.62	in / hr
I_{50} =	5.05	in / hr
I_{100} =	5.48	in / hr

Pre Construction Runoff:

Q_{05} =	0.26	x	3.66	x	3.35	x	1	=	**3.13**	cfs
Q_{10} =	0.26	x	4.06	x	3.35	x	1	=	**3.47**	cfs
Q_{25} =	0.26	x	4.62	x	3.35	x	1.1	=	**4.35**	cfs
Q_{50} =	0.26	x	5.05	x	3.35	x	1.2	=	**5.18**	cfs
Q_{100} =	0.26	x	5.48	x	3.35	x	1.25	=	**5.85**	cfs

Post Construction Runoff:

Q_{05} =	0.29	x	3.66	x	3.51	x	1	=	**3.66**	cfs
Q_{10} =	0.29	x	4.06	x	3.51	x	1	=	**4.05**	cfs
Q_{25} =	0.29	x	4.62	x	3.51	x	1.1	=	**5.08**	cfs
Q_{50} =	0.29	x	5.05	x	3.51	x	1.2	=	**6.05**	cfs
Q_{100} =	0.29	x	5.48	x	3.51	x	1.25	=	**6.84**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 131a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**225**				
9	Watercourse slope, s	----------	ft/ft	**0.0533**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.73**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.017**	+		=	**0.017**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.463**
							min	**27.80**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 131c	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**300**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.016**	+		=	**0.016**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.517**
							min	**31.04**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-131		Outlet	OP	462.67	462.67	0.00	0.77	0.00	31.06	0.00	6.77	0.31	0.00
CB-131c		Other	C.B. TYPE 112	468.34	468.34	3.63	0.07	31.04	31.04	12.86	6.77	0.31	5.10
CB-131b		Other	C.B. TYPE 112	470.18	470.18	3.74	0.03	27.94	27.94	8.04	3.42	0.36	5.37
CB-131a		Other	C.B. TYPE 112	471.61	471.61	3.78	0.00	27.80	27.80	4.94	2.61	0.29	5.39

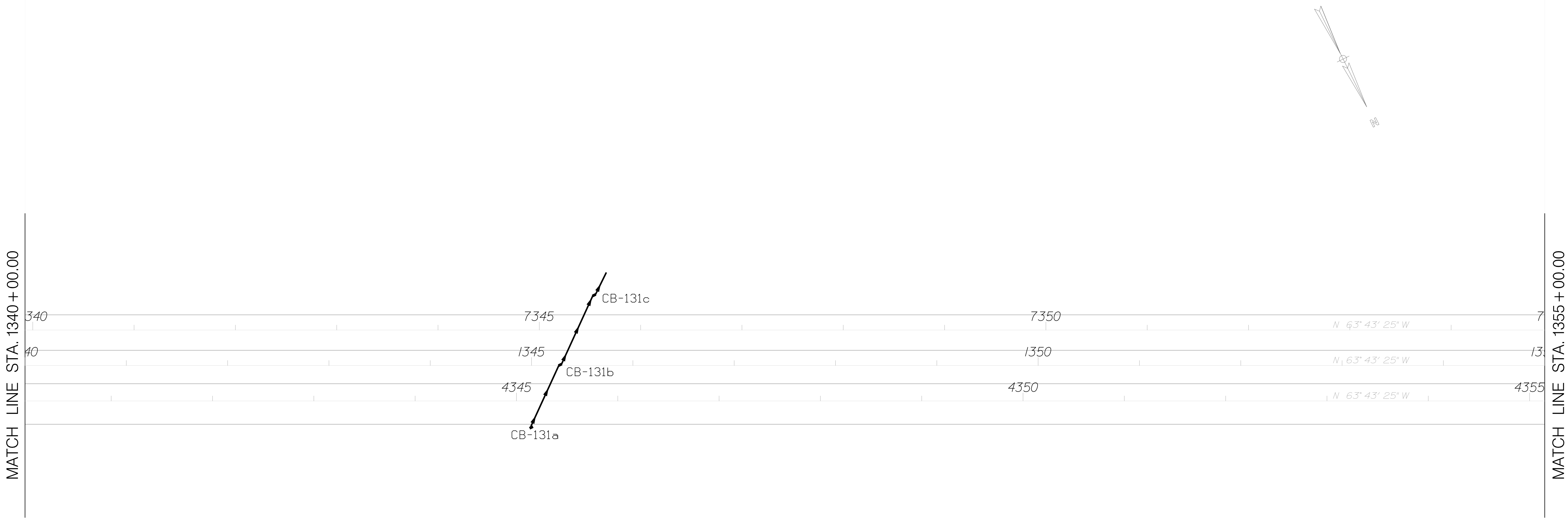
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-63	CB-131c	OF-131	Circular	Concrete	1	1.50	24	8.40	12.86	35.47	0.65	17.51	466.21	466.25	464.17	463.46	464.71	462.67	7.28	13.62	1.50	0.79
NP-62	CB-131b	CB-131c	Circular	Concrete	1	1.50	74	1.27	8.04	13.79	0.86	7.66	467.94	467.61	467.00	466.37	466.44	465.50	5.45	7.56	1.17	0.87
NP-61	CB-131a	CB-131b	Circular	Concrete	1	1.50	66	2.05	4.94	17.53	0.57	8.08	469.33	469.12	467.97	467.05	467.83	466.47	3.05	7.91	1.29	0.58

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-131c	31.04	5.24	5.10	0.26	3.35	0.26	3.35	0.00	0.00
CB-131b	5.00	5.22	9.03	0.60	0.81	0.60	0.81	0.00	0.00
CB-131a	27.80	4.94	5.39	0.29	2.61	0.29	2.61	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	57



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

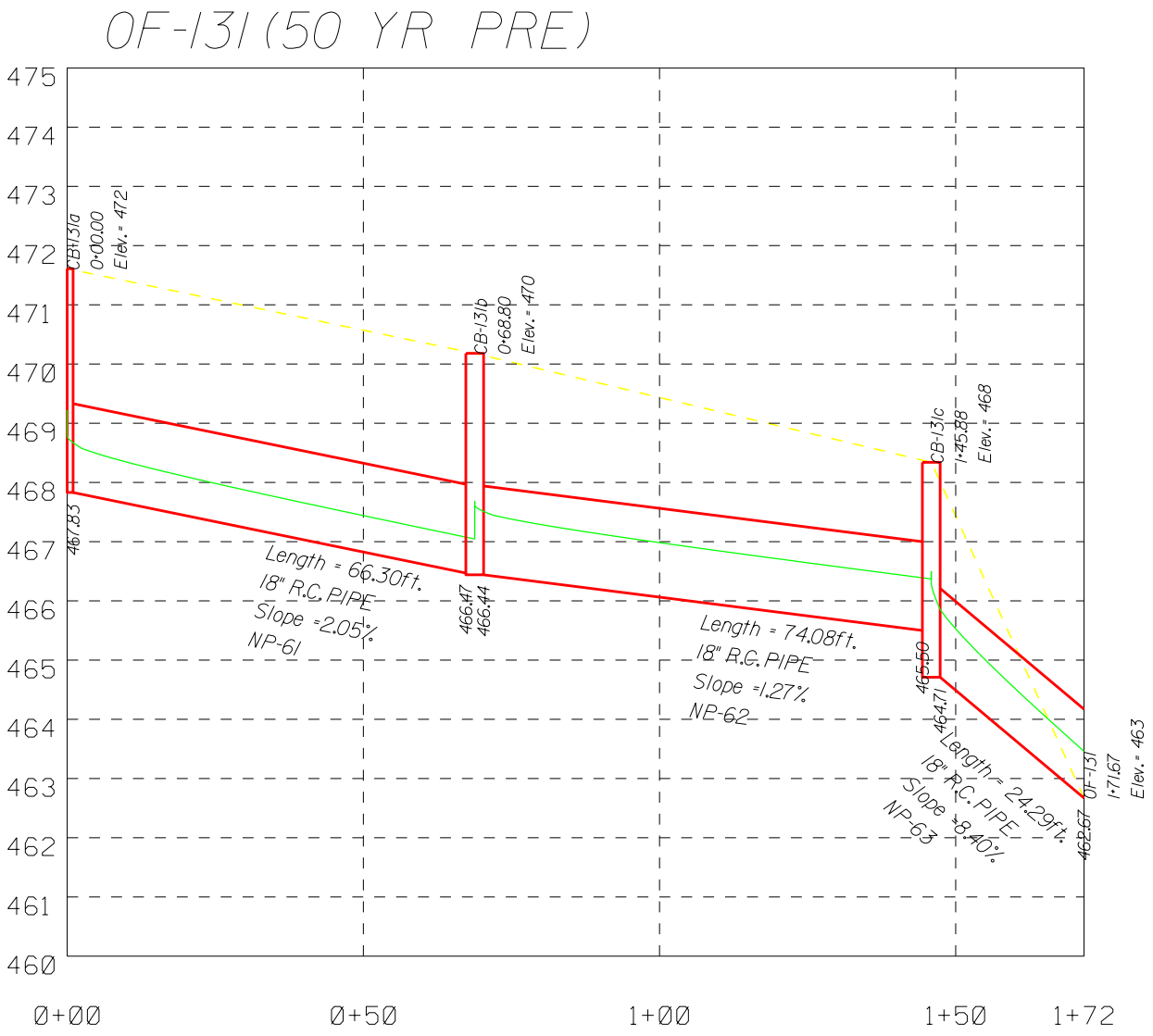
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1340+00.00 TO STA. 1355+00.00

$$$$$path$$$$$$$$$filename$$$$$$$$
$$$date$$$$


OF-131(50 YR PRE)
475
474
473
472
471
470
469
468
467
466
465
464
463
462
461
460
0+00
0+50
1+00
1+50
1+72
CB131a
0+00.00
Elev.= 472
467.83
CB-131b
0+68.80
Elev.= 470
466.47
466.44
CB-131c
1+45.88
Elev.= 468
465.60
464.71
OF-131
1+71.67
Elev.= 463
462.67
Length = 66.30ft.
18" R.C. PIPE
Slope =2.05%
NP-61
Length = 74.08ft.
18" R.C. PIPE
Slope =1.27%
NP-62
Length = 24.29ft.
18" R.C. PIPE
Slope =8.40%
NP-63

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

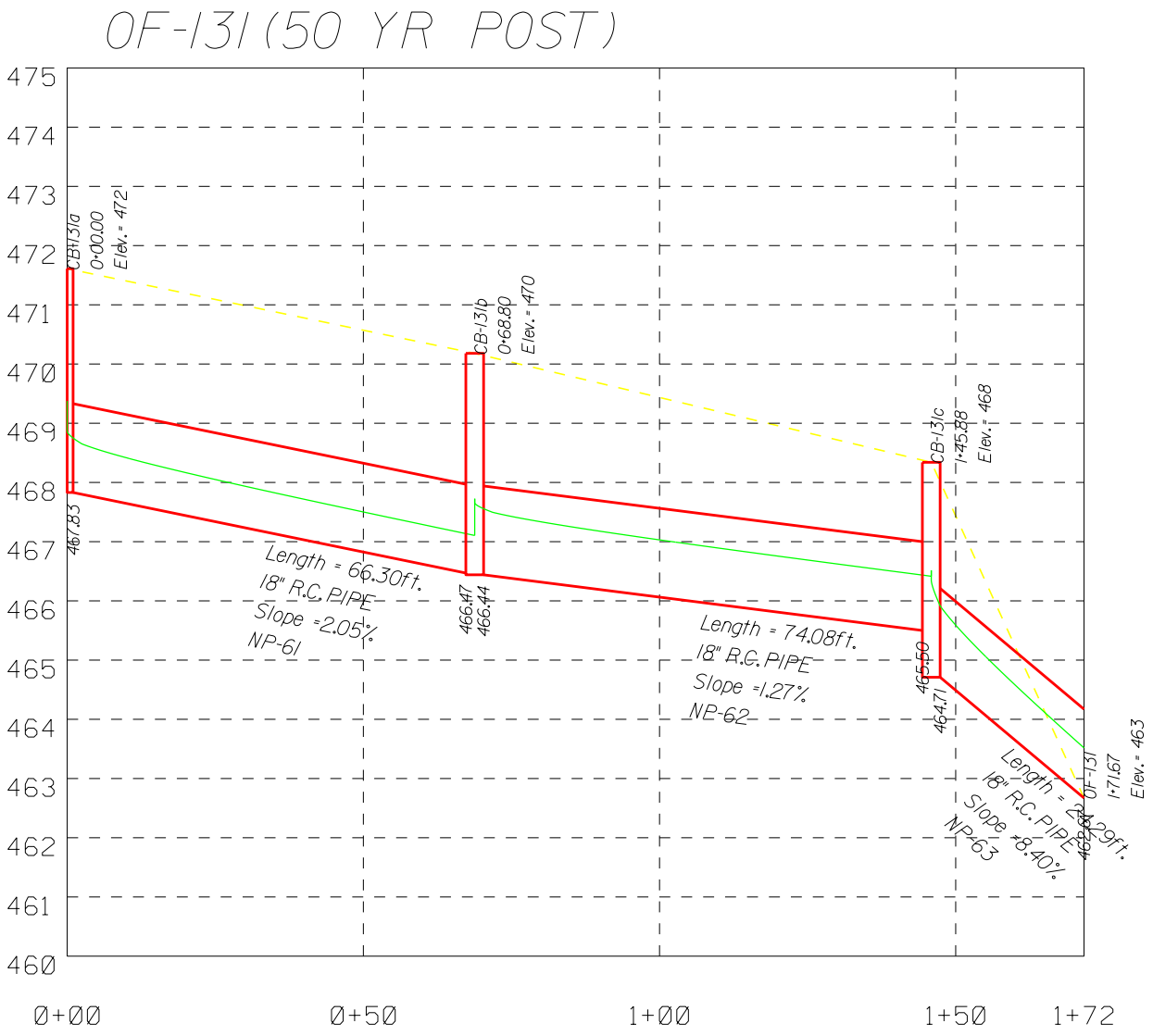
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-131	Outlet	OP	462.67	462.67	0.00	0.77	0.00	31.06	0.00	6.77	0.35	0.00
CB-131c	Other	C.B. TYPE 112	468.34	468.34	3.63	0.04	31.04	31.04	14.37	6.77	0.35	5.10
CB-131b	Other	C.B. TYPE 112	470.18	470.18	3.74	0.03	27.94	27.94	8.70	3.26	0.41	5.37
CB-131a	Other	C.B. TYPE 112	471.61	471.61	3.78	0.00	27.80	27.80	5.87	2.77	0.33	5.39

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-63	CB-131c	OF-131	Circular	Concrete	1	1.50	24	8.40	14.37	35.47	0.69	18.02	466.21	466.26	464.17	463.52	464.71	462.67	8.13	13.97	1.50	0.85
NP-62	CB-131b	CB-131c	Circular	Concrete	1	1.50	74	1.27	8.70	13.79	0.91	7.78	467.94	467.65	467.00	466.42	466.44	465.50	5.70	7.70	1.21	0.92
NP-61	CB-131a	CB-131b	Circular	Concrete	1	1.50	66	2.05	5.87	17.53	0.62	8.49	469.33	469.27	467.97	467.11	467.83	466.47	3.36	8.24	1.44	0.64

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-131c	31.04	6.12	5.10	0.29	3.51	0.29	3.51	0.00	0.00
CB-131b	5.00	4.78	9.03	0.90	0.49	0.90	0.49	0.00	0.00
CB-131a	27.80	5.87	5.39	0.33	2.77	0.33	2.77	0.00	0.00


OF-131(50 YR POST)
475
474
473
472
471
470
469
468
467
466
465
464
463
462
461
460
0+00
0+50
1+00
1+50
1+72
CB1-31a
0+00.00
Elev.= 472
467.83
CB-131b
0+68.80
Elev.= 470
466.47
466.44
CB-131c
1+45.88
Elev.= 468
465.60
464.71
OF-131
1+71.67
Elev.= 463
462.63
Length = 66.30ft.
18" R.C. PIPE
Slope =2.05%
NP-61
Length = 74.08ft.
18" R.C. PIPE
Slope =1.27%
NP-62
Length = 26.29ft.
18" R.C. PIPE
Slope =8.40%
NP-63

CULVERT 132

Hydrograph Report

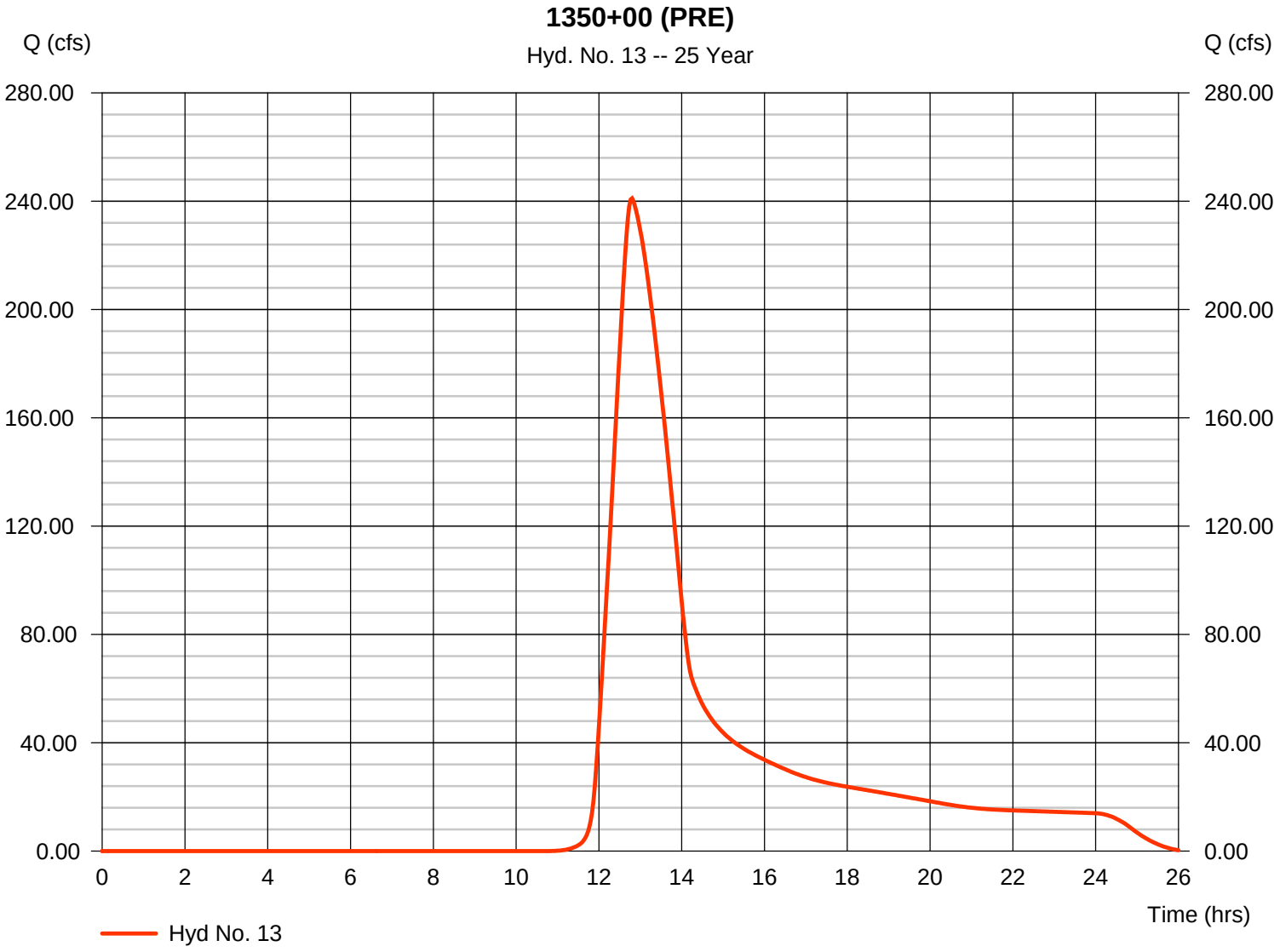
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 13

1350+00 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	241.07 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.80 hrs
Time interval	=	2 min	Hyd. volume	=	2,209,173 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



Hydrograph Report

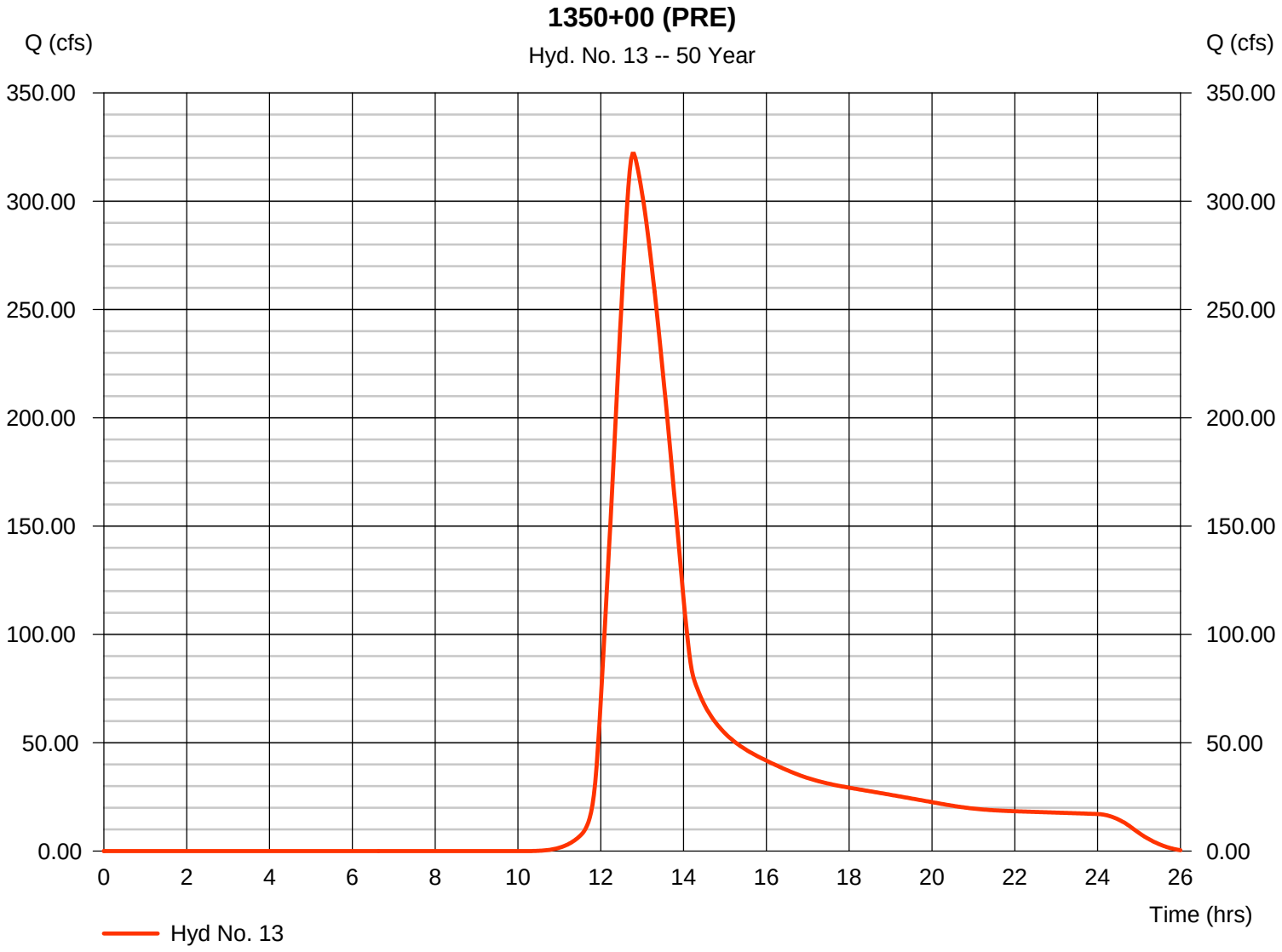
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 13

1350+00 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	321.92 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.77 hrs
Time interval	=	2 min	Hyd. volume	=	2,865,280 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



Hydrograph Report

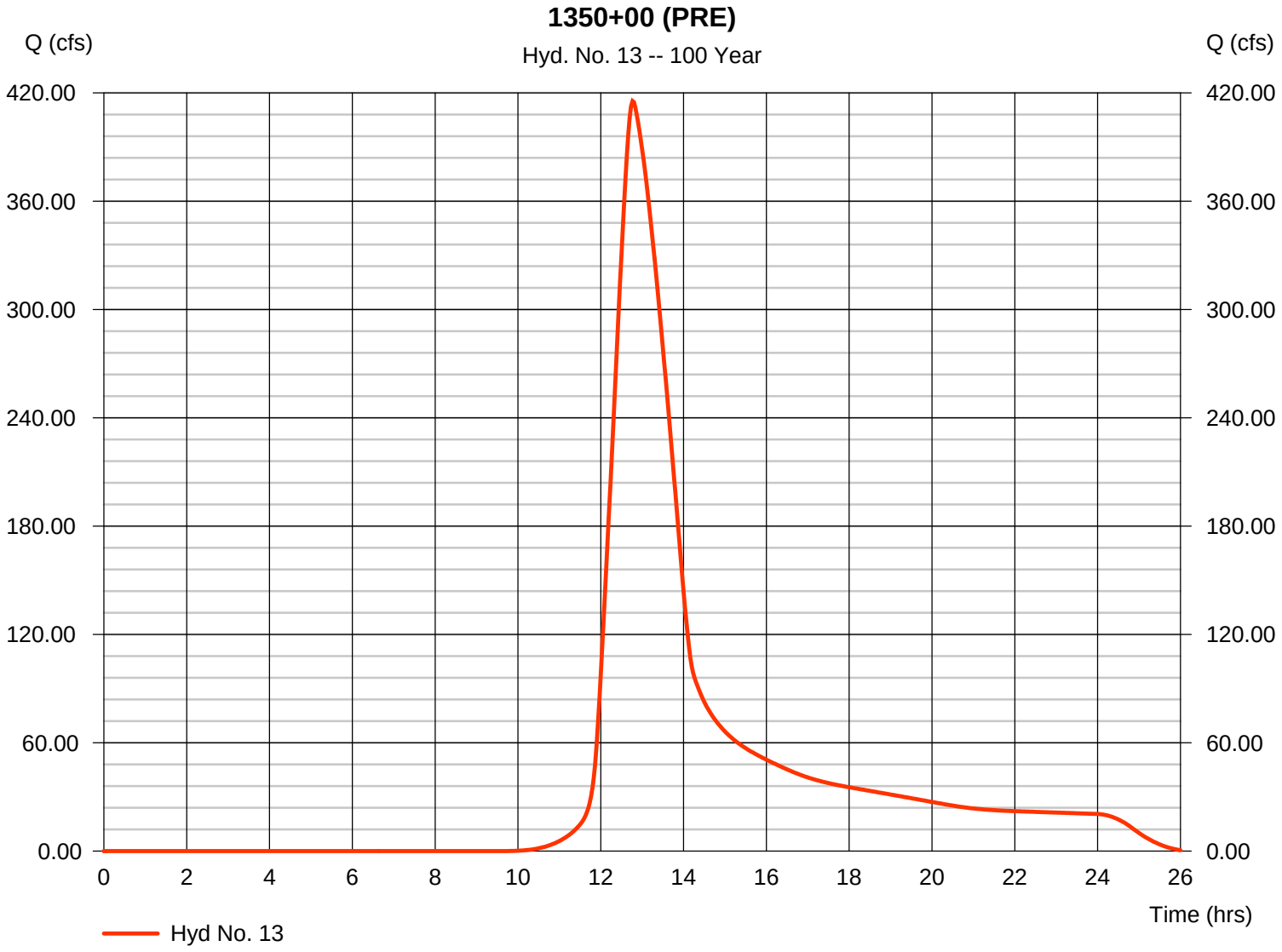
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 13

1350+00 (PRE)

Hydrograph type	=	SCS Runoff	Peak discharge	=	415.48 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.77 hrs
Time interval	=	2 min	Hyd. volume	=	3,622,690 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



Hydrograph Report

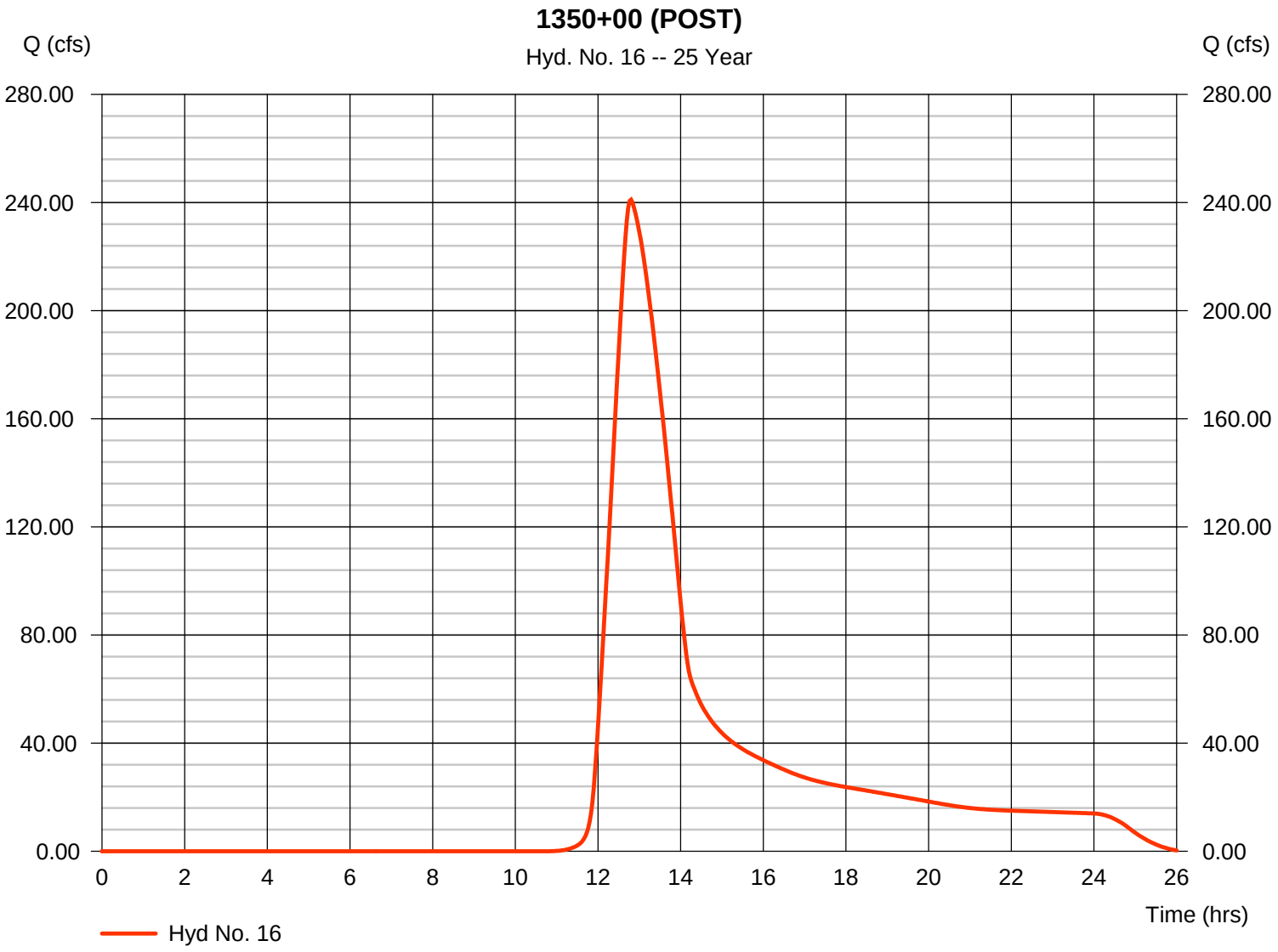
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 16

1350+00 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	241.07 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.80 hrs
Time interval	=	2 min	Hyd. volume	=	2,209,173 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	6.32 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



Hydrograph Report

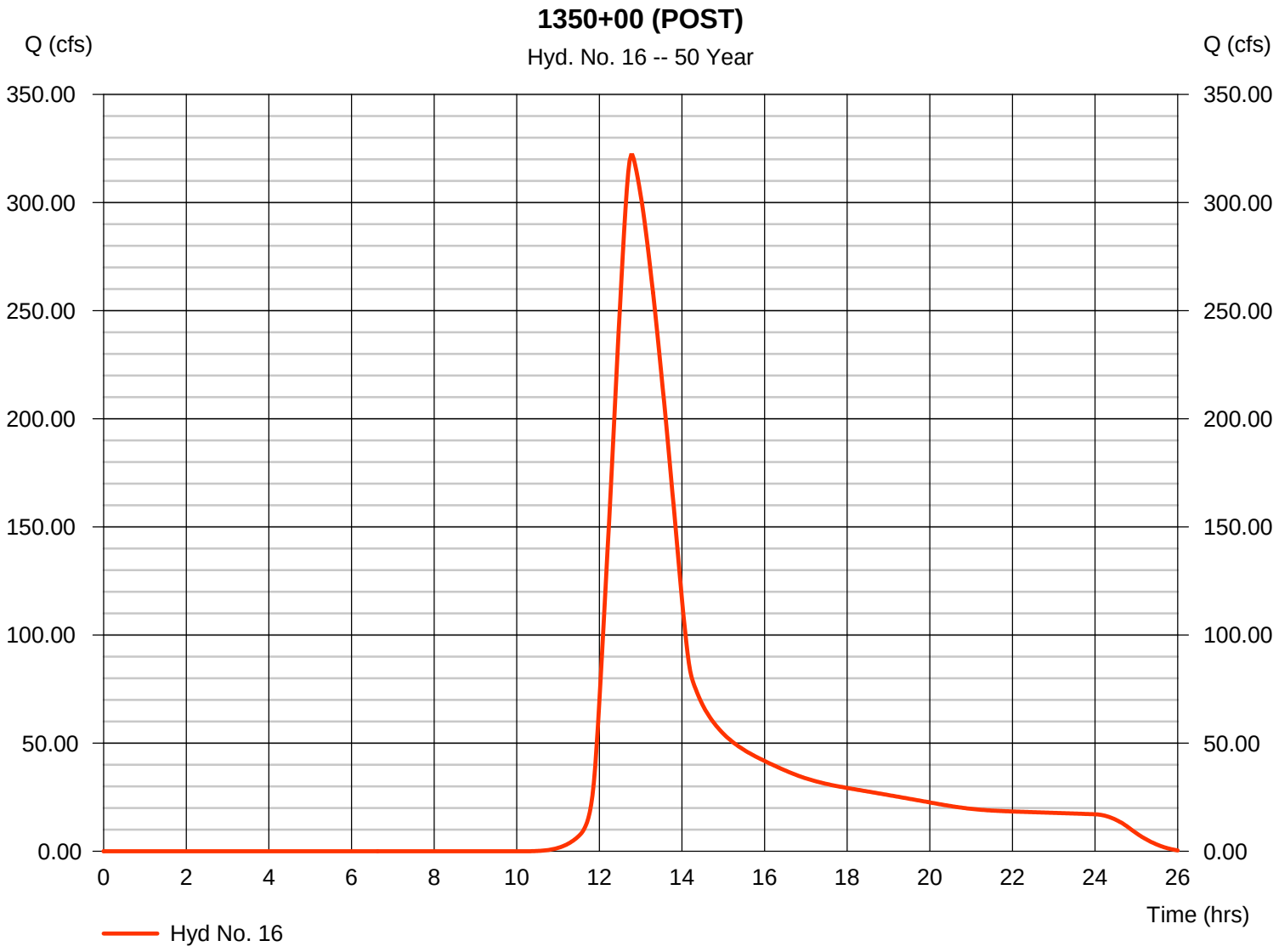
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 16

1350+00 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	321.92 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.77 hrs
Time interval	=	2 min	Hyd. volume	=	2,865,280 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	7.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



Hydrograph Report

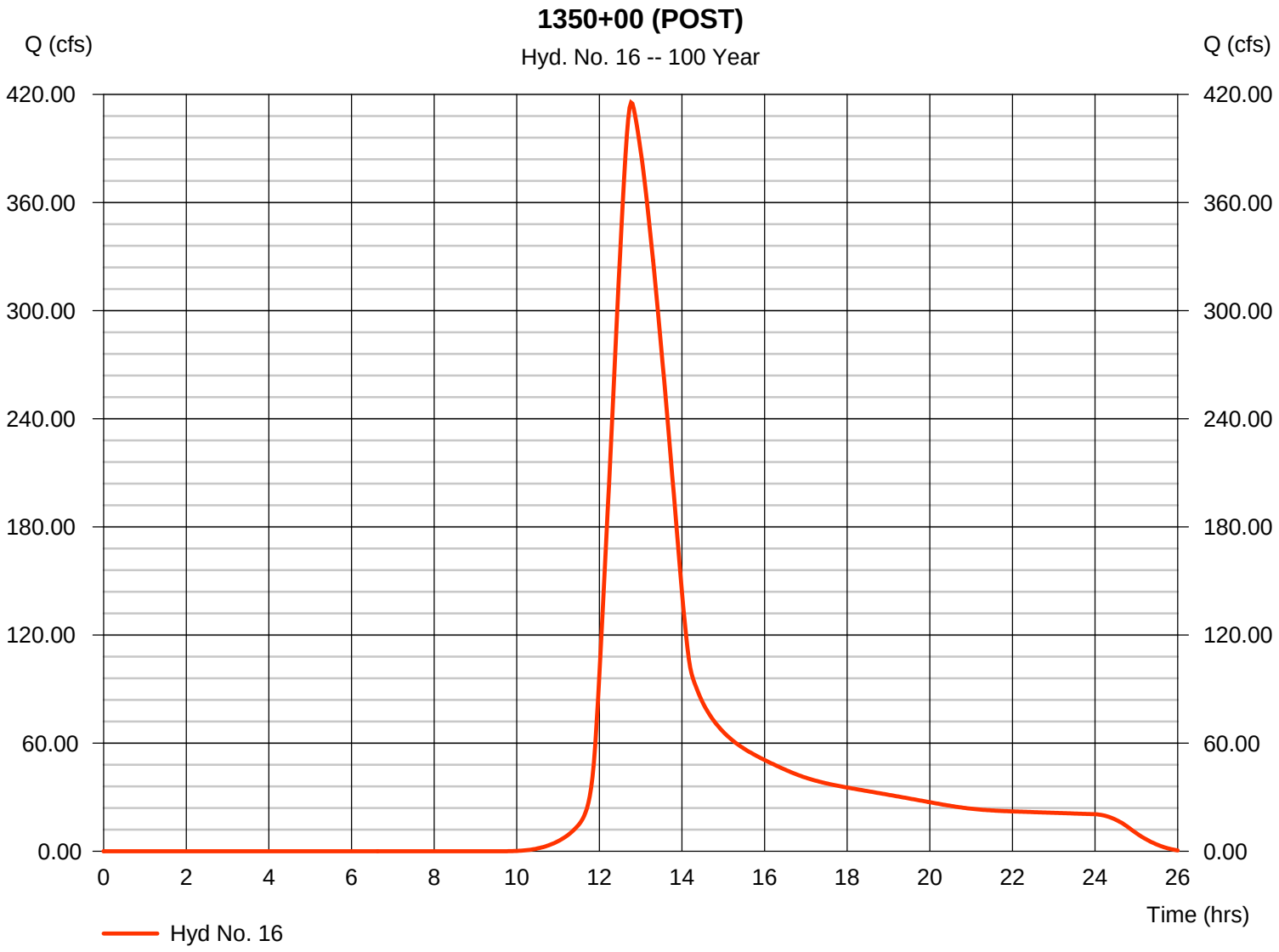
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Wednesday, 03 / 7 / 2018

Hyd. No. 16

1350+00 (POST)

Hydrograph type	=	SCS Runoff	Peak discharge	=	415.48 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.77 hrs
Time interval	=	2 min	Hyd. volume	=	3,622,690 cuft
Drainage area	=	286.580 ac	Curve number	=	60*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	85.00 min
Total precip.	=	8.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(7.380 x 98) + (5.230 x 77) + (60.120 x 70) + (2.720 x 74) + (7.050 x 61) + (204.080 x 55)] / 286.580



HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 241.07 cfs

Design Flow: 321.92 cfs

Maximum Flow: 415.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1350+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
434.65	241.07	241.07	0.00	1
434.93	258.51	258.51	0.00	1
435.20	275.95	275.95	0.00	1
435.47	293.39	293.39	0.00	1
435.74	310.83	310.83	0.00	1
435.91	321.92	321.92	0.00	1
436.28	345.72	345.72	0.00	1
436.56	363.16	363.16	0.00	1
436.84	380.60	380.60	0.00	1
437.13	398.04	398.04	0.00	1
437.43	415.48	415.48	0.00	1
459.00	1092.52	1092.52	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
241.07	241.07	434.65	5.653	0.0*	1-S2n	1.738	3.687	1.975	3.050	20.338	6.532
258.51	258.51	434.93	5.926	0.0*	1-S2n	1.826	3.863	2.088	3.156	20.639	6.654
275.95	275.95	435.20	6.197	0.0*	5-S2n	1.912	4.035	2.198	3.258	20.927	6.769
293.39	293.39	435.47	6.466	0.0*	5-S2n	1.998	4.203	2.307	3.356	21.199	6.879
310.83	310.83	435.74	6.736	0.236	5-S2n	2.083	4.368	2.415	3.450	21.449	6.983
321.92	321.92	435.91	6.909	0.484	5-S2n	2.136	4.471	2.485	3.509	21.595	7.047
345.72	345.72	436.28	7.282	1.686	5-S2n	2.249	4.689	2.630	3.631	21.906	7.180
363.16	363.16	436.56	7.559	2.019	5-S2n	2.331	4.846	2.736	3.717	22.120	7.272
380.60	380.60	436.84	7.842	2.365	5-S2n	2.413	4.999	2.841	3.801	22.325	7.361
398.04	398.04	437.13	8.130	2.721	5-S2n	2.493	5.151	2.946	3.883	22.522	7.448
415.48	415.48	437.43	8.425	3.089	5-S2n	2.573	5.300	3.049	3.962	22.712	7.531

* Full Flow Headwater elevation is below inlet invert.

****

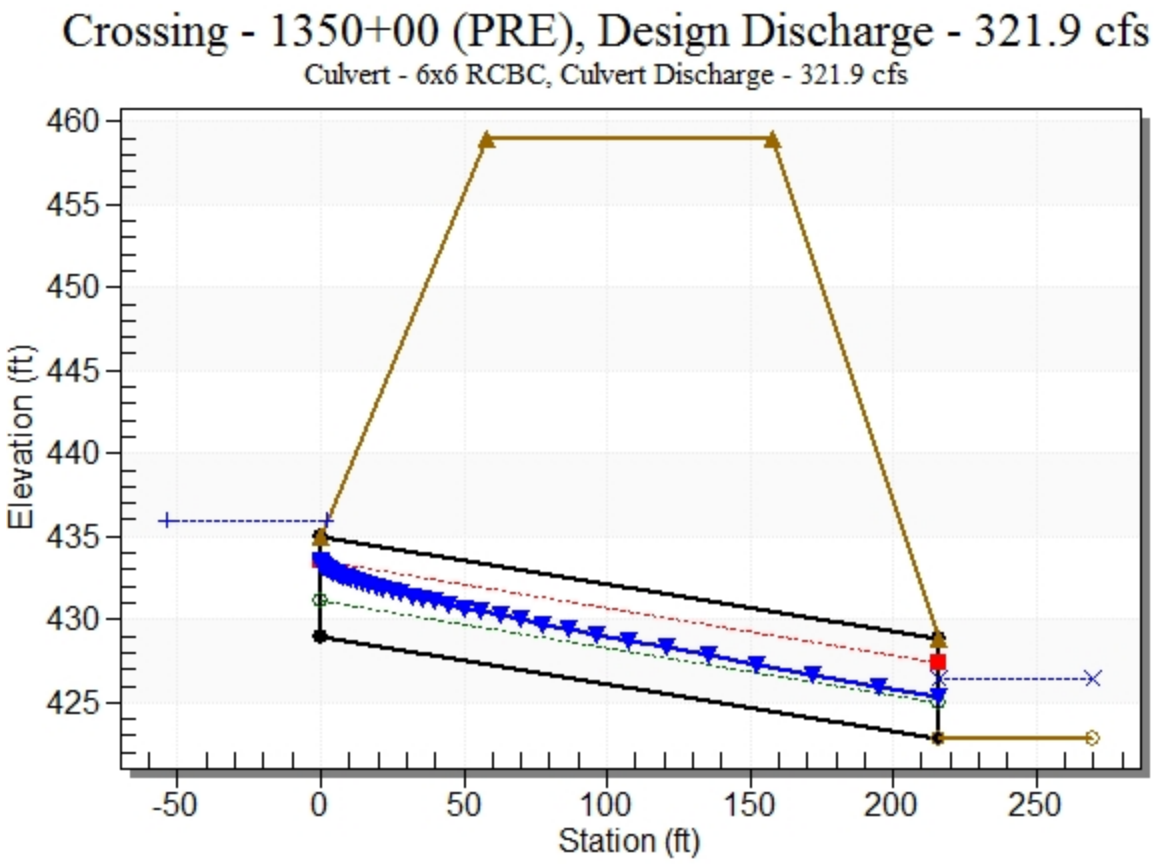
Straight Culvert

Inlet Elevation (invert): 429.00 ft, Outlet Elevation (invert): 422.87 ft

Culvert Length: 216.09 ft, Culvert Slope: 0.0284

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 429.00 ft

Outlet Station: 216.00 ft

Outlet Elevation: 422.87 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1350+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
241.07	425.92	3.05	6.53	5.71	0.81
258.51	426.03	3.16	6.65	5.91	0.81
275.95	426.13	3.26	6.77	6.10	0.81
293.39	426.23	3.36	6.88	6.28	0.82
310.83	426.32	3.45	6.98	6.46	0.82
321.92	426.38	3.51	7.05	6.57	0.82
345.72	426.50	3.63	7.18	6.80	0.83
363.16	426.59	3.72	7.27	6.96	0.83
380.60	426.67	3.80	7.36	7.12	0.83
398.04	426.75	3.88	7.45	7.27	0.83
415.48	426.83	3.96	7.53	7.42	0.84

Tailwater Channel Data - 1350+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 422.87 ft

Roadway Data for Crossing: 1350+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 459.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 241.07 cfs

Design Flow: 321.92 cfs

Maximum Flow: 415.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1350+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	6x6 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
434.65	241.07	241.07	0.00	1
434.93	258.51	258.51	0.00	1
435.20	275.95	275.95	0.00	1
435.47	293.39	293.39	0.00	1
435.74	310.83	310.83	0.00	1
435.91	321.92	321.92	0.00	1
436.28	345.72	345.72	0.00	1
436.56	363.16	363.16	0.00	1
436.84	380.60	380.60	0.00	1
437.13	398.04	398.04	0.00	1
437.43	415.48	415.48	0.00	1
459.00	1092.52	1092.52	0.00	Overtopping

Table 2 - Culvert Summary Table: 6x6 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
241.07	241.07	434.65	5.653	0.0*	1-S2n	1.738	3.687	1.975	3.050	20.338	6.532
258.51	258.51	434.93	5.926	0.0*	1-S2n	1.826	3.863	2.088	3.156	20.639	6.654
275.95	275.95	435.20	6.197	0.0*	5-S2n	1.912	4.035	2.198	3.258	20.927	6.769
293.39	293.39	435.47	6.466	0.0*	5-S2n	1.998	4.203	2.307	3.356	21.199	6.879
310.83	310.83	435.74	6.736	0.236	5-S2n	2.083	4.368	2.415	3.450	21.449	6.983
321.92	321.92	435.91	6.909	0.484	5-S2n	2.136	4.471	2.485	3.509	21.595	7.047
345.72	345.72	436.28	7.282	1.686	5-S2n	2.249	4.689	2.630	3.631	21.906	7.180
363.16	363.16	436.56	7.559	2.019	5-S2n	2.331	4.846	2.736	3.717	22.120	7.272
380.60	380.60	436.84	7.842	2.365	5-S2n	2.413	4.999	2.841	3.801	22.325	7.361
398.04	398.04	437.13	8.130	2.721	5-S2n	2.493	5.151	2.946	3.883	22.522	7.448
415.48	415.48	437.43	8.425	3.089	5-S2n	2.573	5.300	3.049	3.962	22.712	7.531

* Full Flow Headwater elevation is below inlet invert.

****

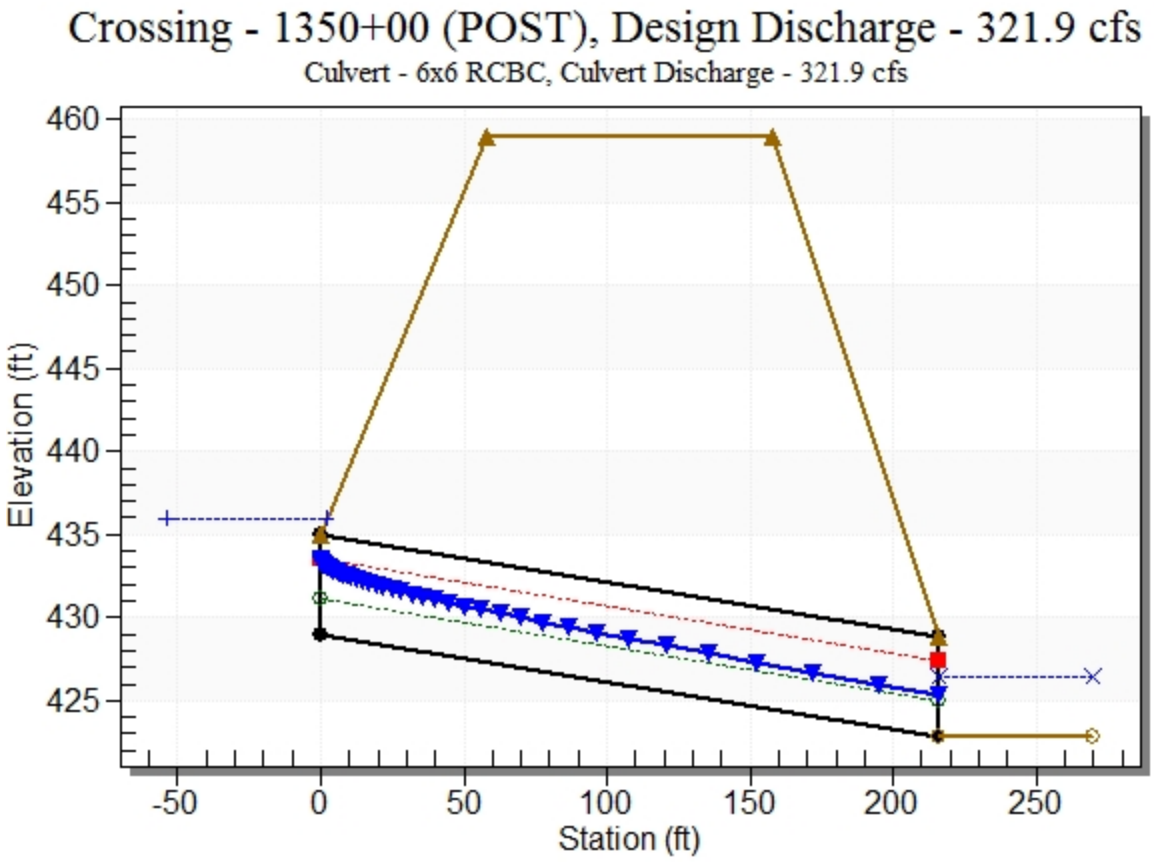
Straight Culvert

Inlet Elevation (invert): 429.00 ft, Outlet Elevation (invert): 422.87 ft

Culvert Length: 216.09 ft, Culvert Slope: 0.0284

****

Water Surface Profile Plot for Culvert: 6x6 RCBC



Site Data - 6x6 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 429.00 ft

Outlet Station: 216.00 ft

Outlet Elevation: 422.87 ft

Number of Barrels: 1

Culvert Data Summary - 6x6 RCBC

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1350+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
241.07	425.92	3.05	6.53	5.71	0.81
258.51	426.03	3.16	6.65	5.91	0.81
275.95	426.13	3.26	6.77	6.10	0.81
293.39	426.23	3.36	6.88	6.28	0.82
310.83	426.32	3.45	6.98	6.46	0.82
321.92	426.38	3.51	7.05	6.57	0.82
345.72	426.50	3.63	7.18	6.80	0.83
363.16	426.59	3.72	7.27	6.96	0.83
380.60	426.67	3.80	7.36	7.12	0.83
398.04	426.75	3.88	7.45	7.27	0.83
415.48	426.83	3.96	7.53	7.42	0.84

Tailwater Channel Data - 1350+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 422.87 ft

Roadway Data for Crossing: 1350+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 459.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 133

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 133**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7862
Grass	0.25	0.81	0.2023
Woods	0.15	0.00	0.0000
	Σ	**1.68**	0.9885

$C_{ave} = \frac{0.9885}{1.68} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.97	0.8740
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.97**	0.8740

$C_{ave} = \frac{0.8740}{0.97} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	1.68	x	1	=	**6.16**	cfs
Q_{10} =	0.59	x	6.98	x	1.68	x	1	=	**6.90**	cfs
Q_{25} =	0.59	x	8.08	x	1.68	x	1.1	=	**8.79**	cfs
Q_{50} =	0.59	x	8.93	x	1.68	x	1.2	=	**10.59**	cfs
Q_{100} =	0.59	x	9.81	x	1.68	x	1.25	=	**12.12**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.97	x	1	=	**5.45**	cfs
Q_{10} =	0.90	x	6.98	x	0.97	x	1	=	**6.10**	cfs
Q_{25} =	0.90	x	8.08	x	0.97	x	1.1	=	**7.77**	cfs
Q_{50} =	0.90	x	8.93	x	0.97	x	1.2	=	**9.36**	cfs
Q_{100} =	0.90	x	9.81	x	0.97	x	1.25	=	**10.72**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.79 cfs

Design Flow: 10.59 cfs

Maximum Flow: 12.12 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1351+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
457.03	8.79	8.15	0.58	21
457.03	9.12	8.17	0.91	4
457.04	9.46	8.18	1.20	3
457.05	9.79	8.20	1.52	3
457.05	10.12	8.21	1.85	3
457.06	10.45	8.23	2.18	3
457.06	10.59	8.23	2.33	3
457.07	11.12	8.25	2.82	3
457.08	11.45	8.27	3.16	3
457.08	11.79	8.28	3.49	3
457.09	12.12	8.29	3.81	3
457.00	8.09	8.09	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.79	8.15	457.03	2.455	0.0*	5-S2n	0.426	1.122	0.455	0.739	19.549	3.418
9.12	8.17	457.03	2.464	0.0*	5-S2n	0.426	1.123	0.454	0.754	19.611	3.452
9.46	8.18	457.04	2.471	0.0*	5-S2n	0.427	1.123	0.454	0.767	19.658	3.486
9.79	8.20	457.05	2.478	0.0*	5-S2n	0.427	1.124	0.454	0.781	19.706	3.519
10.12	8.21	457.05	2.484	0.0*	5-S2n	0.427	1.125	0.454	0.794	19.751	3.551
10.45	8.23	457.06	2.491	0.0*	5-S2n	0.428	1.125	0.454	0.807	19.793	3.582
10.59	8.23	457.06	2.493	0.0*	5-S2n	0.428	1.126	0.454	0.813	19.811	3.595
11.12	8.25	457.07	2.502	0.0*	5-S2n	0.429	1.127	0.454	0.833	19.868	3.642
11.45	8.27	457.08	2.508	0.0*	5-S2n	0.429	1.127	0.453	0.845	19.904	3.671
11.79	8.28	457.08	2.513	0.0*	5-S2n	0.429	1.128	0.453	0.858	19.938	3.700
12.12	8.29	457.09	2.518	0.0*	5-S2n	0.430	1.128	0.453	0.870	19.970	3.727

* Full Flow Headwater elevation is below inlet invert.

****

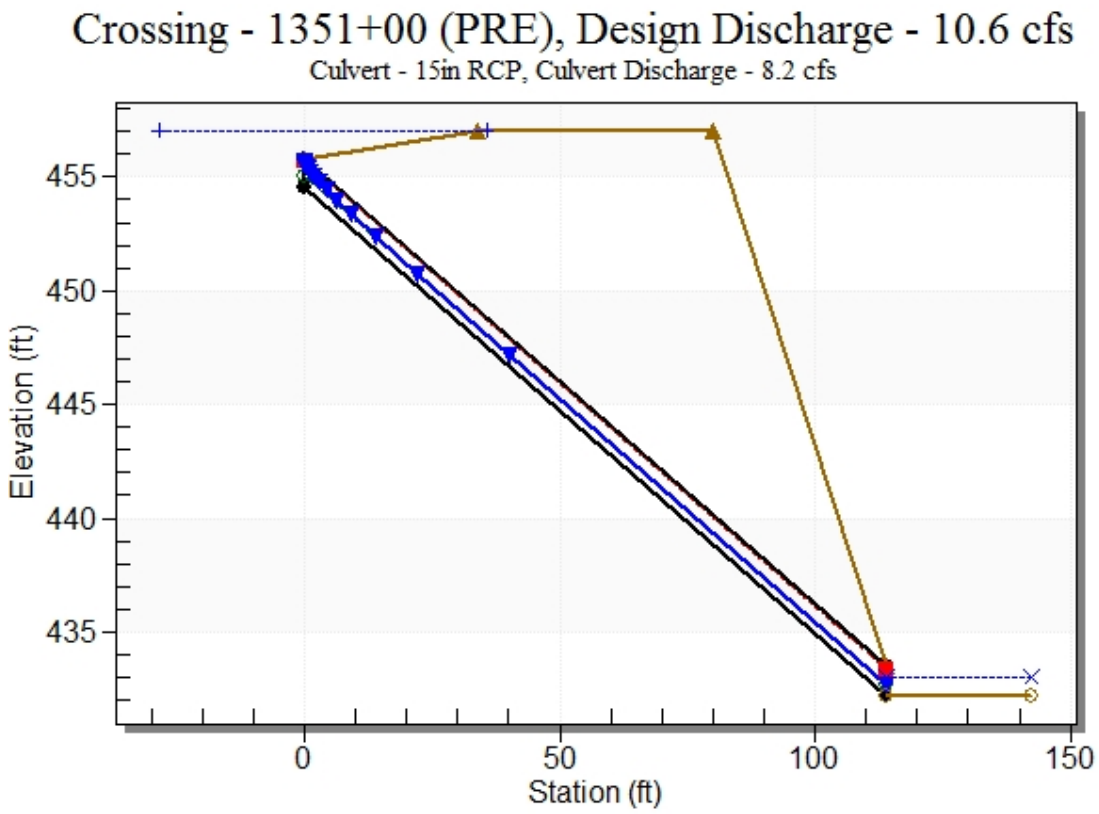
Straight Culvert

Inlet Elevation (invert): 454.57 ft, Outlet Elevation (invert): 432.22 ft

Culvert Length: 116.17 ft, Culvert Slope: 0.1961

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 454.57 ft

Outlet Station: 114.00 ft

Outlet Elevation: 432.22 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1351+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
8.79	432.96	0.74	3.42	2.31	0.84
9.12	432.97	0.75	3.45	2.35	0.84
9.46	432.99	0.77	3.49	2.39	0.84
9.79	433.00	0.78	3.52	2.44	0.84
10.12	433.01	0.79	3.55	2.48	0.84
10.45	433.03	0.81	3.58	2.52	0.84
10.59	433.03	0.81	3.59	2.54	0.85
11.12	433.05	0.83	3.64	2.60	0.85
11.45	433.07	0.85	3.67	2.64	0.85
11.79	433.08	0.86	3.70	2.68	0.85
12.12	433.09	0.87	3.73	2.71	0.85

Tailwater Channel Data - 1351+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 432.22 ft

Roadway Data for Crossing: 1351+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 457.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.77 cfs

Design Flow: 9.36 cfs

Maximum Flow: 10.72 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1351+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
456.87	7.77	7.77	0.00	1
456.99	8.06	8.06	0.00	1
457.01	8.36	8.12	0.20	8
457.02	8.65	8.14	0.46	4
457.03	8.95	8.16	0.75	4
457.04	9.25	8.17	1.01	3
457.04	9.36	8.18	1.14	3
457.05	9.84	8.20	1.57	3
457.05	10.13	8.21	1.87	3
457.06	10.43	8.23	2.16	3
457.07	10.72	8.24	2.45	3
457.00	8.09	8.09	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.77	7.77	456.87	2.296	0.0*	5-S2n	0.415	1.103	0.415	0.694	21.086	3.304
8.06	8.06	456.99	2.420	0.0*	5-S2n	0.423	1.118	0.456	0.708	19.297	3.338
8.36	8.12	457.01	2.442	0.0*	5-S2n	0.425	1.120	0.455	0.721	19.457	3.371
8.65	8.14	457.02	2.451	0.0*	5-S2n	0.425	1.121	0.455	0.734	19.521	3.403
8.95	8.16	457.03	2.459	0.0*	5-S2n	0.426	1.122	0.454	0.746	19.580	3.434
9.25	8.17	457.04	2.466	0.0*	5-S2n	0.426	1.123	0.454	0.759	19.624	3.464
9.36	8.18	457.04	2.469	0.0*	5-S2n	0.427	1.123	0.454	0.763	19.645	3.476
9.84	8.20	457.05	2.478	0.0*	5-S2n	0.427	1.124	0.454	0.783	19.709	3.523
10.13	8.21	457.05	2.484	0.0*	5-S2n	0.427	1.125	0.454	0.795	19.750	3.551
10.43	8.23	457.06	2.490	0.0*	5-S2n	0.428	1.125	0.454	0.806	19.787	3.579
10.72	8.24	457.07	2.495	0.0*	5-S2n	0.428	1.126	0.454	0.818	19.822	3.606

* Full Flow Headwater elevation is below inlet invert.

****

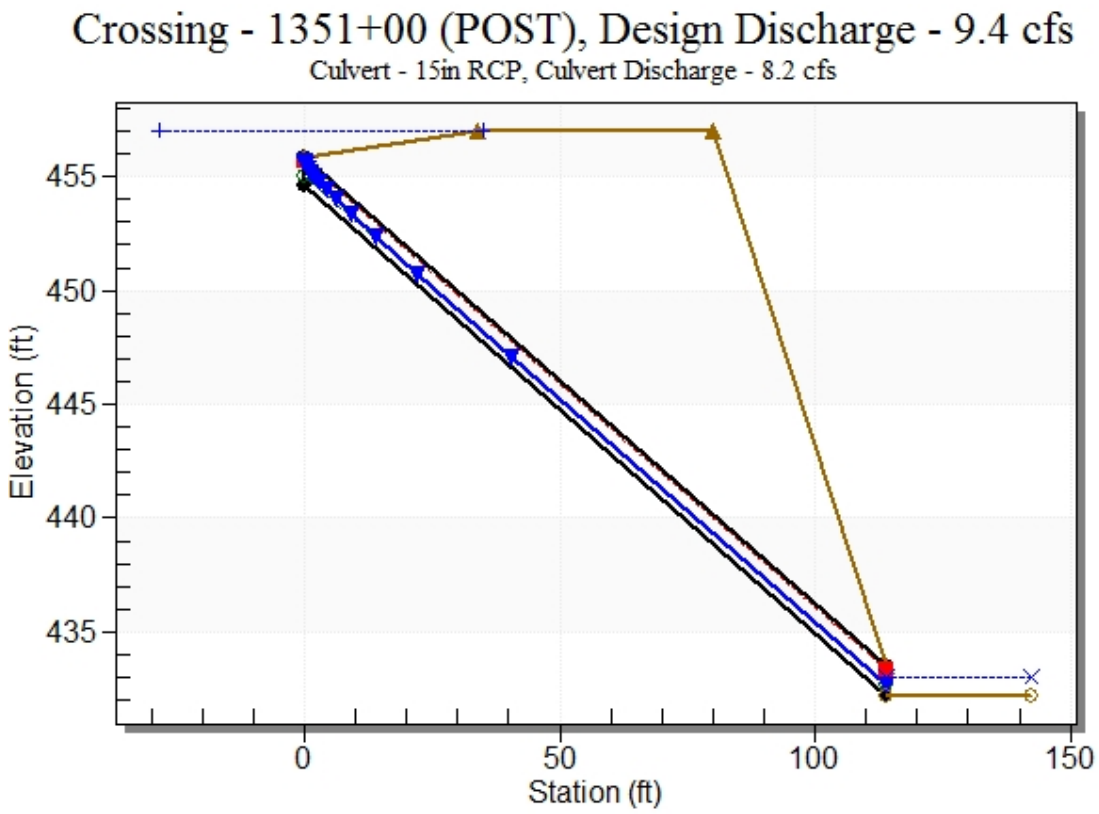
Straight Culvert

Inlet Elevation (invert): 454.57 ft, Outlet Elevation (invert): 432.22 ft

Culvert Length: 116.17 ft, Culvert Slope: 0.1961

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 454.57 ft

Outlet Station: 114.00 ft

Outlet Elevation: 432.22 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1351+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.77	432.91	0.69	3.30	2.17	0.83
8.06	432.93	0.71	3.34	2.21	0.83
8.36	432.94	0.72	3.37	2.25	0.83
8.65	432.95	0.73	3.40	2.29	0.84
8.95	432.97	0.75	3.43	2.33	0.84
9.25	432.98	0.76	3.46	2.37	0.84
9.36	432.98	0.76	3.48	2.38	0.84
9.84	433.00	0.78	3.52	2.44	0.84
10.13	433.01	0.79	3.55	2.48	0.84
10.43	433.03	0.81	3.58	2.52	0.84
10.72	433.04	0.82	3.61	2.55	0.85

Tailwater Channel Data - 1351+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 432.22 ft

Roadway Data for Crossing: 1351+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 457.00 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 134

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 134a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.42	0.3812
Grass	0.25	0.41	0.1030
Woods	0.15	0.00	0.0000
	Σ	**0.84**	0.4842

$C_{ave} = \frac{0.4842}{0.84} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4370
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.49**	0.4370

$C_{ave} = \frac{0.4370}{0.49} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	0.84	x	1	=	**3.02**	cfs
Q_{10} =	0.58	x	6.98	x	0.84	x	1	=	**3.38**	cfs
Q_{25} =	0.58	x	8.08	x	0.84	x	1.1	=	**4.31**	cfs
Q_{50} =	0.58	x	8.93	x	0.84	x	1.2	=	**5.19**	cfs
Q_{100} =	0.58	x	9.81	x	0.84	x	1.25	=	**5.94**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.49	x	1	=	**2.72**	cfs
Q_{10} =	0.90	x	6.98	x	0.49	x	1	=	**3.05**	cfs
Q_{25} =	0.90	x	8.08	x	0.49	x	1.1	=	**3.88**	cfs
Q_{50} =	0.90	x	8.93	x	0.49	x	1.2	=	**4.68**	cfs
Q_{100} =	0.90	x	9.81	x	0.49	x	1.25	=	**5.36**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 134b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4289
Grass	0.25	0.22	0.0554
Woods	0.15	0.52	0.0782
	Σ	**1.22**	0.5625

$C_{ave} = \frac{0.5625}{1.22} = 0.46$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5909
Grass	0.25	0.22	0.0554
Woods	0.15	0.52	0.0782
	Σ	**1.40**	0.7245

$C_{ave} = \frac{0.7245}{1.40} = 0.52$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.46	x	6.23	x	1.22	x	1	=	**3.50**	cfs
Q_{10} =	0.46	x	6.98	x	1.22	x	1	=	**3.93**	cfs
Q_{25} =	0.46	x	8.08	x	1.22	x	1.1	=	**5.00**	cfs
Q_{50} =	0.46	x	8.93	x	1.22	x	1.2	=	**6.02**	cfs
Q_{100} =	0.46	x	9.81	x	1.22	x	1.25	=	**6.90**	cfs

Post Construction Runoff:

Q_{05} =	0.52	x	6.23	x	1.40	x	1	=	**4.51**	cfs
Q_{10} =	0.52	x	6.98	x	1.40	x	1	=	**5.06**	cfs
Q_{25} =	0.52	x	8.08	x	1.40	x	1.1	=	**6.44**	cfs
Q_{50} =	0.52	x	8.93	x	1.40	x	1.2	=	**7.76**	cfs
Q_{100} =	0.52	x	9.81	x	1.40	x	1.25	=	**8.88**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-134		Outlet	OP	471.05	471.05	0.00	0.77	0.00	5.17	0.00	2.06	0.51	0.00
CB-134b		Other	C.B. TYPE 112	475.37	475.37	4.20	0.20	5.13	5.13	11.28	2.06	0.51	8.99
CB-134a		Other	C.B. TYPE 112	475.64	475.64	3.21	0.00	5.00	5.00	5.21	0.84	0.57	9.03

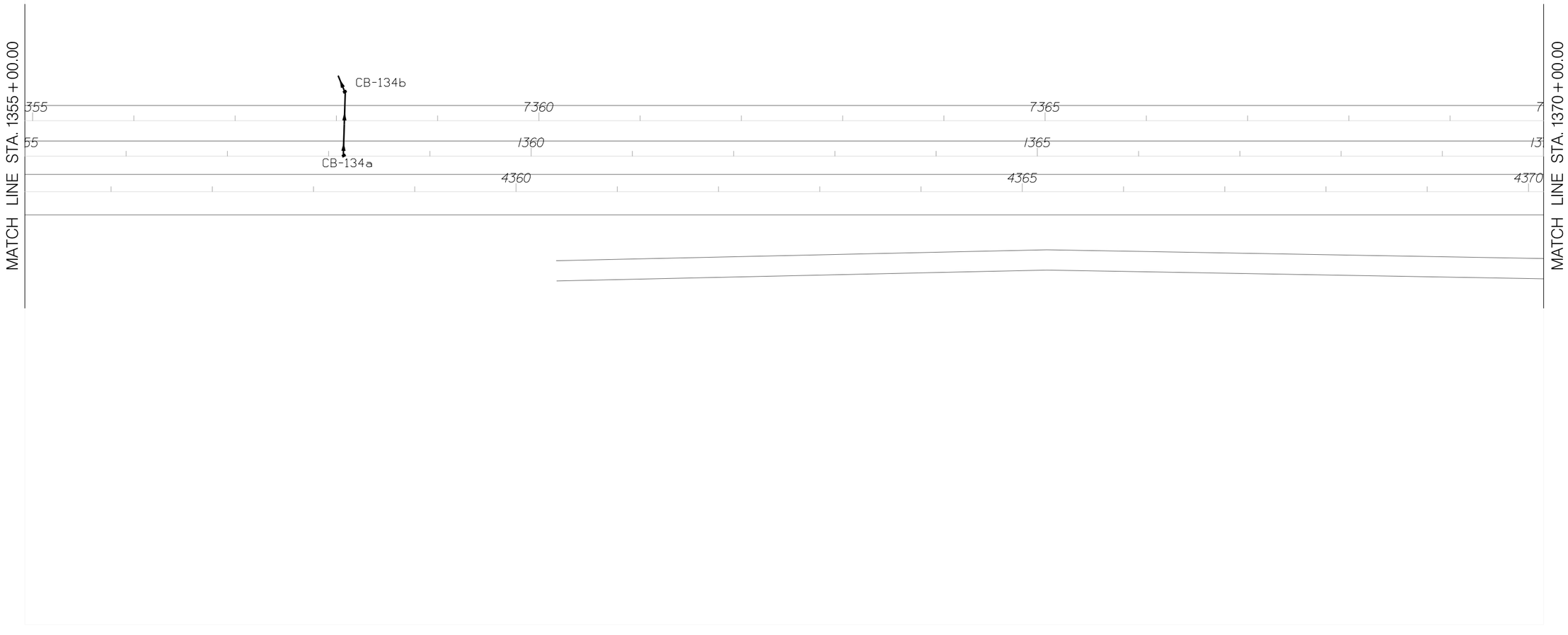
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-65	CB-134b	OF-134	Circular	Concrete	1	1.50	16	0.74	11.28	10.55	1.50	6.55	472.67	472.77	472.55	472.33	471.17	471.05	6.38	7.01	1.50	1.28
NP-64	CB-134a	CB-134b	Circular	Concrete	1	1.25	61	2.06	5.21	10.79	0.64	8.24	473.68	473.99	472.42	471.82	472.43	471.17	4.24	8.05	1.25	0.65

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-134b	5.00	6.12	9.03	0.46	1.22	0.46	1.22	0.00	0.00
CB-134a	5.00	5.21	9.03	0.57	0.84	0.58	0.83	0.00	0.01

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	58



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$$$$date$$$$

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

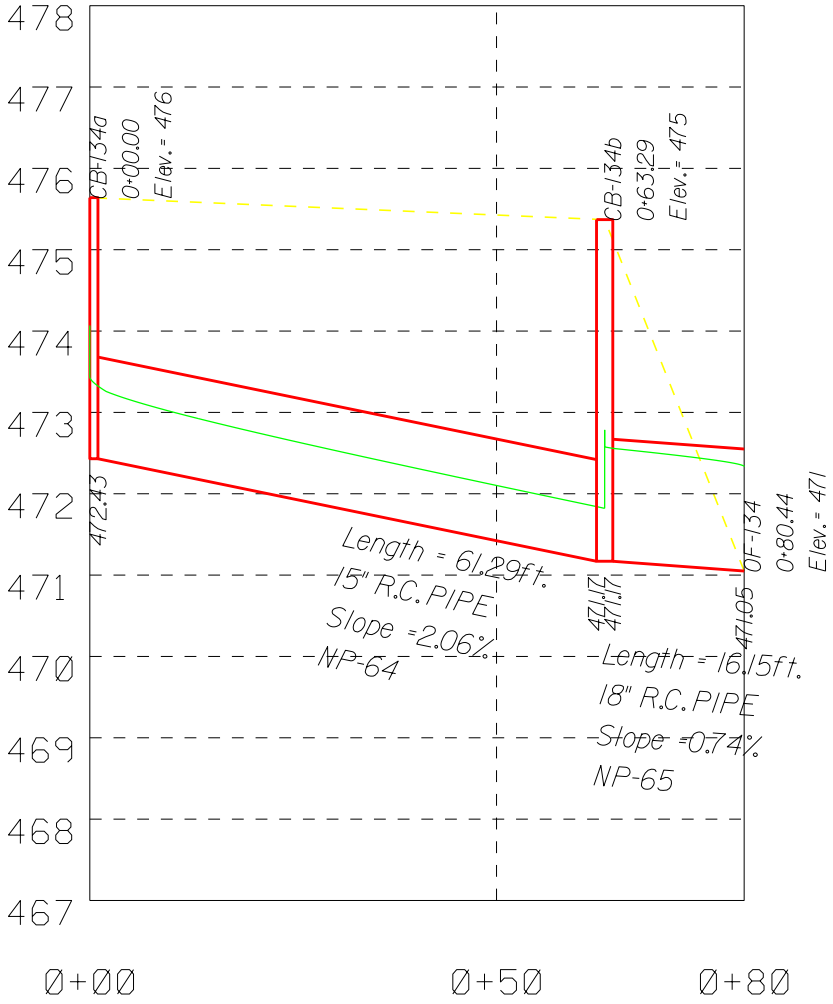
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1355+00.00 TO STA. 1370+00.00

OF-134 (50 YR PRE)



SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-134	Outlet	OP	471.05	471.05	0.00	0.77	0.00	5.17	0.00	1.89	0.62	0.00
CB-134b	Other	C.B. TYPE 112	475.37	475.37	4.20	0.24	5.13	5.13	12.60	1.89	0.62	8.99
CB-134a	Other	C.B. TYPE 112	475.64	475.64	3.21	0.00	5.00	5.00	4.78	0.49	0.90	9.03

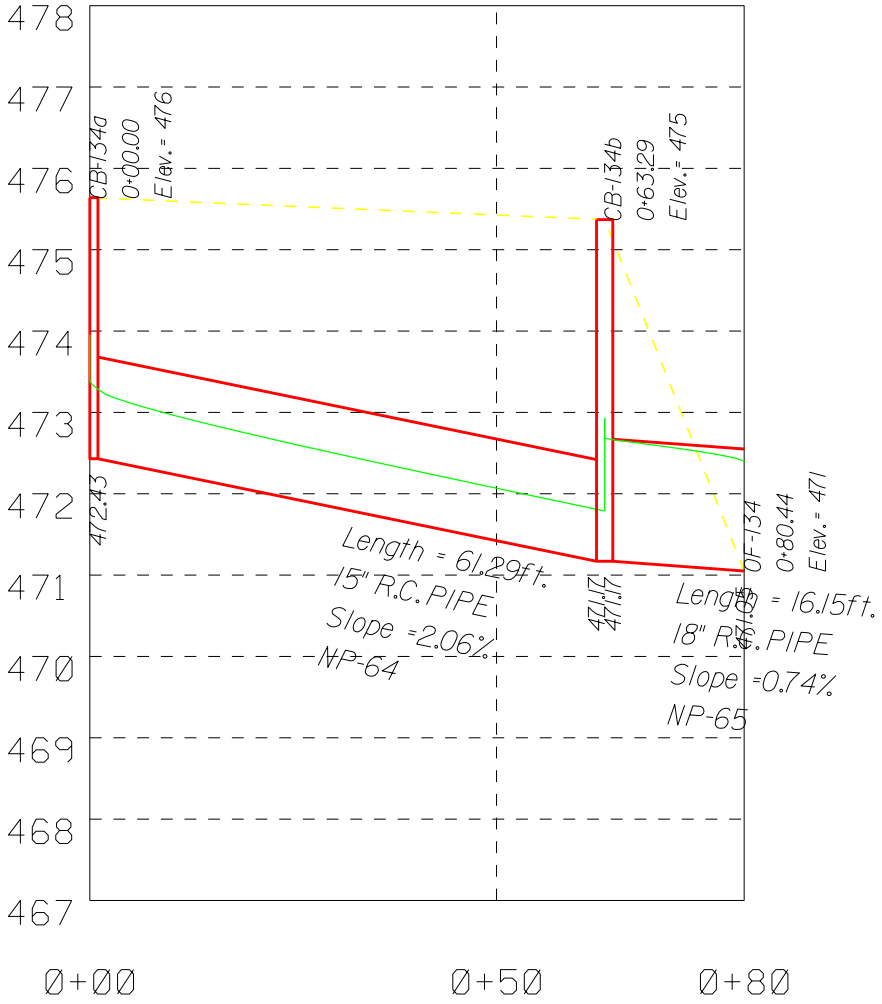
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-65	CB-134b	OF-134	Circular	Concrete	1	1.50	16	0.74	12.60	10.55	1.50	7.32	472.67	472.92	472.55	472.39	471.17	471.05	7.13	7.58	1.50	1.34
NP-64	CB-134a	CB-134b	Circular	Concrete	1	1.25	61	2.06	4.78	10.79	0.61	8.08	473.68	473.88	472.42	471.79	472.43	471.17	3.89	7.89	1.25	0.62

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-134b	5.00	7.88	9.03	0.52	1.40	0.52	1.40	0.00	0.00
CB-134a	5.00	4.78	9.03	0.90	0.49	0.90	0.49	0.00	0.00

OF-134 (50 YR POST)



CULVERT 135

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 135**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3362
Grass	0.25	0.35	0.0866
Woods	0.15	0.00	0.0000
	Σ	**0.72**	0.4227

$C_{ave} = \frac{0.4227}{0.72} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.42	0.3780
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.42**	0.3780

$C_{ave} = \frac{0.3780}{0.42} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	0.72	x	1	=	**2.63**	cfs
Q_{10} =	0.59	x	6.98	x	0.72	x	1	=	**2.95**	cfs
Q_{25} =	0.59	x	8.08	x	0.72	x	1.1	=	**3.76**	cfs
Q_{50} =	0.59	x	8.93	x	0.72	x	1.2	=	**4.53**	cfs
Q_{100} =	0.59	x	9.81	x	0.72	x	1.25	=	**5.18**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.42	x	1	=	**2.36**	cfs
Q_{10} =	0.90	x	6.98	x	0.42	x	1	=	**2.64**	cfs
Q_{25} =	0.90	x	8.08	x	0.42	x	1.1	=	**3.36**	cfs
Q_{50} =	0.90	x	8.93	x	0.42	x	1.2	=	**4.05**	cfs
Q_{100} =	0.90	x	9.81	x	0.42	x	1.25	=	**4.63**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.76 cfs

Design Flow: 4.53 cfs

Maximum Flow: 5.18 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1364+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
495.21	3.76	3.76	0.00	1
495.24	3.90	3.90	0.00	1
495.27	4.04	4.04	0.00	1
495.31	4.19	4.19	0.00	1
495.34	4.33	4.33	0.00	1
495.37	4.47	4.47	0.00	1
495.39	4.53	4.53	0.00	1
495.44	4.75	4.75	0.00	1
495.48	4.90	4.90	0.00	1
495.51	5.04	5.04	0.00	1
495.55	5.18	5.18	0.00	1
496.69	8.41	8.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.76	3.76	495.21	1.200	0.0*	1-S2n	0.527	0.780	0.527	0.451	7.406	2.873
3.90	3.90	495.24	1.231	0.0*	1-S2n	0.538	0.795	0.538	0.460	7.470	2.904
4.04	4.04	495.27	1.263	0.0*	5-S2n	0.549	0.809	0.549	0.469	7.542	2.934
4.19	4.19	495.31	1.295	0.0*	5-S2n	0.560	0.823	0.560	0.478	7.613	2.964
4.33	4.33	495.34	1.328	0.0*	5-S2n	0.571	0.841	0.571	0.486	7.672	2.992
4.47	4.47	495.37	1.361	0.0*	5-S2n	0.581	0.854	0.581	0.495	7.737	3.020
4.53	4.53	495.39	1.375	0.0*	5-S2n	0.586	0.860	0.586	0.499	7.764	3.032
4.75	4.75	495.44	1.430	0.0*	5-S2n	0.602	0.881	0.602	0.512	7.856	3.074
4.90	4.90	495.48	1.465	0.0*	5-S2n	0.613	0.894	0.613	0.520	7.914	3.100
5.04	5.04	495.51	1.501	0.0*	5-S2n	0.623	0.907	0.623	0.528	7.971	3.125
5.18	5.18	495.55	1.539	0.0*	5-S2n	0.634	0.919	0.634	0.535	8.024	3.150

* Full Flow Headwater elevation is below inlet invert.

****

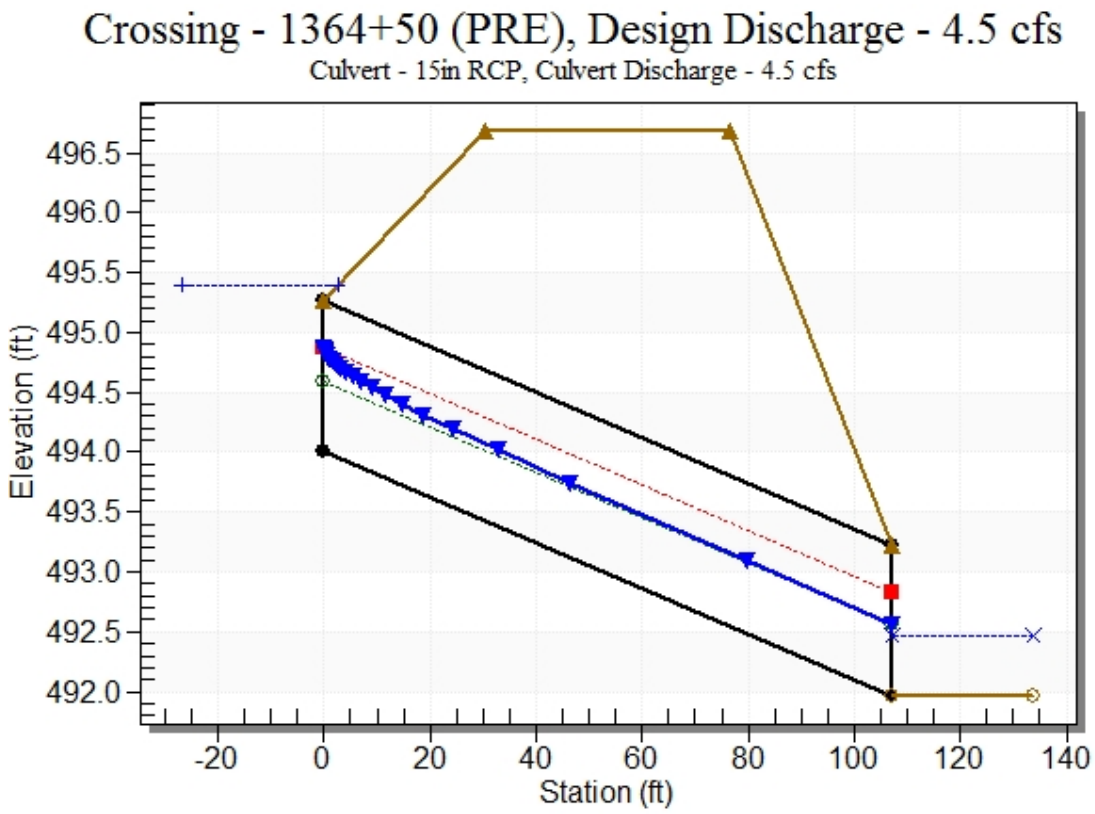
Straight Culvert

Inlet Elevation (invert): 494.01 ft, Outlet Elevation (invert): 491.97 ft

Culvert Length: 107.02 ft, Culvert Slope: 0.0191

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 494.01 ft

Outlet Station: 107.00 ft

Outlet Elevation: 491.97 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1364+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.76	492.42	0.45	2.87	1.69	0.86
3.90	492.43	0.46	2.90	1.72	0.87
4.04	492.44	0.47	2.93	1.76	0.87
4.19	492.45	0.48	2.96	1.79	0.87
4.33	492.46	0.49	2.99	1.82	0.87
4.47	492.47	0.50	3.02	1.85	0.87
4.53	492.47	0.50	3.03	1.87	0.87
4.75	492.48	0.51	3.07	1.92	0.88
4.90	492.49	0.52	3.10	1.95	0.88
5.04	492.50	0.53	3.13	1.98	0.88
5.18	492.51	0.54	3.15	2.00	0.88

Tailwater Channel Data - 1364+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 491.97 ft

Roadway Data for Crossing: 1364+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 496.69 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.36 cfs

Design Flow: 4.05 cfs

Maximum Flow: 4.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1364+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
495.12	3.36	3.36	0.00	1
495.15	3.49	3.49	0.00	1
495.18	3.61	3.61	0.00	1
495.21	3.74	3.74	0.00	1
495.23	3.87	3.87	0.00	1
495.26	4.00	4.00	0.00	1
495.27	4.05	4.05	0.00	1
495.32	4.25	4.25	0.00	1
495.35	4.38	4.38	0.00	1
495.38	4.50	4.50	0.00	1
495.41	4.63	4.63	0.00	1
496.69	8.41	8.41	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.36	3.36	495.12	1.113	0.0*	1-S2n	0.495	0.733	0.495	0.424	7.193	2.780
3.49	3.49	495.15	1.141	0.0*	1-S2n	0.505	0.751	0.505	0.433	7.253	2.810
3.61	3.61	495.18	1.168	0.0*	1-S2n	0.515	0.765	0.515	0.441	7.324	2.839
3.74	3.74	495.21	1.196	0.0*	1-S2n	0.525	0.778	0.525	0.450	7.396	2.868
3.87	3.87	495.23	1.224	0.0*	1-S2n	0.535	0.791	0.552	0.458	7.155	2.896
4.00	4.00	495.26	1.252	0.0*	5-S2n	0.545	0.804	0.545	0.466	7.516	2.924
4.05	4.05	495.27	1.264	0.0*	5-S2n	0.549	0.810	0.549	0.469	7.545	2.935
4.25	4.25	495.32	1.309	0.0*	5-S2n	0.565	0.829	0.565	0.482	7.636	2.977
4.38	4.38	495.35	1.339	0.0*	5-S2n	0.574	0.845	0.574	0.489	7.694	3.002
4.50	4.50	495.38	1.369	0.0*	5-S2n	0.584	0.858	0.584	0.497	7.752	3.027
4.63	4.63	495.41	1.399	0.0*	5-S2n	0.593	0.870	0.593	0.504	7.808	3.050

* Full Flow Headwater elevation is below inlet invert.

****

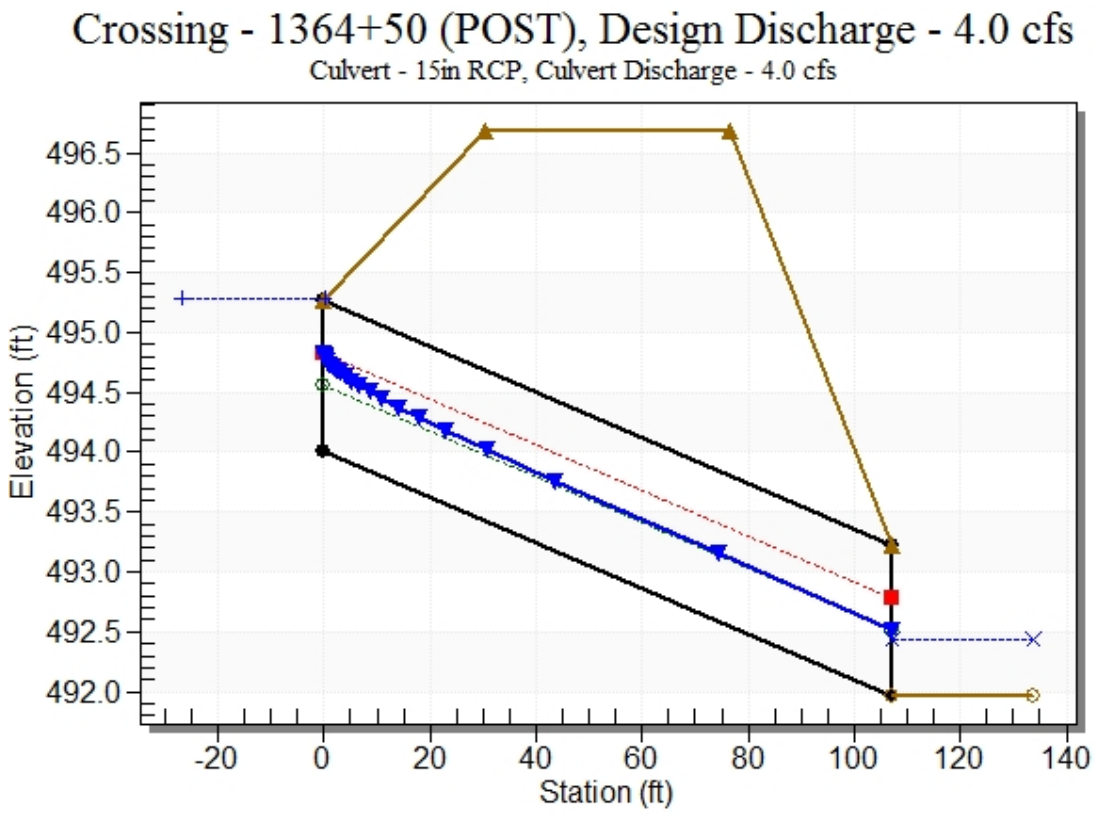
Straight Culvert

Inlet Elevation (invert): 494.01 ft, Outlet Elevation (invert): 491.97 ft

Culvert Length: 107.02 ft, Culvert Slope: 0.0191

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 494.01 ft

Outlet Station: 107.00 ft

Outlet Elevation: 491.97 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1364+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.36	492.39	0.42	2.78	1.59	0.86
3.49	492.40	0.43	2.81	1.62	0.86
3.61	492.41	0.44	2.84	1.65	0.86
3.74	492.42	0.45	2.87	1.68	0.86
3.87	492.43	0.46	2.90	1.71	0.86
4.00	492.44	0.47	2.92	1.74	0.87
4.05	492.44	0.47	2.94	1.76	0.87
4.25	492.45	0.48	2.98	1.80	0.87
4.38	492.46	0.49	3.00	1.83	0.87
4.50	492.47	0.50	3.03	1.86	0.87
4.63	492.47	0.50	3.05	1.89	0.87

Tailwater Channel Data - 1364+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0600

Channel Invert Elevation: 491.97 ft

Roadway Data for Crossing: 1364+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 496.69 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 137

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 137**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.49	1.3368
Grass	0.25	4.01	1.0025
Woods	0.15	16.61	2.4919
	Σ	**22.11**	4.8312

$C_{ave} = \frac{4.8312}{22.11} = 0.22$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.01	1.8130
Grass	0.25	3.48	0.8702
Woods	0.15	16.61	2.4919
	Σ	**22.11**	5.1751

$C_{ave} = \frac{5.1751}{22.11} = 0.23$

T_c =	41.26	min.
I_{05} =	3.15	in / hr
I_{10} =	3.48	in / hr
I_{25} =	3.96	in / hr
I_{50} =	4.31	in / hr
I_{100} =	4.67	in / hr

Pre Construction Runoff:

Q_{05} =	0.22	x	3.15	x	22.11	x	1	=	**15.23**	cfs
Q_{10} =	0.22	x	3.48	x	22.11	x	1	=	**16.82**	cfs
Q_{25} =	0.22	x	3.96	x	22.11	x	1.1	=	**21.04**	cfs
Q_{50} =	0.22	x	4.31	x	22.11	x	1.2	=	**25.00**	cfs
Q_{100} =	0.22	x	4.67	x	22.11	x	1.25	=	**28.22**	cfs

Post Construction Runoff:

Q_{05} =	0.23	x	3.15	x	22.11	x	1	=	**16.31**	cfs
Q_{10} =	0.23	x	3.48	x	22.11	x	1	=	**18.02**	cfs
Q_{25} =	0.23	x	3.96	x	22.11	x	1.1	=	**22.54**	cfs
Q_{50} =	0.23	x	4.31	x	22.11	x	1.2	=	**26.78**	cfs
Q_{100} =	0.23	x	4.67	x	22.11	x	1.25	=	**30.23**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 137	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**1350**				
9	Watercourse slope, s	----------	ft/ft	**0.0556**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.80**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.099**	+		=	**0.099**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.688**
							min	**41.26**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 21.04 cfs

Design Flow: 25 cfs

Maximum Flow: 28.22 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1368+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
485.12	21.04	21.04	0.00	1
485.16	21.76	21.76	0.00	1
485.20	22.48	22.48	0.00	1
485.24	23.19	23.19	0.00	1
485.28	23.91	23.91	0.00	1
485.32	24.63	24.63	0.00	1
485.34	25.00	25.00	0.00	1
485.39	26.07	26.07	0.00	1
485.43	26.78	26.78	0.00	1
485.47	27.50	27.50	0.00	1
485.50	28.22	28.22	0.00	1
503.00	164.20	164.20	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
21.04	21.04	485.12	2.021	0.0*	1-S2n	0.691	1.474	0.691	1.136	16.472	3.513
21.76	21.76	485.16	2.062	0.0*	1-S2n	0.703	1.500	0.749	1.156	15.205	3.545
22.48	22.48	485.20	2.102	0.0*	1-S2n	0.714	1.525	0.730	1.175	16.308	3.577
23.19	23.19	485.24	2.141	0.0*	1-S2n	0.725	1.550	0.725	1.194	17.000	3.607
23.91	23.91	485.28	2.180	0.0*	1-S2n	0.736	1.574	0.736	1.212	17.163	3.637
24.63	24.63	485.32	2.218	0.0*	1-S2n	0.748	1.597	0.793	1.230	15.895	3.666
25.00	25.00	485.34	2.238	0.0*	1-S2n	0.753	1.609	0.788	1.240	16.276	3.681
26.07	26.07	485.39	2.294	0.0*	1-S2n	0.770	1.643	0.770	1.266	17.523	3.723
26.78	26.78	485.43	2.331	0.0*	1-S2n	0.780	1.670	0.780	1.283	17.678	3.750
27.50	27.50	485.47	2.368	0.0*	1-S2n	0.791	1.693	0.837	1.300	16.456	3.777
28.22	28.22	485.50	2.405	0.0*	1-S2n	0.801	1.715	0.829	1.317	17.100	3.803

* Full Flow Headwater elevation is below inlet invert.

****

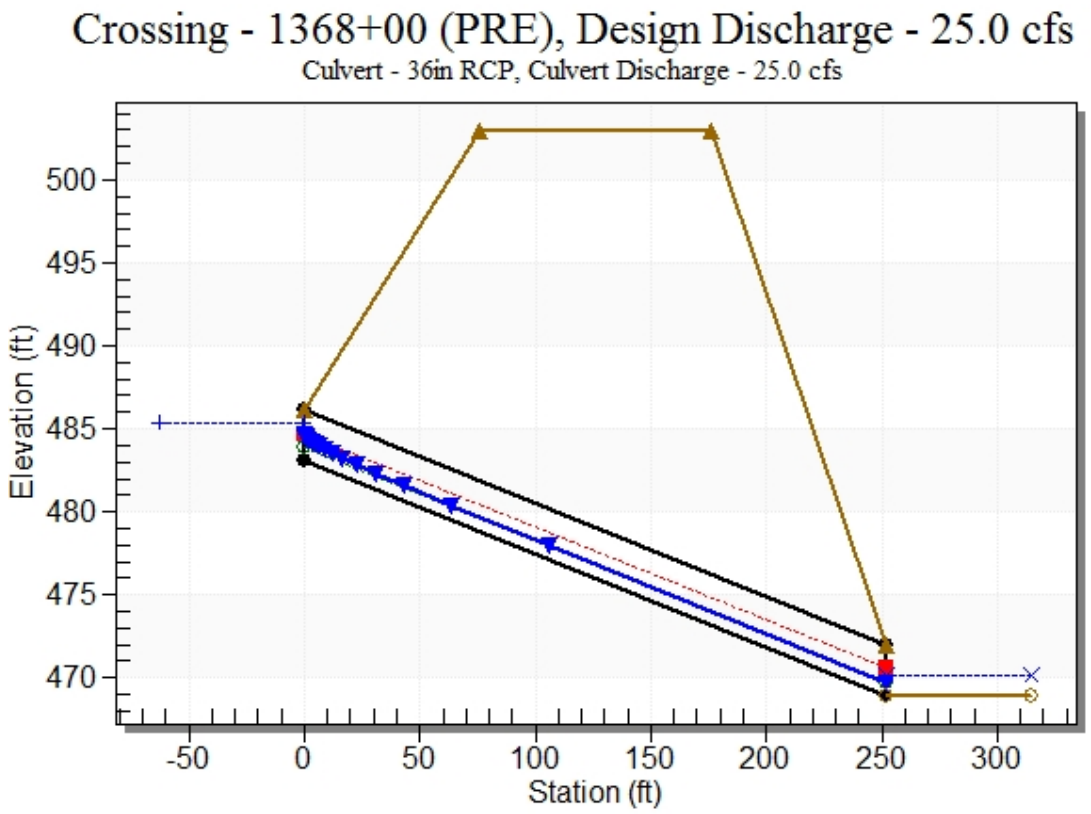
Straight Culvert

Inlet Elevation (invert): 483.10 ft, Outlet Elevation (invert): 468.95 ft

Culvert Length: 252.40 ft, Culvert Slope: 0.0562

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 483.10 ft

Outlet Station: 252.00 ft

Outlet Elevation: 468.95 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1368+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
21.04	470.09	1.14	3.51	2.13	0.69
21.76	470.11	1.16	3.55	2.16	0.70
22.48	470.12	1.17	3.58	2.20	0.70
23.19	470.14	1.19	3.61	2.23	0.70
23.91	470.16	1.21	3.64	2.27	0.70
24.63	470.18	1.23	3.67	2.30	0.70
25.00	470.19	1.24	3.68	2.32	0.70
26.07	470.22	1.27	3.72	2.37	0.70
26.78	470.23	1.28	3.75	2.40	0.71
27.50	470.25	1.30	3.78	2.43	0.71
28.22	470.27	1.32	3.80	2.47	0.71

Tailwater Channel Data - 1368+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 468.95 ft

Roadway Data for Crossing: 1368+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 503.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 22.54 cfs

Design Flow: 26.78 cfs

Maximum Flow: 30.23 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1368+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
485.21	22.54	22.54	0.00	1
485.25	23.31	23.31	0.00	1
485.29	24.08	24.08	0.00	1
485.33	24.85	24.85	0.00	1
485.37	25.62	25.62	0.00	1
485.41	26.38	26.38	0.00	1
485.43	26.78	26.78	0.00	1
485.49	27.92	27.92	0.00	1
485.53	28.69	28.69	0.00	1
485.57	29.46	29.46	0.00	1
485.61	30.23	30.23	0.00	1
503.00	164.20	164.20	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
22.54	22.54	485.21	2.105	0.0*	1-S2n	0.715	1.527	0.729	1.176	16.414	3.580
23.31	23.31	485.25	2.147	0.0*	1-S2n	0.727	1.553	0.727	1.196	17.027	3.612
24.08	24.08	485.29	2.189	0.0*	1-S2n	0.739	1.579	0.739	1.216	17.200	3.644
24.85	24.85	485.33	2.230	0.0*	1-S2n	0.751	1.604	0.791	1.236	16.112	3.675
25.62	25.62	485.37	2.270	0.0*	1-S2n	0.763	1.629	0.763	1.255	17.439	3.705
26.38	26.38	485.41	2.310	0.0*	1-S2n	0.775	1.653	0.775	1.274	17.592	3.735
26.78	26.78	485.43	2.331	0.0*	1-S2n	0.780	1.670	0.780	1.283	17.677	3.750
27.92	27.92	485.49	2.389	0.0*	1-S2n	0.797	1.706	0.833	1.310	16.813	3.792
28.69	28.69	485.53	2.429	0.0*	1-S2n	0.808	1.730	0.808	1.328	18.063	3.820
29.46	29.46	485.57	2.467	0.0*	1-S2n	0.819	1.753	0.819	1.346	18.209	3.847
30.23	30.23	485.61	2.506	0.0*	1-S2n	0.830	1.776	0.830	1.363	18.290	3.873

* Full Flow Headwater elevation is below inlet invert.

****

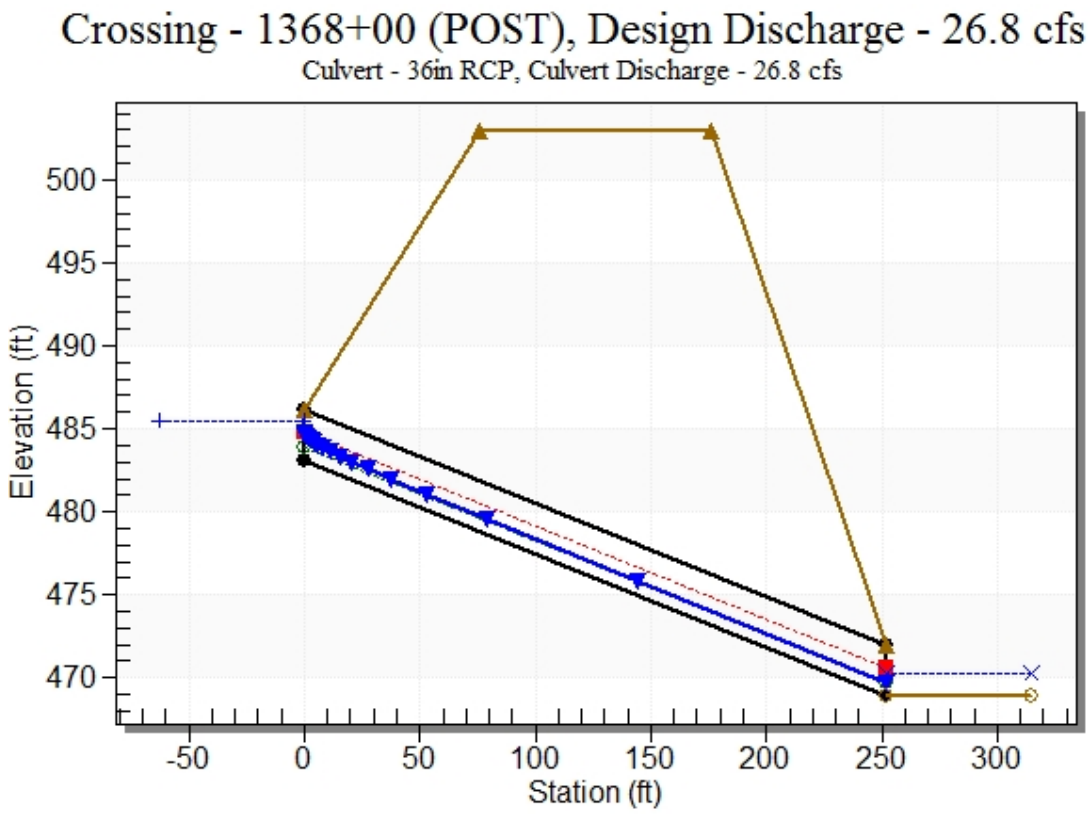
Straight Culvert

Inlet Elevation (invert): 483.10 ft, Outlet Elevation (invert): 468.95 ft

Culvert Length: 252.40 ft, Culvert Slope: 0.0562

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 483.10 ft

Outlet Station: 252.00 ft

Outlet Elevation: 468.95 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1368+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
22.54	470.13	1.18	3.58	2.20	0.70
23.31	470.15	1.20	3.61	2.24	0.70
24.08	470.17	1.22	3.64	2.28	0.70
24.85	470.19	1.24	3.68	2.31	0.70
25.62	470.20	1.25	3.71	2.35	0.70
26.38	470.22	1.27	3.73	2.38	0.70
26.78	470.23	1.28	3.75	2.40	0.71
27.92	470.26	1.31	3.79	2.45	0.71
28.69	470.28	1.33	3.82	2.49	0.71
29.46	470.30	1.35	3.85	2.52	0.71
30.23	470.31	1.36	3.87	2.55	0.71

Tailwater Channel Data - 1368+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 468.95 ft

Roadway Data for Crossing: 1368+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 503.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 138

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 138**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.19	0.1699
Grass	0.25	0.18	0.0456
Woods	0.15	0.00	0.0000
	Σ	**0.37**	0.2155

$C_{ave} = \frac{0.2155}{0.37} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.22	0.1980
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.22**	0.1980

$C_{ave} = \frac{0.1980}{0.22} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.58	**x**	6.23	**x**	0.37	**x**	1	=	**1.34**	cfs
Q_{10} =	0.58	**x**	6.98	**x**	0.37	**x**	1	=	**1.50**	cfs
Q_{25} =	0.58	**x**	8.08	**x**	0.37	**x**	1.1	=	**1.92**	cfs
Q_{50} =	0.58	**x**	8.93	**x**	0.37	**x**	1.2	=	**2.31**	cfs
Q_{100} =	0.58	**x**	9.81	**x**	0.37	**x**	1.25	=	**2.64**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.22	**x**	1	=	**1.23**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.22	**x**	1	=	**1.38**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.22	**x**	1.1	=	**1.76**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.22	**x**	1.2	=	**2.12**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.22	**x**	1.25	=	**2.43**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.92 cfs

Design Flow: 2.31 cfs

Maximum Flow: 2.64 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1370+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
502.09	1.92	1.92	0.00	1
502.11	1.99	1.99	0.00	1
502.13	2.06	2.06	0.00	1
502.15	2.14	2.14	0.00	1
502.16	2.21	2.21	0.00	1
502.18	2.28	2.28	0.00	1
502.19	2.31	2.31	0.00	1
502.21	2.42	2.42	0.00	1
502.23	2.50	2.50	0.00	1
502.25	2.57	2.57	0.00	1
502.26	2.64	2.64	0.00	1
504.15	8.76	8.76	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.92	1.92	502.09	0.732	0.0*	1-S2n	0.240	0.551	0.240	0.349	11.492	2.040
1.99	1.99	502.11	0.750	0.0*	1-S2n	0.244	0.562	0.244	0.356	11.424	2.063
2.06	2.06	502.13	0.768	0.0*	1-S2n	0.249	0.573	0.249	0.363	11.552	2.085
2.14	2.14	502.15	0.786	0.0*	1-S2n	0.253	0.583	0.253	0.370	11.675	2.107
2.21	2.21	502.16	0.803	0.0*	1-S2n	0.257	0.593	0.257	0.377	11.799	2.128
2.28	2.28	502.18	0.821	0.0*	1-S2n	0.261	0.603	0.261	0.384	11.940	2.148
2.31	2.31	502.19	0.828	0.0*	1-S2n	0.263	0.608	0.276	0.386	11.119	2.157
2.42	2.42	502.21	0.854	0.0*	1-S2n	0.269	0.623	0.269	0.397	12.206	2.188
2.50	2.50	502.23	0.871	0.0*	1-S2n	0.273	0.632	0.273	0.403	12.332	2.207
2.57	2.57	502.25	0.887	0.0*	1-S2n	0.277	0.642	0.277	0.409	12.280	2.226
2.64	2.64	502.26	0.903	0.0*	1-S2n	0.281	0.651	0.281	0.416	12.385	2.244

* Full Flow Headwater elevation is below inlet invert.

****

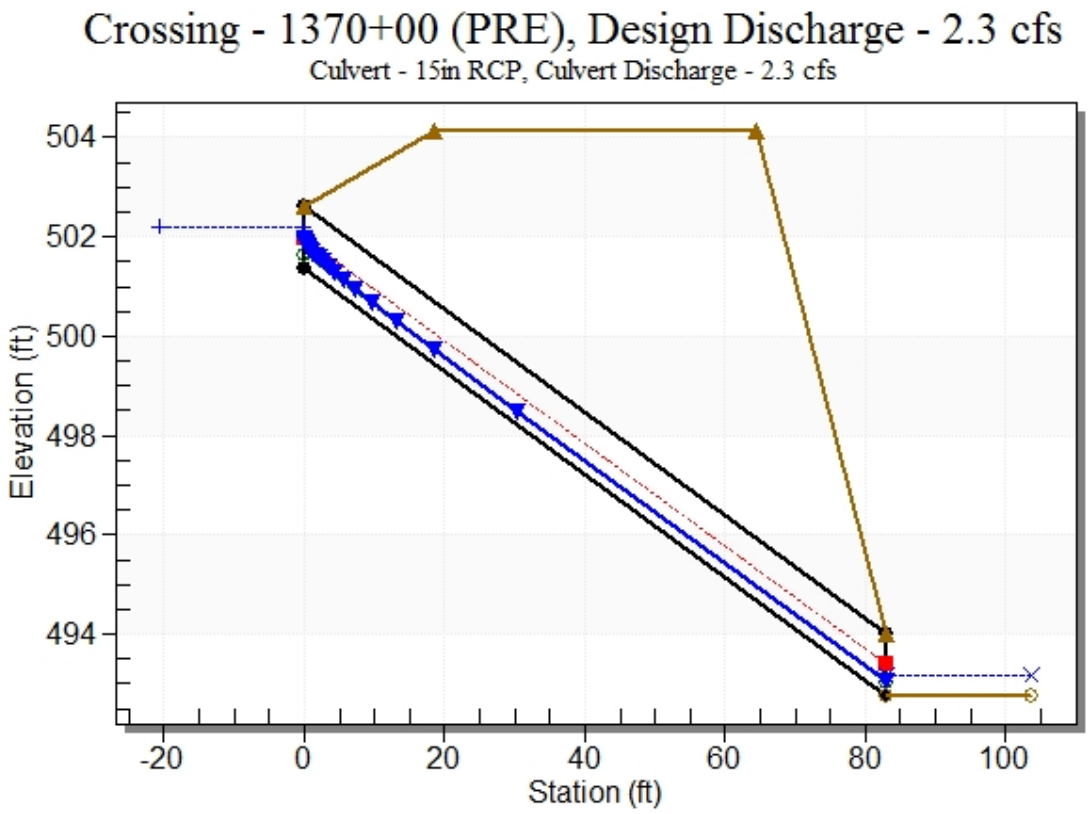
Straight Culvert

Inlet Elevation (invert): 501.36 ft, Outlet Elevation (invert): 492.77 ft

Culvert Length: 83.44 ft, Culvert Slope: 0.1035

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 501.36 ft

Outlet Station: 83.00 ft

Outlet Elevation: 492.77 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1370+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.92	493.12	0.35	2.04	0.87	0.68
1.99	493.13	0.36	2.06	0.89	0.68
2.06	493.13	0.36	2.09	0.91	0.69
2.14	493.14	0.37	2.11	0.92	0.69
2.21	493.15	0.38	2.13	0.94	0.69
2.28	493.15	0.38	2.15	0.96	0.69
2.31	493.16	0.39	2.16	0.96	0.69
2.42	493.17	0.40	2.19	0.99	0.69
2.50	493.17	0.40	2.21	1.01	0.70
2.57	493.18	0.41	2.23	1.02	0.70
2.64	493.19	0.42	2.24	1.04	0.70

Tailwater Channel Data - 1370+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 492.77 ft

Roadway Data for Crossing: 1370+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 504.15 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.76 cfs

Design Flow: 2.12 cfs

Maximum Flow: 2.43 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1370+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
502.05	1.76	1.76	0.00	1
502.07	1.83	1.83	0.00	1
502.09	1.89	1.89	0.00	1
502.10	1.96	1.96	0.00	1
502.12	2.03	2.03	0.00	1
502.14	2.10	2.10	0.00	1
502.14	2.12	2.12	0.00	1
502.17	2.23	2.23	0.00	1
502.18	2.30	2.30	0.00	1
502.20	2.36	2.36	0.00	1
502.22	2.43	2.43	0.00	1
504.15	8.76	8.76	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.76	1.76	502.05	0.690	0.0*	1-S2n	0.230	0.526	0.230	0.332	11.127	1.987
1.83	1.83	502.07	0.708	0.0*	1-S2n	0.234	0.537	0.234	0.339	11.284	2.010
1.89	1.89	502.09	0.725	0.0*	1-S2n	0.238	0.547	0.238	0.346	11.435	2.032
1.96	1.96	502.10	0.743	0.0*	1-S2n	0.242	0.557	0.242	0.353	11.579	2.053
2.03	2.03	502.12	0.759	0.0*	1-S2n	0.246	0.567	0.246	0.360	11.489	2.074
2.10	2.10	502.14	0.776	0.0*	1-S2n	0.250	0.577	0.250	0.366	11.606	2.095
2.12	2.12	502.14	0.782	0.0*	1-S2n	0.252	0.581	0.252	0.368	11.648	2.102
2.23	2.23	502.17	0.808	0.0*	1-S2n	0.258	0.596	0.258	0.379	11.841	2.134
2.30	2.30	502.18	0.824	0.0*	1-S2n	0.262	0.606	0.262	0.385	11.971	2.153
2.36	2.36	502.20	0.840	0.0*	1-S2n	0.266	0.615	0.266	0.391	12.096	2.171
2.43	2.43	502.22	0.856	0.0*	1-S2n	0.270	0.624	0.270	0.397	12.217	2.190

* Full Flow Headwater elevation is below inlet invert.

****

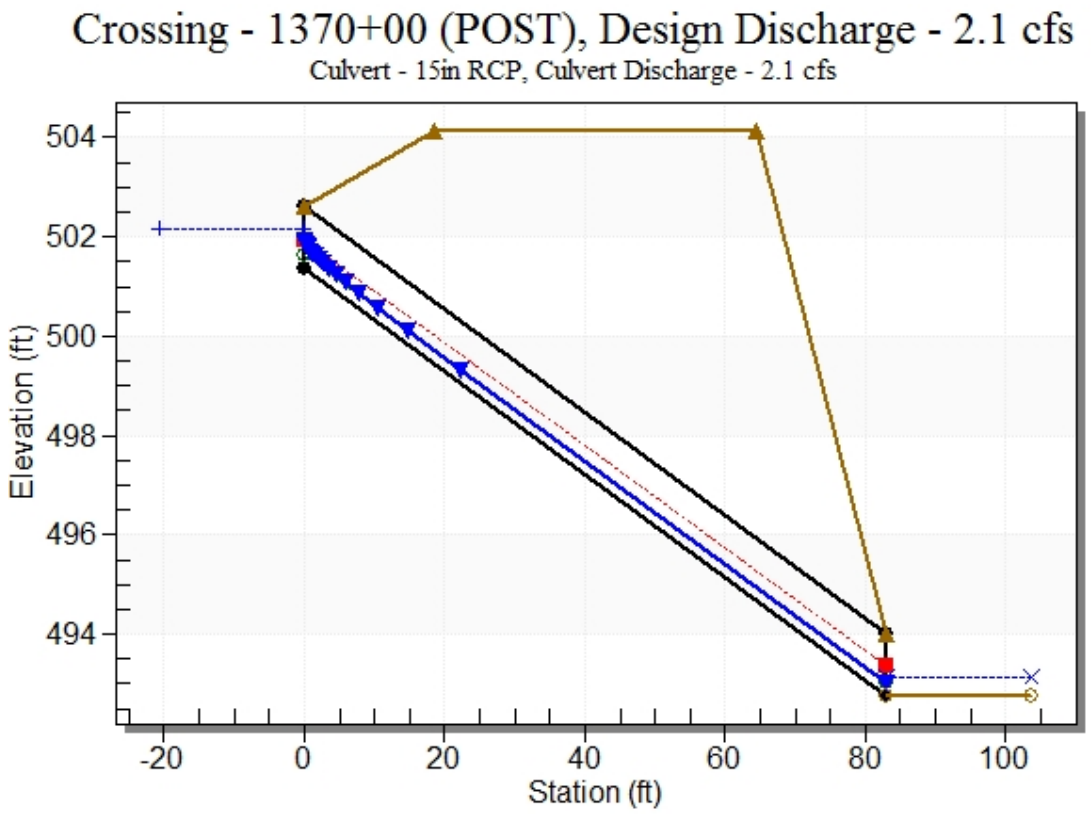
Straight Culvert

Inlet Elevation (invert): 501.36 ft, Outlet Elevation (invert): 492.77 ft

Culvert Length: 83.44 ft, Culvert Slope: 0.1035

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 501.36 ft

Outlet Station: 83.00 ft

Outlet Elevation: 492.77 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1370+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.76	493.10	0.33	1.99	0.83	0.68
1.83	493.11	0.34	2.01	0.85	0.68
1.89	493.12	0.35	2.03	0.86	0.68
1.96	493.12	0.35	2.05	0.88	0.68
2.03	493.13	0.36	2.07	0.90	0.69
2.10	493.14	0.37	2.09	0.91	0.69
2.12	493.14	0.37	2.10	0.92	0.69
2.23	493.15	0.38	2.13	0.95	0.69
2.30	493.15	0.38	2.15	0.96	0.69
2.36	493.16	0.39	2.17	0.98	0.69
2.43	493.17	0.40	2.19	0.99	0.69

Tailwater Channel Data - 1370+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 492.77 ft

Roadway Data for Crossing: 1370+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 504.15 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 139

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 139**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.55	0.4963
Grass	0.25	0.45	0.1121
Woods	0.15	0.65	0.0976
	Σ	**1.65**	0.7059

$C_{ave} = \frac{0.7059}{1.65} = 0.43$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.75	0.6777
Grass	0.25	0.25	0.0617
Woods	0.15	0.65	0.0976
	Σ	**1.65**	0.8369

$C_{ave} = \frac{0.8369}{1.65} = 0.51$

T_c =	30.38	min.								
I_{05} =	3.70	in / hr								
I_{10} =	4.10	in / hr								
I_{25} =	4.67	in / hr								
I_{50} =	5.10	in / hr								
I_{100} =	5.54	in / hr								

Pre Construction Runoff:

Q_{05} =	0.43	**x**	3.70	**x**	1.65	**x**	1	=	**2.61**	cfs
Q_{10} =	0.43	**x**	4.10	**x**	1.65	**x**	1	=	**2.89**	cfs
Q_{25} =	0.43	**x**	4.67	**x**	1.65	**x**	1.1	=	**3.63**	cfs
Q_{50} =	0.43	**x**	5.10	**x**	1.65	**x**	1.2	=	**4.32**	cfs
Q_{100} =	0.43	**x**	5.54	**x**	1.65	**x**	1.25	=	**4.89**	cfs

Post Construction Runoff:

Q_{05} =	0.51	**x**	3.70	**x**	1.65	**x**	1	=	**3.10**	cfs
Q_{10} =	0.51	**x**	4.10	**x**	1.65	**x**	1	=	**3.43**	cfs
Q_{25} =	0.51	**x**	4.67	**x**	1.65	**x**	1.1	=	**4.30**	cfs
Q_{50} =	0.51	**x**	5.10	**x**	1.65	**x**	1.2	=	**5.12**	cfs
Q_{100} =	0.51	**x**	5.54	**x**	1.65	**x**	1.25	=	**5.80**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 139	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**100**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.005**	+		=	**0.005**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.506**
							min	**30.38**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.63 cfs

Design Flow: 4.32 cfs

Maximum Flow: 4.89 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1376+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
502.80	3.63	3.63	0.00	1
502.82	3.76	3.76	0.00	1
502.84	3.88	3.88	0.00	1
502.86	4.01	4.01	0.00	1
502.89	4.13	4.13	0.00	1
502.91	4.26	4.26	0.00	1
502.92	4.32	4.32	0.00	1
502.95	4.51	4.51	0.00	1
502.97	4.64	4.64	0.00	1
502.99	4.76	4.76	0.00	1
503.01	4.89	4.89	0.00	1
504.63	12.25	12.25	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.63	3.63	502.80	1.057	0.0*	1-S2n	0.507	0.728	0.507	0.465	6.693	2.665
3.76	3.76	502.82	1.079	0.0*	1-S2n	0.516	0.741	0.516	0.473	6.742	2.692
3.88	3.88	502.84	1.102	0.0*	1-S2n	0.525	0.753	0.525	0.482	6.807	2.717
4.01	4.01	502.86	1.123	0.0*	1-S2n	0.534	0.766	0.534	0.490	6.868	2.743
4.13	4.13	502.89	1.145	0.0*	1-S2n	0.543	0.778	0.543	0.498	6.930	2.768
4.26	4.26	502.91	1.167	0.0*	1-S2n	0.552	0.790	0.552	0.507	6.977	2.791
4.32	4.32	502.92	1.177	0.0*	1-S2n	0.556	0.796	0.556	0.510	7.005	2.802
4.51	4.51	502.95	1.209	0.0*	1-S2n	0.569	0.813	0.569	0.522	7.090	2.837
4.64	4.64	502.97	1.230	0.0*	1-S2n	0.578	0.824	0.578	0.530	7.144	2.860
4.76	4.76	502.99	1.251	0.0*	1-S2n	0.586	0.835	0.586	0.538	7.201	2.881
4.89	4.89	503.01	1.271	0.0*	1-S2n	0.595	0.846	0.595	0.545	7.242	2.903

* Full Flow Headwater elevation is below inlet invert.

****

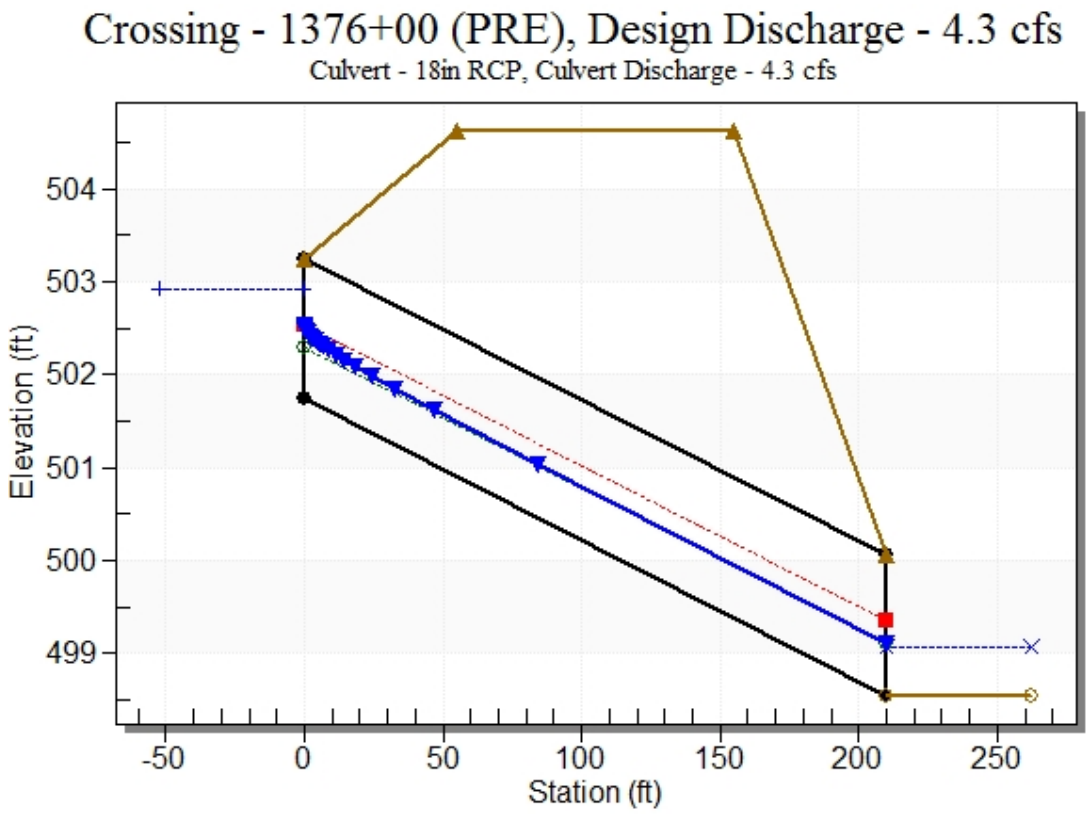
Straight Culvert

Inlet Elevation (invert): 501.74 ft, Outlet Elevation (invert): 498.55 ft

Culvert Length: 210.02 ft, Culvert Slope: 0.0152

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 501.74 ft

Outlet Station: 210.00 ft

Outlet Elevation: 498.55 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1376+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.63	499.01	0.46	2.67	1.45	0.79
3.76	499.02	0.47	2.69	1.48	0.79
3.88	499.03	0.48	2.72	1.50	0.79
4.01	499.04	0.49	2.74	1.53	0.80
4.13	499.05	0.50	2.77	1.56	0.80
4.26	499.06	0.51	2.79	1.58	0.80
4.32	499.06	0.51	2.80	1.59	0.80
4.51	499.07	0.52	2.84	1.63	0.80
4.64	499.08	0.53	2.86	1.65	0.80
4.76	499.09	0.54	2.88	1.68	0.80
4.89	499.10	0.55	2.90	1.70	0.81

Tailwater Channel Data - 1376+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 498.55 ft

Roadway Data for Crossing: 1376+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 504.63 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.3 cfs

Design Flow: 5.12 cfs

Maximum Flow: 5.8 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1376+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
502.91	4.30	4.30	0.00	1
502.94	4.45	4.45	0.00	1
502.96	4.60	4.60	0.00	1
502.99	4.75	4.75	0.00	1
503.01	4.90	4.90	0.00	1
503.04	5.05	5.05	0.00	1
503.05	5.12	5.12	0.00	1
503.09	5.35	5.35	0.00	1
503.11	5.50	5.50	0.00	1
503.14	5.65	5.65	0.00	1
503.16	5.80	5.80	0.00	1
504.63	12.25	12.25	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.30	4.30	502.91	1.173	0.0*	1-S2n	0.555	0.794	0.555	0.509	6.996	2.799
4.45	4.45	502.94	1.199	0.0*	1-S2n	0.565	0.808	0.565	0.518	7.063	2.826
4.60	4.60	502.96	1.224	0.0*	1-S2n	0.575	0.821	0.575	0.528	7.128	2.853
4.75	4.75	502.99	1.248	0.0*	1-S2n	0.585	0.834	0.585	0.537	7.195	2.879
4.90	4.90	503.01	1.273	0.0*	1-S2n	0.595	0.847	0.595	0.546	7.246	2.905
5.05	5.05	503.04	1.298	0.0*	1-S2n	0.605	0.860	0.605	0.554	7.306	2.930
5.12	5.12	503.05	1.309	0.0*	1-S2n	0.610	0.866	0.610	0.558	7.333	2.941
5.35	5.35	503.09	1.347	0.0*	1-S2n	0.625	0.889	0.625	0.572	7.424	2.978
5.50	5.50	503.11	1.372	0.0*	1-S2n	0.635	0.901	0.635	0.580	7.471	3.001
5.65	5.65	503.14	1.396	0.0*	1-S2n	0.645	0.914	0.645	0.588	7.525	3.024
5.80	5.80	503.16	1.421	0.0*	1-S2n	0.654	0.926	0.654	0.596	7.577	3.046

* Full Flow Headwater elevation is below inlet invert.

****

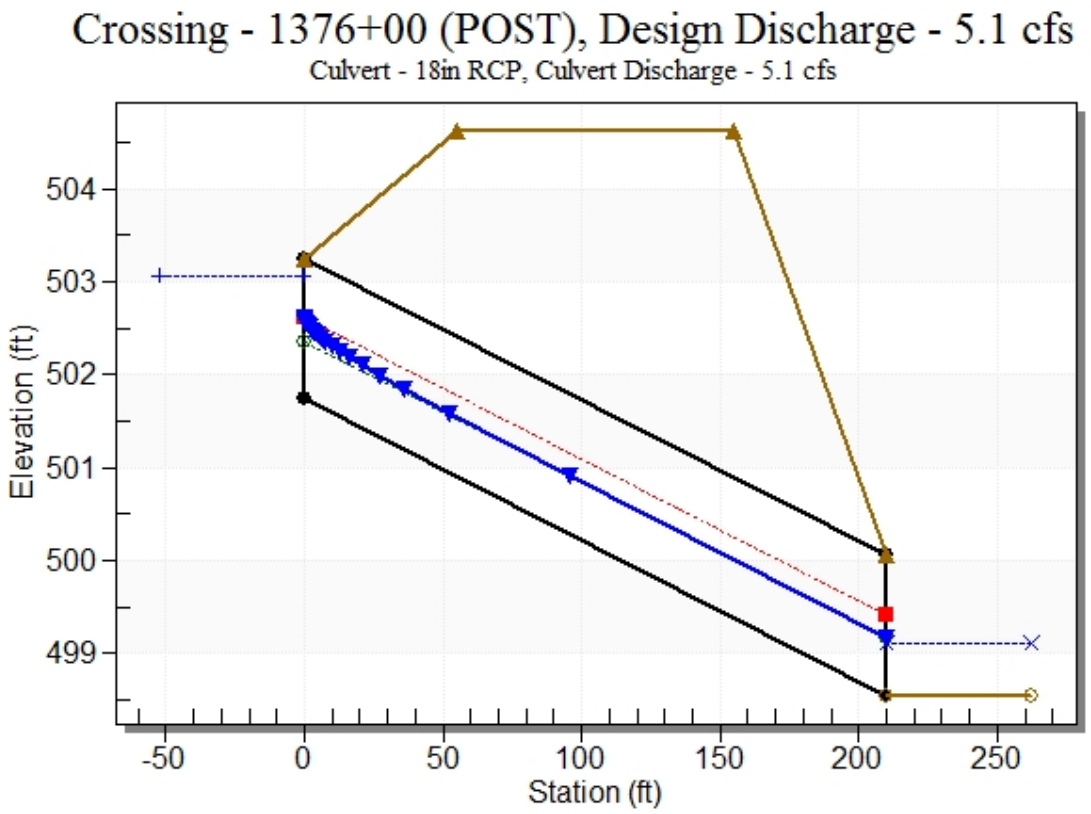
Straight Culvert

Inlet Elevation (invert): 501.74 ft, Outlet Elevation (invert): 498.55 ft

Culvert Length: 210.02 ft, Culvert Slope: 0.0152

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 501.74 ft

Outlet Station: 210.00 ft

Outlet Elevation: 498.55 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1376+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.30	499.06	0.51	2.80	1.59	0.80
4.45	499.07	0.52	2.83	1.62	0.80
4.60	499.08	0.53	2.85	1.65	0.80
4.75	499.09	0.54	2.88	1.67	0.80
4.90	499.10	0.55	2.90	1.70	0.81
5.05	499.10	0.55	2.93	1.73	0.81
5.12	499.11	0.56	2.94	1.74	0.81
5.35	499.12	0.57	2.98	1.78	0.81
5.50	499.13	0.58	3.00	1.81	0.81
5.65	499.14	0.59	3.02	1.84	0.81
5.80	499.15	0.60	3.05	1.86	0.81

Tailwater Channel Data - 1376+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 498.55 ft

Roadway Data for Crossing: 1376+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 504.63 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 140

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 140a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.23	0.2033
Grass	0.25	0.30	0.0745
Woods	0.15	0.91	0.1358
	Σ	**1.43**	0.4136

$C_{ave} = \frac{0.4136}{1.43} = 0.29$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.31	0.2753
Grass	0.25	0.30	0.0745
Woods	0.15	0.91	0.1358
	Σ	**1.51**	0.4856

$C_{ave} = \frac{0.4856}{1.51} = 0.32$

T_c =	24.50	min.
I_{05} =	4.09	in / hr
I_{10} =	4.53	in / hr
I_{25} =	5.18	in / hr
I_{50} =	5.66	in / hr
I_{100} =	6.16	in / hr

Pre Construction Runoff:

Q_{05} =	0.29	x	4.09	x	1.43	x	1	=	**1.69**	cfs
Q_{10} =	0.29	x	4.53	x	1.43	x	1	=	**1.88**	cfs
Q_{25} =	0.29	x	5.18	x	1.43	x	1.1	=	**2.36**	cfs
Q_{50} =	0.29	x	5.66	x	1.43	x	1.2	=	**2.81**	cfs
Q_{100} =	0.29	x	6.16	x	1.43	x	1.25	=	**3.18**	cfs

Post Construction Runoff:

Q_{05} =	0.32	x	4.09	x	1.51	x	1	=	**1.99**	cfs
Q_{10} =	0.32	x	4.53	x	1.51	x	1	=	**2.20**	cfs
Q_{25} =	0.32	x	5.18	x	1.51	x	1.1	=	**2.77**	cfs
Q_{50} =	0.32	x	5.66	x	1.51	x	1.2	=	**3.30**	cfs
Q_{100} =	0.32	x	6.16	x	1.51	x	1.25	=	**3.74**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 140b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.48	1.3291
Grass	0.25	12.36	3.0894
Woods	0.15	6.53	0.9788
	Σ	**20.36**	5.3973

$C_{ave} = \frac{5.3973}{20.36} = 0.27$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.71	1.5361
Grass	0.25	12.13	3.0319
Woods	0.15	6.53	0.9788
	Σ	**20.36**	5.5468

$C_{ave} = \frac{5.5468}{20.36} = 0.27$

T_c =	60.92	min.								
I_{05} =	2.48	in / hr								
I_{10} =	2.74	in / hr								
I_{25} =	3.10	in / hr								
I_{50} =	3.37	in / hr								
I_{100} =	3.65	in / hr								

Pre Construction Runoff:

Q_{05} =	0.27	**x**	2.48	**x**	20.36	**x**	1	=	**13.39**	cfs
Q_{10} =	0.27	**x**	2.74	**x**	20.36	**x**	1	=	**14.77**	cfs
Q_{25} =	0.27	**x**	3.10	**x**	20.36	**x**	1.1	=	**18.41**	cfs
Q_{50} =	0.27	**x**	3.37	**x**	20.36	**x**	1.2	=	**21.84**	cfs
Q_{100} =	0.27	**x**	3.65	**x**	20.36	**x**	1.25	=	**24.61**	cfs

Post Construction Runoff:

Q_{05} =	0.27	**x**	2.48	**x**	20.36	**x**	1	=	**13.76**	cfs
Q_{10} =	0.27	**x**	2.74	**x**	20.36	**x**	1	=	**15.18**	cfs
Q_{25} =	0.27	**x**	3.10	**x**	20.36	**x**	1.1	=	**18.92**	cfs
Q_{50} =	0.27	**x**	3.37	**x**	20.36	**x**	1.2	=	**22.45**	cfs
Q_{100} =	0.27	**x**	3.65	**x**	20.36	**x**	1.25	=	**25.29**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 140c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.76	0.6864
Grass	0.25	0.72	0.1798
Woods	0.15	0.00	0.0000
	Σ	**1.48**	0.8662

$C_{ave} = \frac{0.8662}{1.48} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7830
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.87**	0.7830

$C_{ave} = \frac{0.7830}{0.87} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	1.48	x	1	=	**5.40**	cfs
Q_{10} =	0.58	x	6.98	x	1.48	x	1	=	**6.04**	cfs
Q_{25} =	0.58	x	8.08	x	1.48	x	1.1	=	**7.70**	cfs
Q_{50} =	0.58	x	8.93	x	1.48	x	1.2	=	**9.28**	cfs
Q_{100} =	0.58	x	9.81	x	1.48	x	1.25	=	**10.62**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.87	x	1	=	**4.88**	cfs
Q_{10} =	0.90	x	6.98	x	0.87	x	1	=	**5.46**	cfs
Q_{25} =	0.90	x	8.08	x	0.87	x	1.1	=	**6.96**	cfs
Q_{50} =	0.90	x	8.93	x	0.87	x	1.2	=	**8.39**	cfs
Q_{100} =	0.90	x	9.81	x	0.87	x	1.25	=	**9.60**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 140a Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Woods				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft	**100**					
4 Two-yr 24-hr rainfall, P_2		in	**3.58**					
5 Land slope, s		ft/ft	**0.0500**					
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.408**	+		=	**0.408**	
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)								
8 Flow length, L		ft						
9 Watercourse slope, s		ft/ft						
10 Average velocity, V (figure 3-1)		ft/s						
11 $T_t = L / (3600\ V)$	Compute T_t	hr		+		=	**0.000**	
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2	**0.00**	**0.00**				
13 Wetted perimeter, p_w		ft	**0.00**	**0.00**				
14 Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**				
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**				
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.408**
							min	**24.50**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 140b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**200**				
9	Watercourse slope, s		ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)		ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0.5**				
12	Cross sectional flow area, a		ft^2	**1.75**	**0.00**			
13	Wetted perimeter, p_w		ft	**5.16**	**0.00**			
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.34**	**#DIV/0!**			
15	Channel Slope, s		ft/ft	**0.0300**				
16	Manning's roughness coeff., n			**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**2.09**	**#DIV/0!**			
18	Flow length, L		ft	**1700**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.226**	+	**0.000**	=	**0.226**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**1.015**
							min	**60.92**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-140		Outlet	OP	489.39	489.39	0.00	0.00	0.00	61.20	0.00	23.27	0.29	0.00
CB-140c		Other	C.B. TYPE 112	499.10	499.10	4.25	0.03	61.08	61.08	27.24	23.27	0.29	3.40
CB-140b		Other	C.B. TYPE 112	498.98	498.98	3.53	0.53	60.92	60.92	23.76	21.79	0.27	3.40
CB-140a		Other	C.B. TYPE 112	501.02	501.02	2.72	0.00	24.50	24.50	2.86	1.43	0.29	5.72

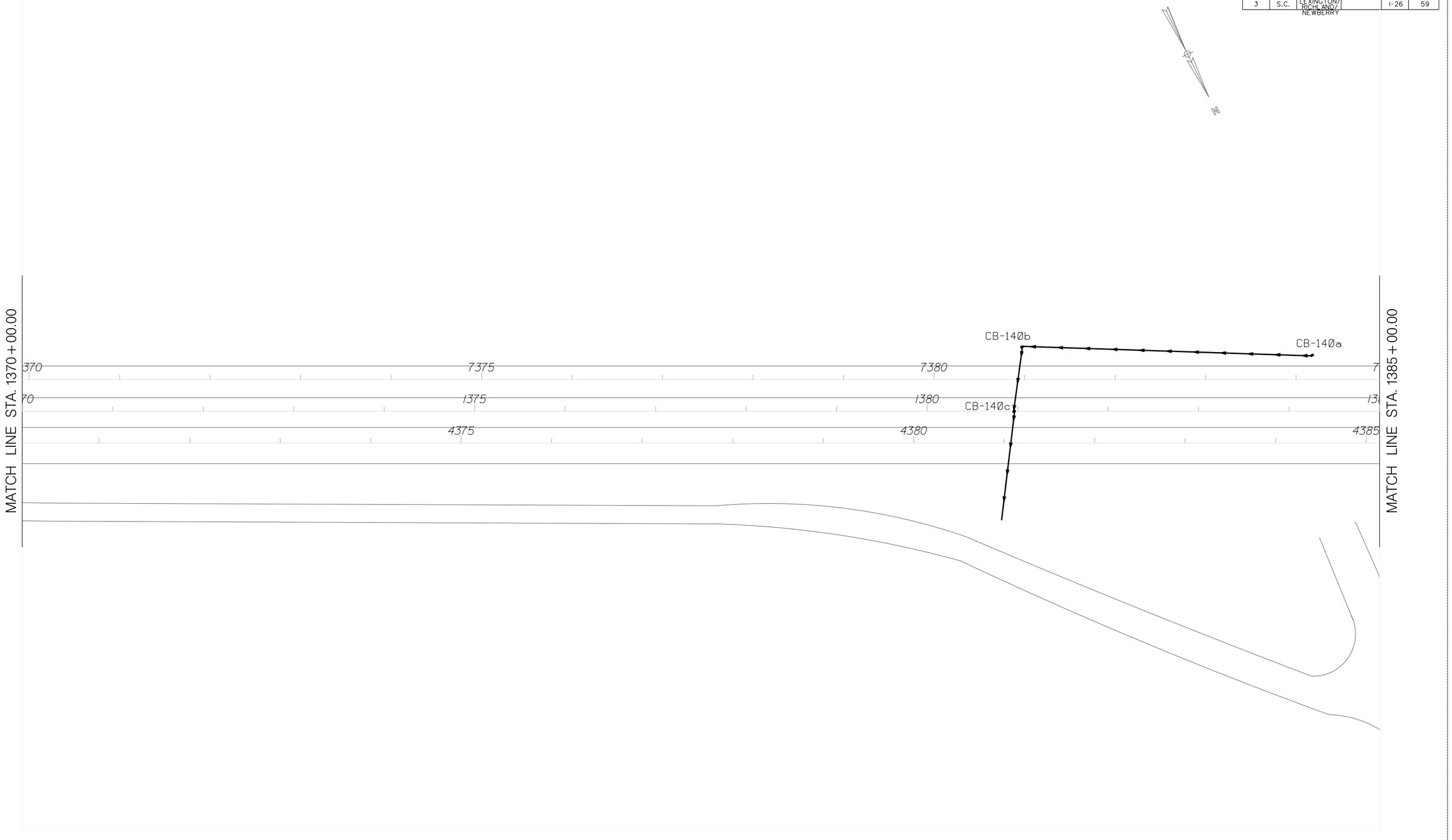
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-68	CB-140c	OF-140	Circular	Concrete	1	2.50	120	4.53	27.24	101.76	0.92	16.66	497.35	496.70	491.89	490.35	494.85	489.39	6.98	15.74	1.85	0.96
NP-67	CB-140b	CB-140c	Circular	Concrete	1	2.50	70	0.56	23.76	35.67	1.56	7.38	497.95	497.65	497.56	496.63	495.45	495.06	5.19	7.33	2.20	1.57
NP-66	CB-140a	CB-140b	Circular	Concrete	1	1.50	318	0.67	2.86	10.04	0.57	4.62	499.80	499.22	497.66	496.73	498.30	496.16	2.51	4.62	0.92	0.57

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-140c	5.00	9.36	9.03	0.58	1.48	0.58	1.48	0.00	0.00
CB-140b	60.92	22.06	3.40	0.27	20.36	0.27	20.36	0.00	0.00
CB-140a	24.50	2.86	5.72	0.29	1.43	0.29	1.43	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	59



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

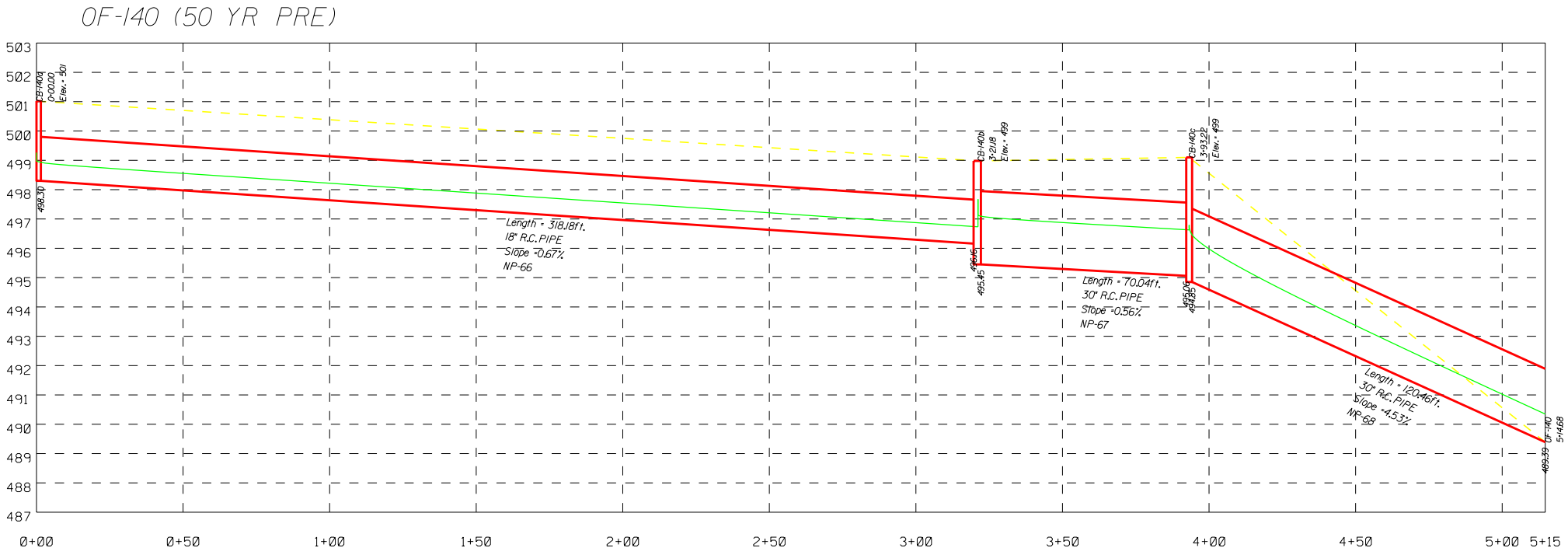
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1370+00.00 TO STA. 1385+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-140 (50 YR PRE)
503
502
501
500
499
498
497
496
495
494
493
492
491
490
489
488
487
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+15
CB-140a
0+00.00
Elev.= 501
498.30
Length = 318.18ft.
18" R.C. PIPE
Slope =0.67%
NP-66
CB-140b
3+21.18
Elev.= 499
496.46
495.45
CB-140c
3+93.22
Elev.= 499
495.04
494.35
Length = 70.04ft.
30" R.C. PIPE
Slope =0.56%
NP-67
Length = 120.46ft.
30" R.C. PIPE
Slope =4.53%
NP-68
489.39
OF-140
5+14.68
Elev.= 489

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

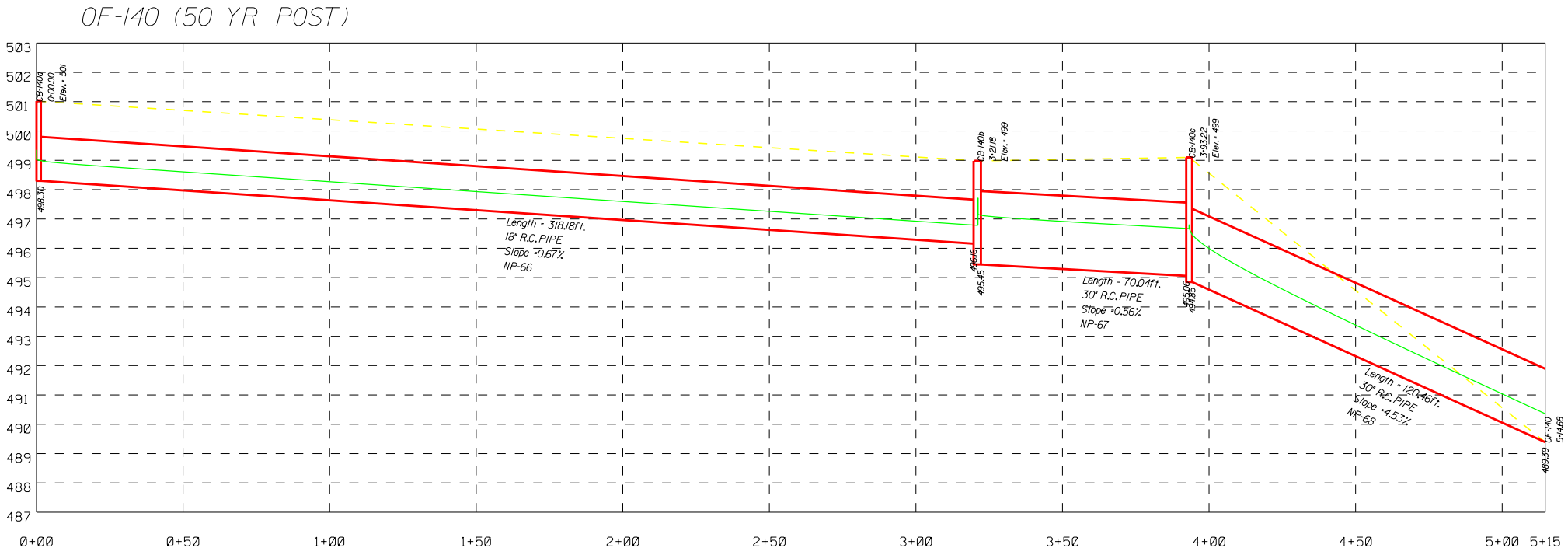
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-140	Outlet	OP	489.39	489.39	0.00	0.00	0.00	61.20	0.00	22.74	0.30	0.00
CB-140c	Other	C.B. TYPE 112	499.10	499.10	4.25	0.03	61.08	61.08	27.81	22.74	0.30	3.40
CB-140b	Other	C.B. TYPE 112	498.98	498.98	3.53	0.54	60.92	60.92	24.66	21.87	0.28	3.40
CB-140a	Other	C.B. TYPE 112	501.02	501.02	2.72	0.00	24.50	24.50	3.36	1.51	0.32	5.72

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-68	CB-140c	OF-140	Circular	Concrete	1	2.50	120	4.53	27.81	101.76	0.93	16.75	497.35	496.72	491.89	490.36	494.85	489.39	7.06	15.81	1.87	0.97
NP-67	CB-140b	CB-140c	Circular	Concrete	1	2.50	70	0.56	24.66	35.67	1.61	7.36	497.95	497.70	497.56	496.67	495.45	495.06	5.31	7.36	2.25	1.61
NP-66	CB-140a	CB-140b	Circular	Concrete	1	1.50	318	0.67	3.36	10.04	0.62	4.85	499.80	499.32	497.66	496.78	498.30	496.16	2.63	4.85	1.02	0.62

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-140c	5.00	8.48	9.03	0.90	0.87	0.90	0.87	0.00	0.00
CB-140b	60.92	22.67	3.40	0.27	20.36	0.27	20.36	0.00	0.00
CB-140a	24.50	3.36	5.72	0.32	1.51	0.32	1.51	0.00	0.00


OF-140 (50 YR POST)
503
502
501
500
499
498
497
496
495
494
493
492
491
490
489
488
487
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+15
CB1400
0+00.00
Elev.= 501
498.30
Length = 318.18ft.
18" R.C. PIPE
Slope =0.67%
NP-66
CB1400b
3+21.18
Elev.= 499
496.46
495.45
CB1400c
3+93.22
Elev.= 499
495.04
494.35
Length = 70.04ft.
30" R.C. PIPE
Slope =0.56%
NP-67
Length = 120.46ft.
30" R.C. PIPE
Slope =4.53%
NP-68
489.39
OF-140
5+14.68
Elev.= 489

CULVERT 141

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 141**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.19	2.8674
Grass	0.25	14.23	3.5584
Woods	0.15	9.12	1.3686
	Σ	**26.54**	7.7944

$C_{ave} = \frac{7.7944}{26.54} = 0.29$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.91	3.5145
Grass	0.25	13.51	3.3787
Woods	0.15	9.12	1.3686
	Σ	**26.54**	8.2617

$C_{ave} = \frac{8.2617}{26.54} = 0.31$

T_c =	60.92	min.								
I_{05} =	2.48	in / hr								
I_{10} =	2.74	in / hr								
I_{25} =	3.10	in / hr								
I_{50} =	3.37	in / hr								
I_{100} =	3.65	in / hr								

Pre Construction Runoff:

Q_{05} =	0.29	**x**	2.48	**x**	26.54	**x**	1	=	**19.34**	cfs
Q_{10} =	0.29	**x**	2.74	**x**	26.54	**x**	1	=	**21.32**	cfs
Q_{25} =	0.29	**x**	3.10	**x**	26.54	**x**	1.1	=	**26.59**	cfs
Q_{50} =	0.29	**x**	3.37	**x**	26.54	**x**	1.2	=	**31.54**	cfs
Q_{100} =	0.29	**x**	3.65	**x**	26.54	**x**	1.25	=	**35.53**	cfs

Post Construction Runoff:

Q_{05} =	0.31	**x**	2.48	**x**	26.54	**x**	1	=	**20.50**	cfs
Q_{10} =	0.31	**x**	2.74	**x**	26.54	**x**	1	=	**22.60**	cfs
Q_{25} =	0.31	**x**	3.10	**x**	26.54	**x**	1.1	=	**28.19**	cfs
Q_{50} =	0.31	**x**	3.37	**x**	26.54	**x**	1.2	=	**33.43**	cfs
Q_{100} =	0.31	**x**	3.65	**x**	26.54	**x**	1.25	=	**37.66**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 141	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**200**				
9	Watercourse slope, s	----------	ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.012**	+		=	**0.012**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------		**3**				
	Back Slope, (_ : 1)	----------		**3**				
	Bottom Width	----------	ft	**2**				
	Flow Depth	----------	ft	**0.5**				
12	Cross sectional flow area, a	----------	ft^2	**1.75**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**5.16**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**0.34**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft	**0.0300**				
16	Manning's roughness coeff., n	----------		**0.06**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**2.09**		**#DIV/0!**		
18	Flow length, L	----------	ft	**1700**				
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.226**	+	**0.000**	=	**0.226**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**1.015**
							min	**60.92**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 26.59 cfs

Design Flow: 31.54 cfs

Maximum Flow: 35.53 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1381+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
491.16	26.59	26.59	0.00	1
491.23	27.48	27.48	0.00	1
491.30	28.38	28.38	0.00	1
491.36	29.27	29.27	0.00	1
491.43	30.17	30.17	0.00	1
491.50	31.06	31.06	0.00	1
491.54	31.54	31.54	0.00	1
491.65	32.85	32.85	0.00	1
491.73	33.74	33.74	0.00	1
491.81	34.64	34.64	0.00	1
491.89	35.53	35.53	0.00	1
497.00	71.14	71.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
26.59	26.59	491.16	2.635	1.211	5-S2n	1.107	1.756	1.236	1.149	10.630	3.672
27.48	27.48	491.23	2.699	1.294	5-S2n	1.128	1.785	1.261	1.170	10.714	3.707
28.38	28.38	491.30	2.765	1.379	5-S2n	1.149	1.814	1.286	1.189	10.798	3.740
29.27	29.27	491.36	2.833	1.464	5-S2n	1.170	1.842	1.310	1.209	10.881	3.773
30.17	30.17	491.43	2.902	1.551	5-S2n	1.190	1.870	1.334	1.228	10.965	3.805
31.06	31.06	491.50	2.973	1.940	5-S2n	1.211	1.897	1.358	1.247	11.045	3.836
31.54	31.54	491.54	3.012	1.980	5-S2n	1.222	1.911	1.370	1.257	11.088	3.852
32.85	32.85	491.65	3.120	2.093	5-S2n	1.252	1.948	1.405	1.284	11.204	3.896
33.74	33.74	491.73	3.197	2.171	5-S2n	1.272	1.973	1.428	1.302	11.279	3.925
34.64	34.64	491.81	3.276	2.251	5-S2n	1.292	1.997	1.452	1.319	11.351	3.954
35.53	35.53	491.89	3.357	2.333	5-S2n	1.312	2.021	1.475	1.337	11.427	3.982

****

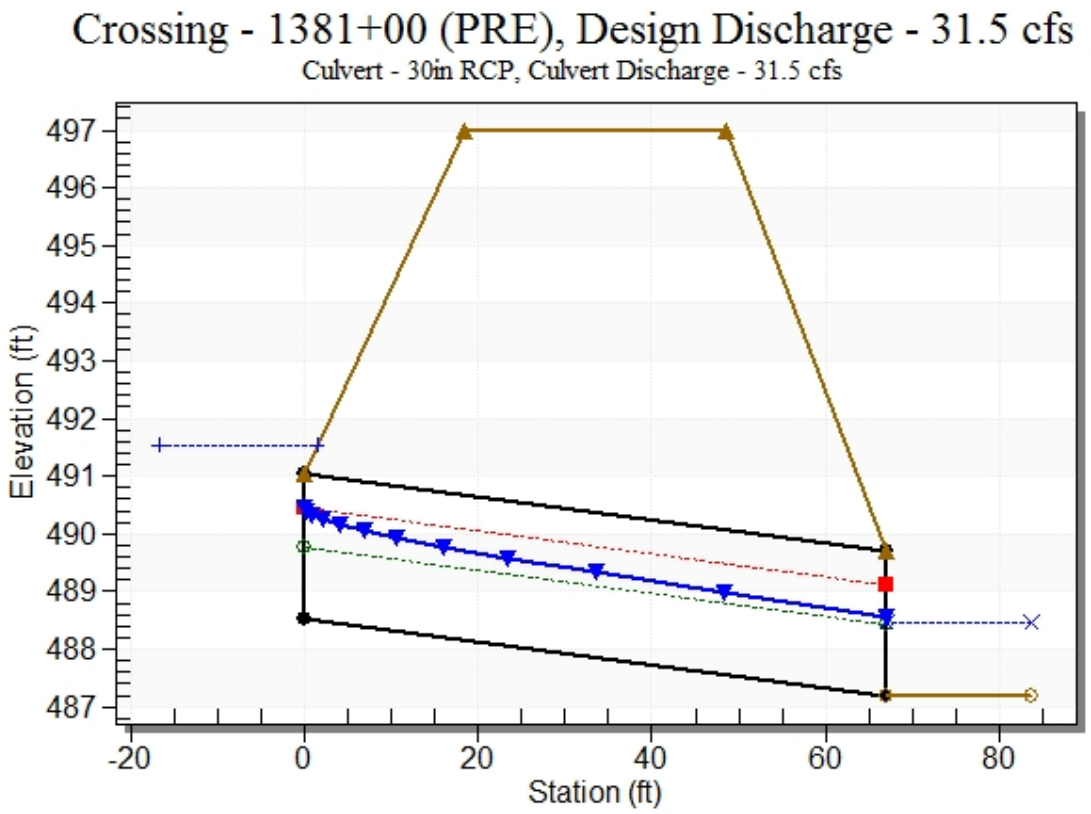
Straight Culvert

Inlet Elevation (invert): 488.53 ft, Outlet Elevation (invert): 487.20 ft

Culvert Length: 67.01 ft, Culvert Slope: 0.0199

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 488.53 ft

Outlet Station: 67.00 ft

Outlet Elevation: 487.20 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1381+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
26.59	488.35	1.15	3.67	2.15	0.71
27.48	488.37	1.17	3.71	2.19	0.71
28.38	488.39	1.19	3.74	2.23	0.71
29.27	488.41	1.21	3.77	2.26	0.71
30.17	488.43	1.23	3.80	2.30	0.71
31.06	488.45	1.25	3.84	2.33	0.71
31.54	488.46	1.26	3.85	2.35	0.71
32.85	488.48	1.28	3.90	2.40	0.71
33.74	488.50	1.30	3.93	2.44	0.72
34.64	488.52	1.32	3.95	2.47	0.72
35.53	488.54	1.34	3.98	2.50	0.72

Tailwater Channel Data - 1381+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 487.20 ft

Roadway Data for Crossing: 1381+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 497.00 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 28.19 cfs

Design Flow: 33.43 cfs

Maximum Flow: 37.66 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1381+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
491.28	28.19	28.19	0.00	1
491.35	29.14	29.14	0.00	1
491.43	30.08	30.08	0.00	1
491.50	31.03	31.03	0.00	1
491.58	31.98	31.98	0.00	1
491.66	32.92	32.92	0.00	1
491.70	33.43	33.43	0.00	1
491.82	34.82	34.82	0.00	1
491.91	35.77	35.77	0.00	1
492.00	36.71	36.71	0.00	1
492.09	37.66	37.66	0.00	1
497.00	71.14	71.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
28.19	28.19	491.28	2.751	1.361	5-S2n	1.145	1.808	1.281	1.185	10.781	3.733
29.14	29.14	491.35	2.823	1.451	5-S2n	1.167	1.838	1.306	1.206	10.869	3.768
30.08	30.08	491.43	2.896	1.543	5-S2n	1.188	1.867	1.332	1.226	10.956	3.802
31.03	31.03	491.50	2.970	1.937	5-S2n	1.210	1.896	1.357	1.246	11.043	3.835
31.98	31.98	491.58	3.048	2.018	5-S2n	1.232	1.923	1.382	1.266	11.126	3.867
32.92	32.92	491.66	3.127	2.099	5-S2n	1.253	1.950	1.407	1.285	11.210	3.899
33.43	33.43	491.70	3.170	2.144	5-S2n	1.265	1.965	1.420	1.295	11.253	3.915
34.82	34.82	491.82	3.292	2.268	5-S2n	1.296	2.002	1.457	1.323	11.366	3.960
35.77	35.77	491.91	3.379	2.354	5-S2n	1.318	2.027	1.481	1.342	11.445	3.989
36.71	36.71	492.00	3.467	2.443	5-S2n	1.339	2.051	1.506	1.360	11.518	4.018
37.66	37.66	492.09	3.559	2.532	5-S2n	1.360	2.074	1.531	1.378	11.595	4.046

****

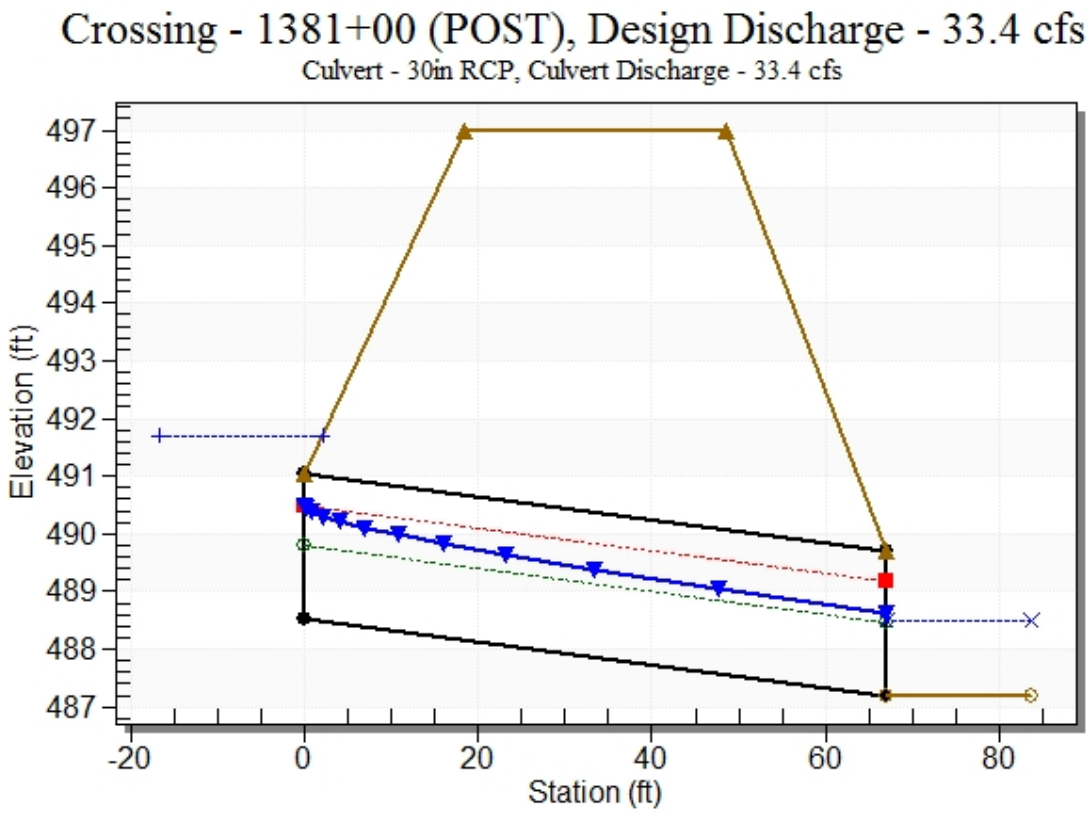
Straight Culvert

Inlet Elevation (invert): 488.53 ft, Outlet Elevation (invert): 487.20 ft

Culvert Length: 67.01 ft, Culvert Slope: 0.0199

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 488.53 ft

Outlet Station: 67.00 ft

Outlet Elevation: 487.20 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1381+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
28.19	488.39	1.19	3.73	2.22	0.71
29.14	488.41	1.21	3.77	2.26	0.71
30.08	488.43	1.23	3.80	2.30	0.71
31.03	488.45	1.25	3.83	2.33	0.71
31.98	488.47	1.27	3.87	2.37	0.71
32.92	488.49	1.29	3.90	2.41	0.71
33.43	488.50	1.30	3.92	2.43	0.72
34.82	488.52	1.32	3.96	2.48	0.72
35.77	488.54	1.34	3.99	2.51	0.72
36.71	488.56	1.36	4.02	2.55	0.72
37.66	488.58	1.38	4.05	2.58	0.72

Tailwater Channel Data - 1381+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 487.20 ft

Roadway Data for Crossing: 1381+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 497.00 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

CULVERT 142

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 142a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.56	0.5000
Grass	0.25	1.30	0.3242
Woods	0.15	3.53	0.5290
	Σ	**5.38**	1.3532

$C_{ave} = \frac{1.3532}{5.38} = 0.25$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.76	0.6800
Grass	0.25	1.30	0.3242
Woods	0.15	3.53	0.5290
	Σ	**5.58**	1.5332

$C_{ave} = \frac{1.5332}{5.58} = 0.27$

T_c =	39.48	min.
I_{05} =	3.23	in / hr
I_{10} =	3.57	in / hr
I_{25} =	4.06	in / hr
I_{50} =	4.42	in / hr
I_{100} =	4.80	in / hr

Pre Construction Runoff:

Q_{05} =	0.25	x	3.23	x	5.38	x	1	=	**4.37**	cfs
Q_{10} =	0.25	x	3.57	x	5.38	x	1	=	**4.83**	cfs
Q_{25} =	0.25	x	4.06	x	5.38	x	1.1	=	**6.04**	cfs
Q_{50} =	0.25	x	4.42	x	5.38	x	1.2	=	**7.18**	cfs
Q_{100} =	0.25	x	4.80	x	5.38	x	1.25	=	**8.11**	cfs

Post Construction Runoff:

Q_{05} =	0.27	x	3.23	x	5.58	x	1	=	**4.95**	cfs
Q_{10} =	0.27	x	3.57	x	5.58	x	1	=	**5.47**	cfs
Q_{25} =	0.27	x	4.06	x	5.58	x	1.1	=	**6.85**	cfs
Q_{50} =	0.27	x	4.42	x	5.58	x	1.2	=	**8.14**	cfs
Q_{100} =	0.27	x	4.80	x	5.58	x	1.25	=	**9.19**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 142b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.50	0.4530
Grass	0.25	0.53	0.1323
Woods	0.15	0.00	0.0000
	Σ	**1.03**	0.5853

$C_{ave} = \frac{0.5853}{1.03} = 0.57$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.63	0.5670
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.63**	0.5670

$C_{ave} = \frac{0.5670}{0.63} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.57	x	6.23	x	1.03	x	1	=	**3.65**	cfs
Q_{10} =	0.57	x	6.98	x	1.03	x	1	=	**4.08**	cfs
Q_{25} =	0.57	x	8.08	x	1.03	x	1.1	=	**5.20**	cfs
Q_{50} =	0.57	x	8.93	x	1.03	x	1.2	=	**6.27**	cfs
Q_{100} =	0.57	x	9.81	x	1.03	x	1.25	=	**7.18**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.63	x	1	=	**3.53**	cfs
Q_{10} =	0.90	x	6.98	x	0.63	x	1	=	**3.96**	cfs
Q_{25} =	0.90	x	8.08	x	0.63	x	1.1	=	**5.04**	cfs
Q_{50} =	0.90	x	8.93	x	0.63	x	1.2	=	**6.07**	cfs
Q_{100} =	0.90	x	9.81	x	0.63	x	1.25	=	**6.95**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 142c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.45	0.4046
Grass	0.25	0.40	0.1010
Woods	0.15	0.88	0.1325
	Σ	**1.74**	0.6381

$C_{ave} = \frac{0.6381}{1.74} = 0.37$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.65	0.5846
Grass	0.25	0.40	0.1010
Woods	0.15	0.88	0.1325
	Σ	**1.94**	0.8181

$C_{ave} = \frac{0.8181}{1.94} = 0.42$

T_c =	24.50	min.								
I_{05} =	4.09	in / hr								
I_{10} =	4.53	in / hr								
I_{25} =	5.18	in / hr								
I_{50} =	5.66	in / hr								
I_{100} =	6.16	in / hr								

Pre Construction Runoff:

Q_{05} =	0.37	x	4.09	x	1.74	x	1	=	**2.61**	cfs
Q_{10} =	0.37	x	4.53	x	1.74	x	1	=	**2.89**	cfs
Q_{25} =	0.37	x	5.18	x	1.74	x	1.1	=	**3.64**	cfs
Q_{50} =	0.37	x	5.66	x	1.74	x	1.2	=	**4.34**	cfs
Q_{100} =	0.37	x	6.16	x	1.74	x	1.25	=	**4.91**	cfs

Post Construction Runoff:

Q_{05} =	0.42	x	4.09	x	1.94	x	1	=	**3.35**	cfs
Q_{10} =	0.42	x	4.53	x	1.94	x	1	=	**3.71**	cfs
Q_{25} =	0.42	x	5.18	x	1.94	x	1.1	=	**4.66**	cfs
Q_{50} =	0.42	x	5.66	x	1.94	x	1.2	=	**5.56**	cfs
Q_{100} =	0.42	x	6.16	x	1.94	x	1.25	=	**6.30**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 142a Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Woods				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft	**100**					
4 Two-yr 24-hr rainfall, P_2		in	**3.58**					
5 Land slope, s		ft/ft	**0.0200**					
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**	
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)				unpaved				
8 Flow length, L		ft	**800**					
9 Watercourse slope, s		ft/ft	**0.0400**					
10 Average velocity, V (figure 3-1)		ft/s	**3.23**					
11 $T_t = L / (3600\ V)$	Compute T_t	hr	**0.069**	+		=	**0.069**	
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2	**0.00**	**0.00**				
13 Wetted perimeter, p_w		ft	**0.00**	**0.00**				
14 Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**				
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**				
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.658**
							min	**39.48**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 142c	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------						
8	Flow length, L	----------	ft					
9	Watercourse slope, s	----------	ft/ft					
10	Average velocity, V (figure 3-1)	----------	ft/s					
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.408**
							min	**24.50**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-142		Outlet	OP	479.99	479.99	0.00	0.00	0.00	39.79	0.00	8.15	0.32	0.00
CB-142c		Other	C.B. TYPE 112	484.49	484.49	3.61	0.21	39.75	39.75	13.76	8.15	0.32	4.45
CB-142b		Other	C.B. TYPE 112	486.45	486.45	3.29	0.03	39.63	39.63	10.38	6.41	0.30	4.46
CB-142a		Other	C.B. TYPE 112	487.78	487.78	3.38	0.00	39.48	39.48	7.28	5.38	0.25	4.47

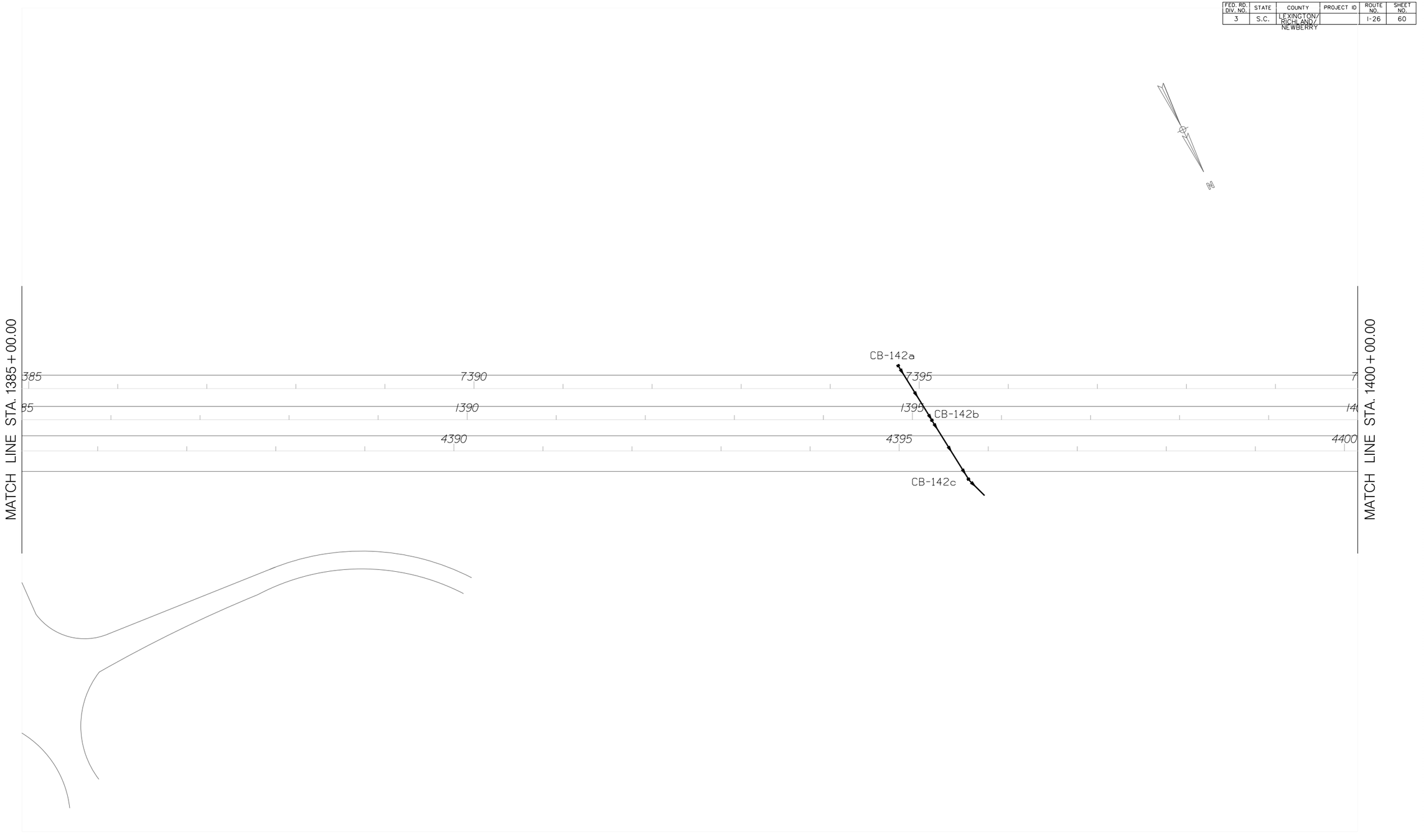
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-71	CB-142c	OF-142	Circular	Concrete	1	1.50	25	3.57	13.76	23.14	0.87	12.91	482.38	482.50	481.49	481.00	480.88	479.99	7.79	10.83	1.50	1.01
NP-70	CB-142b	CB-142c	Circular	Concrete	1	1.50	76	2.47	10.38	19.22	0.82	10.48	484.66	484.48	482.79	482.14	483.16	481.29	6.29	10.10	1.32	0.85
NP-69	CB-142a	CB-142b	Circular	Concrete	1	1.50	70	1.50	7.28	14.98	0.77	7.96	485.90	486.09	484.85	484.13	484.40	483.35	4.12	7.80	1.50	0.78

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-142c	24.50	4.37	5.72	0.37	1.74	0.37	1.73	0.00	0.01
CB-142b	5.00	6.31	9.03	0.57	1.03	0.57	1.03	0.00	0.00
CB-142a	39.48	7.28	4.47	0.25	5.38	0.25	5.38	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	60



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

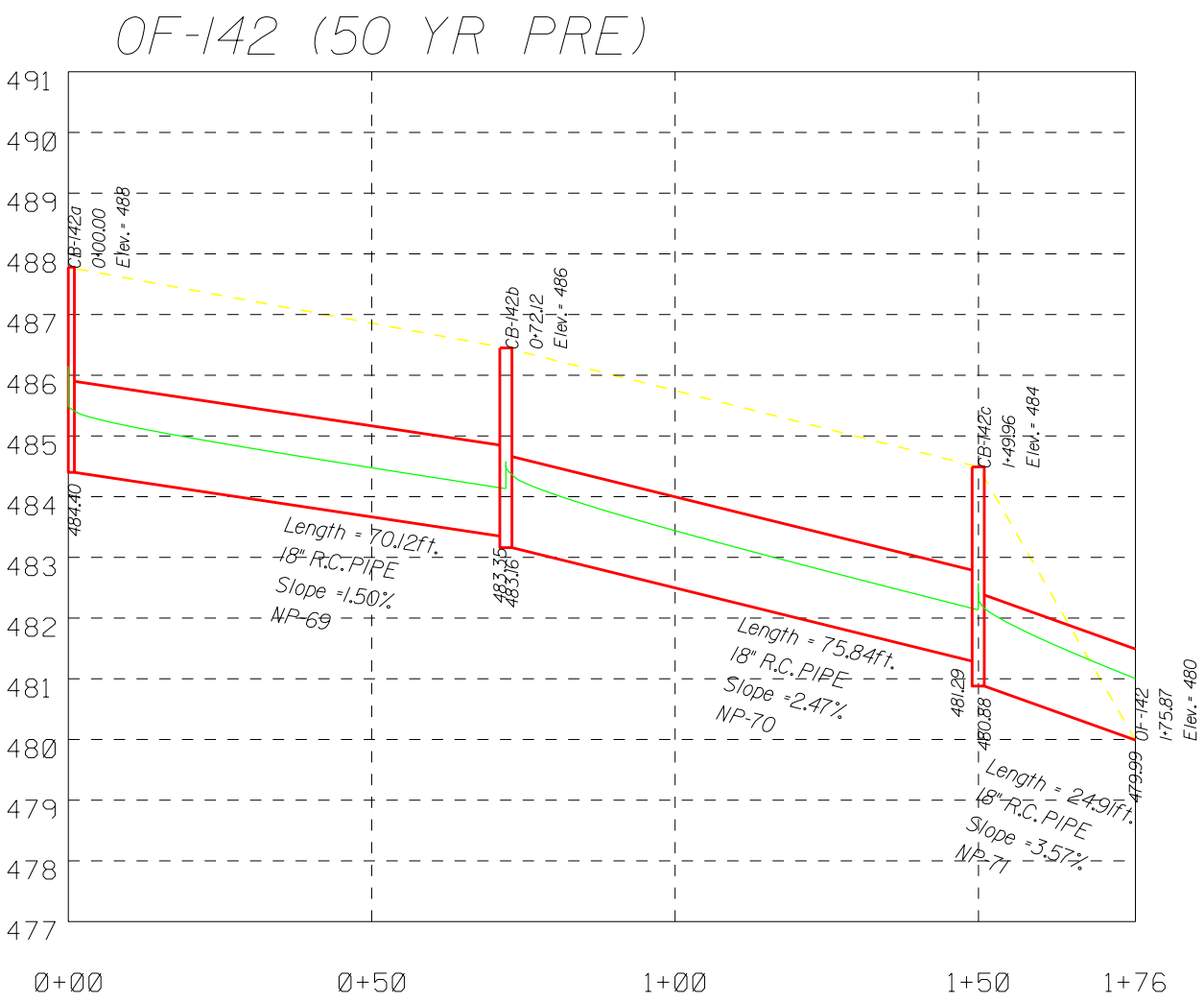
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1385+00.00 TO STA. 1400+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-142 (50 YR PRE)
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
0+00
0+50
1+00
1+50
1+76
CB-142a
0+00.00
Elev.= 488
484.40
Length = 70.12ft.
18" R.C. PIPE
Slope =1.50%
NP-69
CB-142b
0+72.12
Elev.= 486
483.35
483.16
Length = 75.84ft.
18" R.C. PIPE
Slope =2.47%
NP-70
CB-142c
1+49.96
Elev.= 484
481.29
480.88
Length = 24.91ft.
18" R.C. PIPE
Slope =3.57%
NP-71
OF-142
1+75.87
Elev.= 480
479.99

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

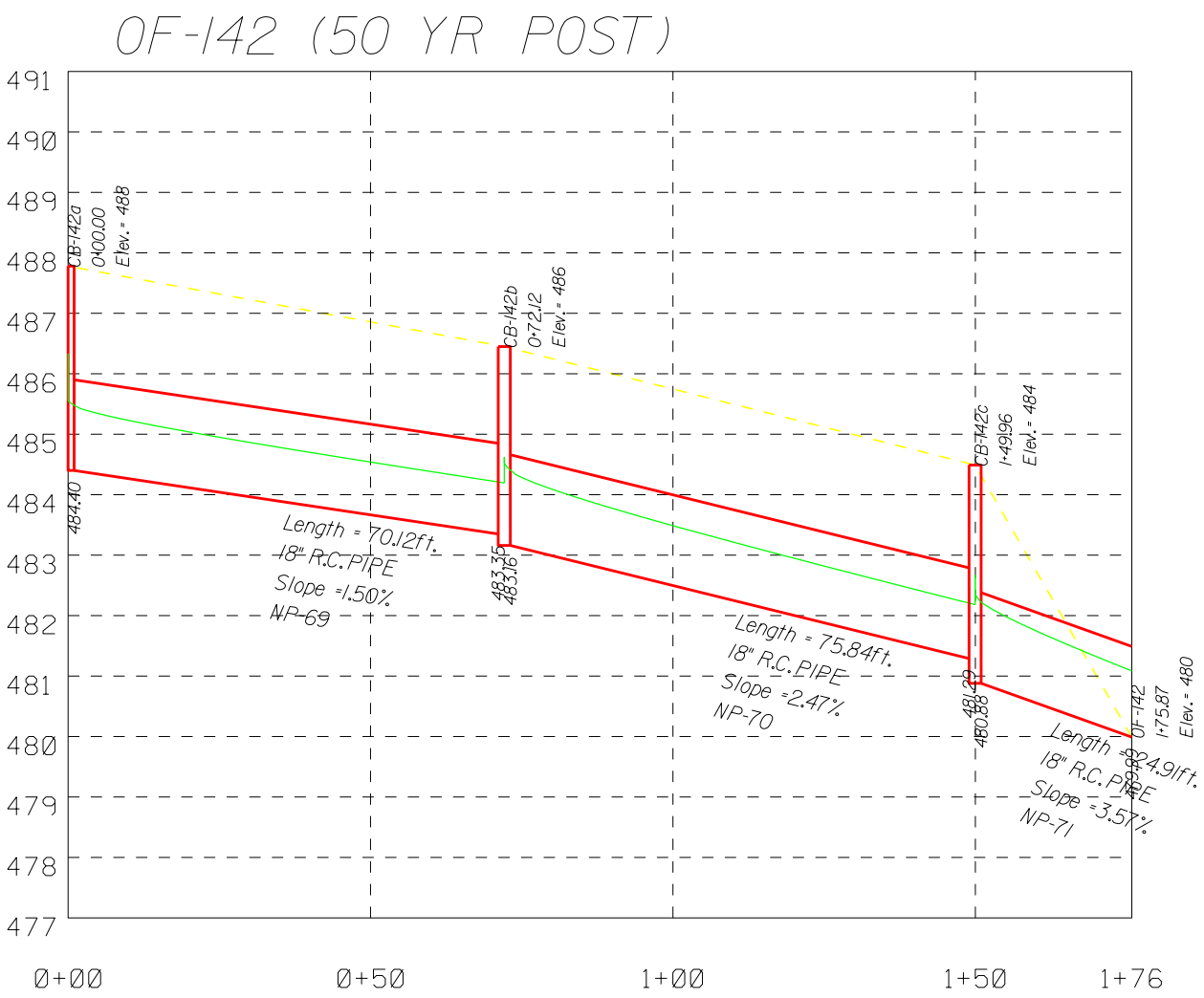
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-142	Outlet	OP	479.99	479.99	0.00	0.00	0.00	39.78	0.00	8.15	0.36	0.00
CB-142c	Other	C.B. TYPE 112	484.49	484.49	3.61	0.27	39.75	39.75	15.60	8.15	0.36	4.45
CB-142b	Other	C.B. TYPE 112	486.45	486.45	3.29	0.03	39.63	39.63	11.26	6.21	0.34	4.46
CB-142a	Other	C.B. TYPE 112	487.78	487.78	3.38	0.00	39.48	39.48	8.24	5.58	0.28	4.47

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-71	CB-142c	OF-142	Circular	Concrete	1	1.50	25	3.57	15.60	23.14	0.95	13.26	482.38	482.60	481.49	481.09	480.88	479.99	8.83	11.28	1.50	1.10
NP-70	CB-142b	CB-142c	Circular	Concrete	1	1.50	76	2.47	11.26	19.22	0.86	10.69	484.66	484.53	482.79	482.18	483.16	481.29	6.66	10.29	1.37	0.89
NP-69	CB-142a	CB-142b	Circular	Concrete	1	1.50	70	1.50	8.24	14.98	0.83	8.21	485.90	486.27	484.85	484.20	484.40	483.35	4.66	8.03	1.50	0.85

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-142c	24.50	5.61	5.72	0.42	1.94	0.42	1.93	0.00	0.01
CB-142b	5.00	6.14	9.03	0.90	0.63	0.90	0.63	0.00	0.00
CB-142a	39.48	8.24	4.47	0.28	5.58	0.28	5.58	0.00	0.00


OF-142 (50 YR POST)
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
0+00
0+50
1+00
1+50
1+76
CB-142a
0+00.00
Elev.= 488
484.40
CB-142b
0+72.12
Elev.= 486
483.35
483.16
CB-142c
1+49.96
Elev.= 484
481.22
480.88
OF-142
1+75.87
Elev.= 480
479.83
Length = 70.12ft.
18" R.C. PIPE
Slope =1.50%
NP-69
Length = 75.84ft.
18" R.C. PIPE
Slope =2.47%
NP-70
Length = 24.91ft.
18" R.C. PIPE
Slope =3.57%
NP-71

CULVERT 143

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 143**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.61	2.3475
Grass	0.25	9.16	2.2894
Woods	0.15	7.17	1.0753
	Σ	**18.93**	5.7121

$C_{ave} = \frac{5.7121}{18.93} = 0.30$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.33	2.9933
Grass	0.25	8.30	2.0750
Woods	0.15	7.17	1.0753
	Σ	**18.79**	6.1435

$C_{ave} = \frac{6.1435}{18.79} = 0.33$

T_c =	41.97	min.
I_{05} =	3.12	in / hr
I_{10} =	3.45	in / hr
I_{25} =	3.92	in / hr
I_{50} =	4.27	in / hr
I_{100} =	4.63	in / hr

Pre Construction Runoff:

Q_{05} =	0.30	x	3.12	x	18.93	x	1	=	**17.83**	cfs
Q_{10} =	0.30	x	3.45	x	18.93	x	1	=	**19.70**	cfs
Q_{25} =	0.30	x	3.92	x	18.93	x	1.1	=	**24.63**	cfs
Q_{50} =	0.30	x	4.27	x	18.93	x	1.2	=	**29.27**	cfs
Q_{100} =	0.30	x	4.63	x	18.93	x	1.25	=	**33.03**	cfs

Post Construction Runoff:

Q_{05} =	0.33	x	3.12	x	18.79	x	1	=	**19.18**	cfs
Q_{10} =	0.33	x	3.45	x	18.79	x	1	=	**21.19**	cfs
Q_{25} =	0.33	x	3.92	x	18.79	x	1.1	=	**26.49**	cfs
Q_{50} =	0.33	x	4.27	x	18.79	x	1.2	=	**31.48**	cfs
Q_{100} =	0.33	x	4.63	x	18.79	x	1.25	=	**35.53**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 143	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**800**				
9	Watercourse slope, s	----------	ft/ft	**0.0400**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.23**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.069**	+		=	**0.069**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------		**3**				
	Back Slope, (_ : 1)	----------		**3**				
	Bottom Width	----------	ft	**2**				
	Flow Depth	----------	ft	**0.5**				
12	Cross sectional flow area, a	----------	ft^2	**1.75**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**5.16**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**0.34**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft	**0.0514**				
16	Manning's roughness coeff., n	----------		**0.07**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**2.35**		**#DIV/0!**		
18	Flow length, L	----------	ft	**350**				
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.041**	+	**0.000**	=	**0.041**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.699**
							min	**41.97**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 24.63 cfs

Design Flow: 29.27 cfs

Maximum Flow: 33.03 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1400+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
464.97	24.63	24.63	0.00	1
465.03	25.47	25.47	0.00	1
465.09	26.31	26.31	0.00	1
465.15	27.15	27.15	0.00	1
465.21	27.99	27.99	0.00	1
465.28	28.83	28.83	0.00	1
465.31	29.27	29.27	0.00	1
465.41	30.51	30.51	0.00	1
465.47	31.35	31.35	0.00	1
465.54	32.19	32.19	0.00	1
465.61	33.03	33.03	0.00	1
472.00	76.16	76.16	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
24.63	24.63	464.97	2.494	0.0*	1-S2n	1.021	1.686	1.068	1.104	11.907	3.594
25.47	25.47	465.03	2.552	0.0*	5-S2n	1.040	1.715	1.078	1.124	12.156	3.628
26.31	26.31	465.09	2.611	0.0*	5-S2n	1.059	1.743	1.059	1.143	12.854	3.661
27.15	27.15	465.15	2.672	0.0*	5-S2n	1.078	1.774	1.078	1.162	12.955	3.694
27.99	27.99	465.21	2.733	0.0*	5-S2n	1.097	1.802	1.097	1.181	13.058	3.726
28.83	28.83	465.28	2.796	0.0*	5-S2n	1.115	1.828	1.171	1.199	12.357	3.757
29.27	29.27	465.31	2.829	0.0*	5-S2n	1.125	1.842	1.179	1.209	12.432	3.773
30.51	30.51	465.41	2.925	0.0*	5-S2n	1.152	1.880	1.201	1.235	12.662	3.816
31.35	31.35	465.47	2.993	0.0*	5-S2n	1.170	1.905	1.214	1.253	12.820	3.846
32.19	32.19	465.54	3.061	0.0*	5-S2n	1.188	1.930	1.188	1.270	13.537	3.874
33.03	33.03	465.61	3.132	0.0*	5-S2n	1.206	1.953	1.206	1.287	13.623	3.902

* Full Flow Headwater elevation is below inlet invert.

****

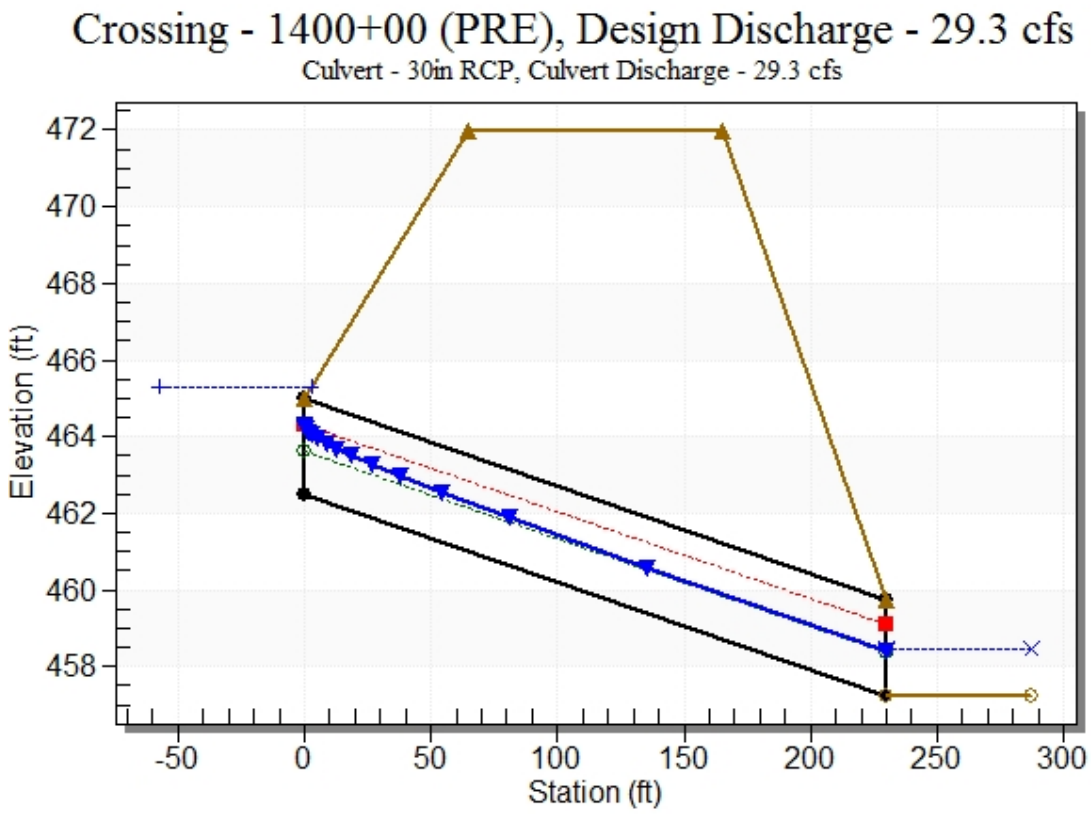
Straight Culvert

Inlet Elevation (invert): 462.48 ft, Outlet Elevation (invert): 457.25 ft

Culvert Length: 230.06 ft, Culvert Slope: 0.0227

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 462.48 ft

Outlet Station: 230.00 ft

Outlet Elevation: 457.25 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1400+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
24.63	458.35	1.10	3.59	2.07	0.70
25.47	458.37	1.12	3.63	2.10	0.70
26.31	458.39	1.14	3.66	2.14	0.70
27.15	458.41	1.16	3.69	2.18	0.71
27.99	458.43	1.18	3.73	2.21	0.71
28.83	458.45	1.20	3.76	2.25	0.71
29.27	458.46	1.21	3.77	2.26	0.71
30.51	458.49	1.24	3.82	2.31	0.71
31.35	458.50	1.25	3.85	2.35	0.71
32.19	458.52	1.27	3.87	2.38	0.71
33.03	458.54	1.29	3.90	2.41	0.71

Tailwater Channel Data - 1400+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 457.25 ft

Roadway Data for Crossing: 1400+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 472.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 26.49 cfs

Design Flow: 31.48 cfs

Maximum Flow: 35.53 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1400+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	30in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
465.10	26.49	26.49	0.00	1
465.17	27.39	27.39	0.00	1
465.24	28.30	28.30	0.00	1
465.30	29.20	29.20	0.00	1
465.37	30.11	30.11	0.00	1
465.45	31.01	31.01	0.00	1
465.48	31.48	31.48	0.00	1
465.59	32.82	32.82	0.00	1
465.67	33.72	33.72	0.00	1
465.75	34.63	34.63	0.00	1
465.83	35.53	35.53	0.00	1
472.00	76.16	76.16	0.00	Overtopping

Table 2 - Culvert Summary Table: 30in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
26.49	26.49	465.10	2.624	0.0*	5-S2n	1.063	1.749	1.063	1.147	12.877	3.669
27.39	27.39	465.17	2.689	0.0*	5-S2n	1.083	1.782	1.083	1.168	12.984	3.703
28.30	28.30	465.24	2.756	0.0*	5-S2n	1.103	1.812	1.160	1.188	12.273	3.737
29.20	29.20	465.30	2.824	0.0*	5-S2n	1.123	1.840	1.178	1.207	12.420	3.770
30.11	30.11	465.37	2.894	0.0*	5-S2n	1.143	1.868	1.194	1.227	12.586	3.802
31.01	31.01	465.45	2.965	0.0*	5-S2n	1.163	1.895	1.209	1.246	12.756	3.834
31.48	31.48	465.48	3.003	0.0*	5-S2n	1.173	1.909	1.217	1.256	12.845	3.850
32.82	32.82	465.59	3.114	0.0*	5-S2n	1.202	1.947	1.202	1.283	13.604	3.895
33.72	33.72	465.67	3.192	0.0*	5-S2n	1.221	1.973	1.221	1.301	13.694	3.924
34.63	34.63	465.75	3.271	0.0*	5-S2n	1.240	1.997	1.240	1.319	13.785	3.953
35.53	35.53	465.83	3.353	0.0*	5-S2n	1.260	2.021	1.321	1.337	13.073	3.982

* Full Flow Headwater elevation is below inlet invert.

****

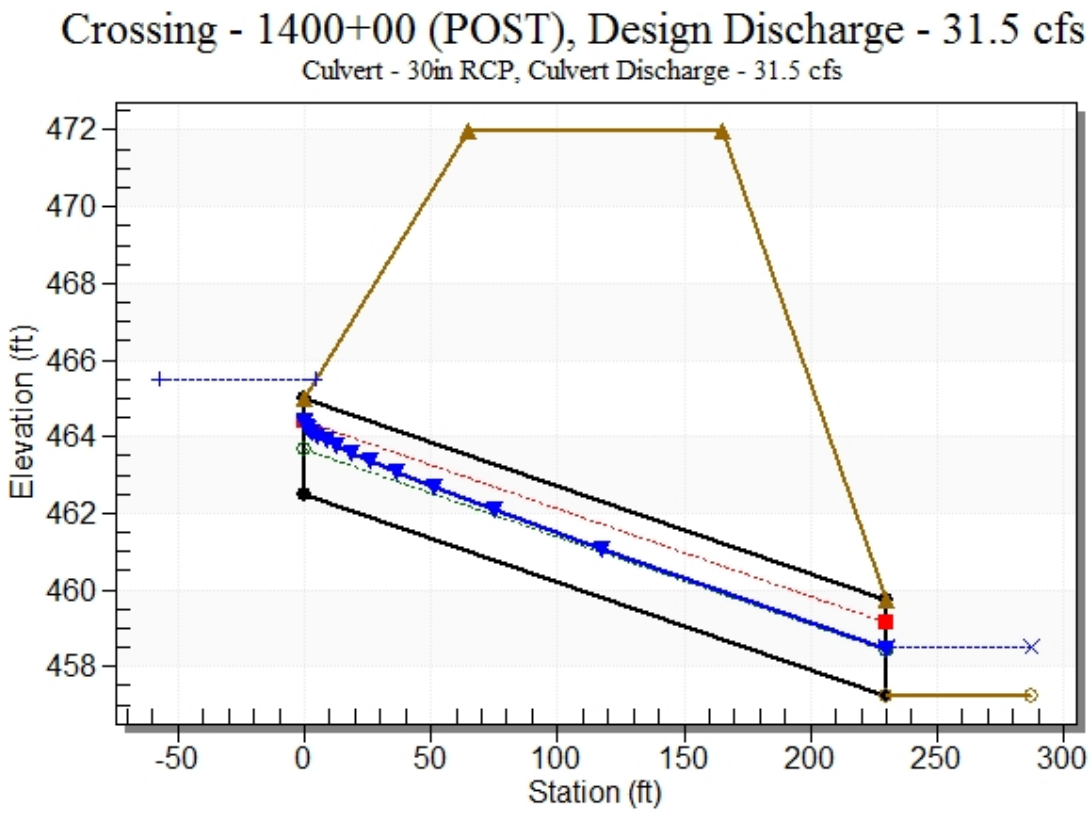
Straight Culvert

Inlet Elevation (invert): 462.48 ft, Outlet Elevation (invert): 457.25 ft

Culvert Length: 230.06 ft, Culvert Slope: 0.0227

****

Water Surface Profile Plot for Culvert: 30in RCP



Site Data - 30in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 462.48 ft

Outlet Station: 230.00 ft

Outlet Elevation: 457.25 ft

Number of Barrels: 1

Culvert Data Summary - 30in RCP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1400+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
26.49	458.40	1.15	3.67	2.15	0.71
27.39	458.42	1.17	3.70	2.19	0.71
28.30	458.44	1.19	3.74	2.22	0.71
29.20	458.46	1.21	3.77	2.26	0.71
30.11	458.48	1.23	3.80	2.30	0.71
31.01	458.50	1.25	3.83	2.33	0.71
31.48	458.51	1.26	3.85	2.35	0.71
32.82	458.53	1.28	3.90	2.40	0.71
33.72	458.55	1.30	3.92	2.44	0.72
34.63	458.57	1.32	3.95	2.47	0.72
35.53	458.59	1.34	3.98	2.50	0.72

Tailwater Channel Data - 1400+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 457.25 ft

Roadway Data for Crossing: 1400+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 472.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 144/145

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 144/145a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.11	0.0270
Woods	0.15	0.68	0.1014
	Σ	**0.78**	0.1284

$C_{ave} = \frac{0.1284}{0.78} = 0.16$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.11	0.0270
Woods	0.15	0.68	0.1014
	Σ	**0.78**	0.1284

$C_{ave} = \frac{0.1284}{0.78} = 0.16$

T_c =	28.46	min.
I_{05} =	3.82	in / hr
I_{10} =	4.23	in / hr
I_{25} =	4.83	in / hr
I_{50} =	5.27	in / hr
I_{100} =	5.73	in / hr

Pre Construction Runoff:

Q_{05} =	0.16	x	3.82	x	0.78	x	1	=	**0.49**	cfs
Q_{10} =	0.16	x	4.23	x	0.78	x	1	=	**0.54**	cfs
Q_{25} =	0.16	x	4.83	x	0.78	x	1.1	=	**0.68**	cfs
Q_{50} =	0.16	x	5.27	x	0.78	x	1.2	=	**0.81**	cfs
Q_{100} =	0.16	x	5.73	x	0.78	x	1.25	=	**0.92**	cfs

Post Construction Runoff:

Q_{05} =	0.16	x	3.82	x	0.78	x	1	=	**0.49**	cfs
Q_{10} =	0.16	x	4.23	x	0.78	x	1	=	**0.54**	cfs
Q_{25} =	0.16	x	4.83	x	0.78	x	1.1	=	**0.68**	cfs
Q_{50} =	0.16	x	5.27	x	0.78	x	1.2	=	**0.81**	cfs
Q_{100} =	0.16	x	5.73	x	0.78	x	1.25	=	**0.92**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Location: **Site 144/145b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.17	0.1548
Grass	0.25	0.13	0.0322
Woods	0.15	0.41	0.0618
	Σ	**0.71**	0.2488

$C_{ave} = \frac{0.2488}{0.71} = 0.35$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2268
Grass	0.25	0.13	0.0322
Woods	0.15	0.41	0.0618
	Σ	**0.79**	0.3208

$C_{ave} = \frac{0.3208}{0.79} = 0.40$

T_c =	27.21	min.								
I_{05} =	3.90	in / hr								
I_{10} =	4.32	in / hr								
I_{25} =	4.93	in / hr								
I_{50} =	5.39	in / hr								
I_{100} =	5.86	in / hr								

Pre Construction Runoff:

Q_{05} =	0.35	**x**	3.90	**x**	0.71	**x**	1	=	**0.97**	cfs
Q_{10} =	0.35	**x**	4.32	**x**	0.71	**x**	1	=	**1.08**	cfs
Q_{25} =	0.35	**x**	4.93	**x**	0.71	**x**	1.1	=	**1.35**	cfs
Q_{50} =	0.35	**x**	5.39	**x**	0.71	**x**	1.2	=	**1.61**	cfs
Q_{100} =	0.35	**x**	5.86	**x**	0.71	**x**	1.25	=	**1.82**	cfs

Post Construction Runoff:

Q_{05} =	0.40	**x**	3.90	**x**	0.79	**x**	1	=	**1.25**	cfs
Q_{10} =	0.40	**x**	4.32	**x**	0.79	**x**	1	=	**1.39**	cfs
Q_{25} =	0.40	**x**	4.93	**x**	0.79	**x**	1.1	=	**1.74**	cfs
Q_{50} =	0.40	**x**	5.39	**x**	0.79	**x**	1.2	=	**2.07**	cfs
Q_{100} =	0.40	**x**	5.86	**x**	0.79	**x**	1.25	=	**2.35**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Checked By: _____ Date: _____

Location: **Site 144/145c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.16	0.1406
Grass	0.25	0.47	0.1178
Woods	0.15	7.37	1.1052
	Σ	**7.99**	1.3635

$C_{ave} = \frac{1.3635}{7.99} = 0.17$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.16	0.1406
Grass	0.25	0.47	0.1178
Woods	0.15	7.37	1.1052
	Σ	**7.99**	1.3635

$C_{ave} = \frac{1.3635}{7.99} = 0.17$

T_c =	49.81	min.								
I_{05} =	2.82	in / hr								
I_{10} =	3.11	in / hr								
I_{25} =	3.53	in / hr								
I_{50} =	3.85	in / hr								
I_{100} =	4.16	in / hr								

Pre Construction Runoff:

Q_{05} =	0.17	**x**	2.82	**x**	7.99	**x**	1	=	**3.85**	cfs
Q_{10} =	0.17	**x**	3.11	**x**	7.99	**x**	1	=	**4.24**	cfs
Q_{25} =	0.17	**x**	3.53	**x**	7.99	**x**	1.1	=	**5.30**	cfs
Q_{50} =	0.17	**x**	3.85	**x**	7.99	**x**	1.2	=	**6.29**	cfs
Q_{100} =	0.17	**x**	4.16	**x**	7.99	**x**	1.25	=	**7.10**	cfs

Post Construction Runoff:

Q_{05} =	0.17	**x**	2.82	**x**	7.99	**x**	1	=	**3.85**	cfs
Q_{10} =	0.17	**x**	3.11	**x**	7.99	**x**	1	=	**4.24**	cfs
Q_{25} =	0.17	**x**	3.53	**x**	7.99	**x**	1.1	=	**5.30**	cfs
Q_{50} =	0.17	**x**	3.85	**x**	7.99	**x**	1.2	=	**6.29**	cfs
Q_{100} =	0.17	**x**	4.16	**x**	7.99	**x**	1.25	=	**7.10**	cfs

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Job: ***I-26 DB Prep MM 85-101***
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Location: **Site 144/145d**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.06	0.0581
Grass	0.25	0.11	0.0276
Woods	0.15	0.15	0.0225
	Σ	**0.32**	0.1082

$C_{ave} = \frac{0.1082}{0.32} = 0.33$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.06	0.0581
Grass	0.25	0.11	0.0276
Woods	0.15	0.15	0.0225
	Σ	**0.32**	0.1082

$C_{ave} = \frac{0.1082}{0.32} = 0.33$

T_c =	5.00 min.
I_{05} =	6.23 in / hr
I_{10} =	6.98 in / hr
I_{25} =	8.08 in / hr
I_{50} =	8.93 in / hr
I_{100} =	9.81 in / hr

Pre Construction Runoff:

Q_{05} =	0.33	x	6.23	x	0.32	x	1	=	**0.67**	cfs
Q_{10} =	0.33	x	6.98	x	0.32	x	1	=	**0.76**	cfs
Q_{25} =	0.33	x	8.08	x	0.32	x	1.1	=	**0.96**	cfs
Q_{50} =	0.33	x	8.93	x	0.32	x	1.2	=	**1.16**	cfs
Q_{100} =	0.33	x	9.81	x	0.32	x	1.25	=	**1.33**	cfs

Post Construction Runoff:

Q_{05} =	0.33	x	6.23	x	0.32	x	1	=	**0.67**	cfs
Q_{10} =	0.33	x	6.98	x	0.32	x	1	=	**0.76**	cfs
Q_{25} =	0.33	x	8.08	x	0.32	x	1.1	=	**0.96**	cfs
Q_{50} =	0.33	x	8.93	x	0.32	x	1.2	=	**1.16**	cfs
Q_{100} =	0.33	x	9.81	x	0.32	x	1.25	=	**1.33**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Location: **Site 144/145e**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3984
Grass	0.25	0.44	0.1111
Woods	0.15	0.00	0.0000
	Σ	**0.89**	0.5096

$C_{ave} = \frac{0.5096}{0.89} = 0.57$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.81	0.7290
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.81**	0.7290

$C_{ave} = \frac{0.7290}{0.81} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.57	x	6.23	x	0.89	x	1	=	**3.17**	cfs
Q_{10} =	0.57	x	6.98	x	0.89	x	1	=	**3.56**	cfs
Q_{25} =	0.57	x	8.08	x	0.89	x	1.1	=	**4.53**	cfs
Q_{50} =	0.57	x	8.93	x	0.89	x	1.2	=	**5.46**	cfs
Q_{100} =	0.57	x	9.81	x	0.89	x	1.25	=	**6.25**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.81	x	1	=	**4.54**	cfs
Q_{10} =	0.90	x	6.98	x	0.81	x	1	=	**5.09**	cfs
Q_{25} =	0.90	x	8.08	x	0.81	x	1.1	=	**6.48**	cfs
Q_{50} =	0.90	x	8.93	x	0.81	x	1.2	=	**7.81**	cfs
Q_{100} =	0.90	x	9.81	x	0.81	x	1.25	=	**8.94**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 144/145a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**315**				
9	Watercourse slope, s	----------	ft/ft	**0.0381**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.15**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.028**	+		=	**0.028**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.474**
							min	**28.46**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 144/145b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**100**				
9	Watercourse slope, s		ft/ft	**0.0600**				
10	Average velocity, V (figure 3-1)		ft/s	**3.95**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.007**	+		=	**0.007**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.454**
							min	**27.21**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 144/145c	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0100**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.777**	+		=	**0.777**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**750**				
9	Watercourse slope, s		ft/ft	**0.0600**				
10	Average velocity, V (figure 3-1)		ft/s	**3.95**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.053**	+		=	**0.053**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.830**
							min	**49.81**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-144/145		Outlet	OP	439.16	439.16	0.00	0.00	0.00	50.18	0.00	10.69	0.22	0.00
CB-144/145e		Other	C.B. TYPE 112	447.00	447.00	4.24	0.03	49.99	49.99	10.97	10.69	0.22	3.87
CB-144/145d		Other	C.B. TYPE 112	449.00	449.00	3.86	0.16	49.86	49.86	8.59	9.80	0.19	3.88
CB-144/145b		Other	C.B. TYPE 112	456.00	456.00	4.64	0.12	28.63	28.63	2.39	1.49	0.25	5.31
DN-144/145c		Other	DUMMY JOINT	448.43	448.43	0.00	0.00	49.81	49.81	6.36	7.99	0.17	3.88
CB-144/145a		Other	C.B. TYPE 112	461.88	461.88	9.38	0.00	28.46	28.46	0.82	0.78	0.16	5.33

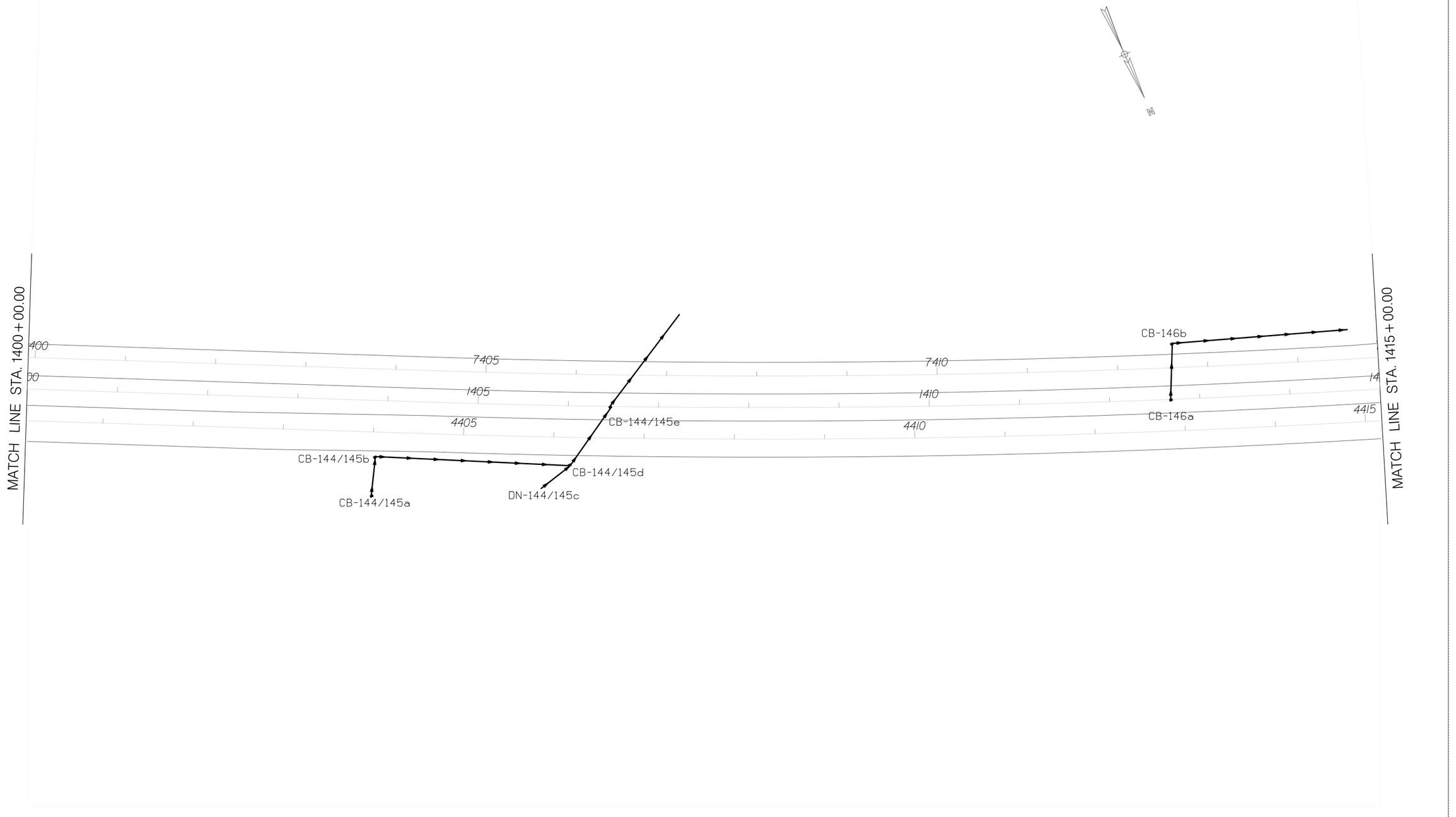
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-76	CB-144/145e	OF-144/145	Circular	Concrete	1	2.00	128	2.81	10.97	44.20	0.71	11.07	444.76	444.01	441.16	439.87	442.76	439.16	5.33	10.90	1.25	0.71
NP-75	CB-144/145d	CB-144/145e	Circular	Concrete	1	2.00	77	2.86	8.59	44.60	0.62	10.40	447.14	446.42	444.95	443.58	445.14	442.95	4.05	10.04	1.28	0.63
NP-73	CB-144/145b	CB-144/145d	Circular	Concrete	1	1.50	213	2.80	2.39	20.49	0.36	7.36	452.86	452.15	446.88	445.74	451.36	445.38	2.55	7.36	0.79	0.36
NP-74	DN-144/145c	CB-144/145d	Circular	Concrete	1	1.50	41	7.21	6.36	32.86	0.46	13.65	449.93	449.96	446.98	445.98	448.43	445.48	3.60	12.40	1.50	0.50
NP-72	CB-144/145a	CB-144/145b	Circular	Concrete	1	1.25	42	1.45	0.82	9.05	0.26	4.34	453.75	452.96	453.15	452.16	452.50	451.90	1.99	4.32	0.46	0.26

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-144/145e	5.00	5.58	9.03	0.58	0.89	0.58	0.89	0.00	0.00
CB-144/145d	5.00	1.13	9.03	0.33	0.32	0.33	0.32	0.00	0.00
CB-144/145b	27.21	1.61	5.44	0.35	0.71	0.35	0.71	0.00	0.00
DN-144/145c	49.81	6.36	3.88	0.17	7.99	0.17	7.99	0.00	0.00
CB-144/145a	28.46	0.82	5.33	0.16	0.78	0.16	0.78	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	61



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

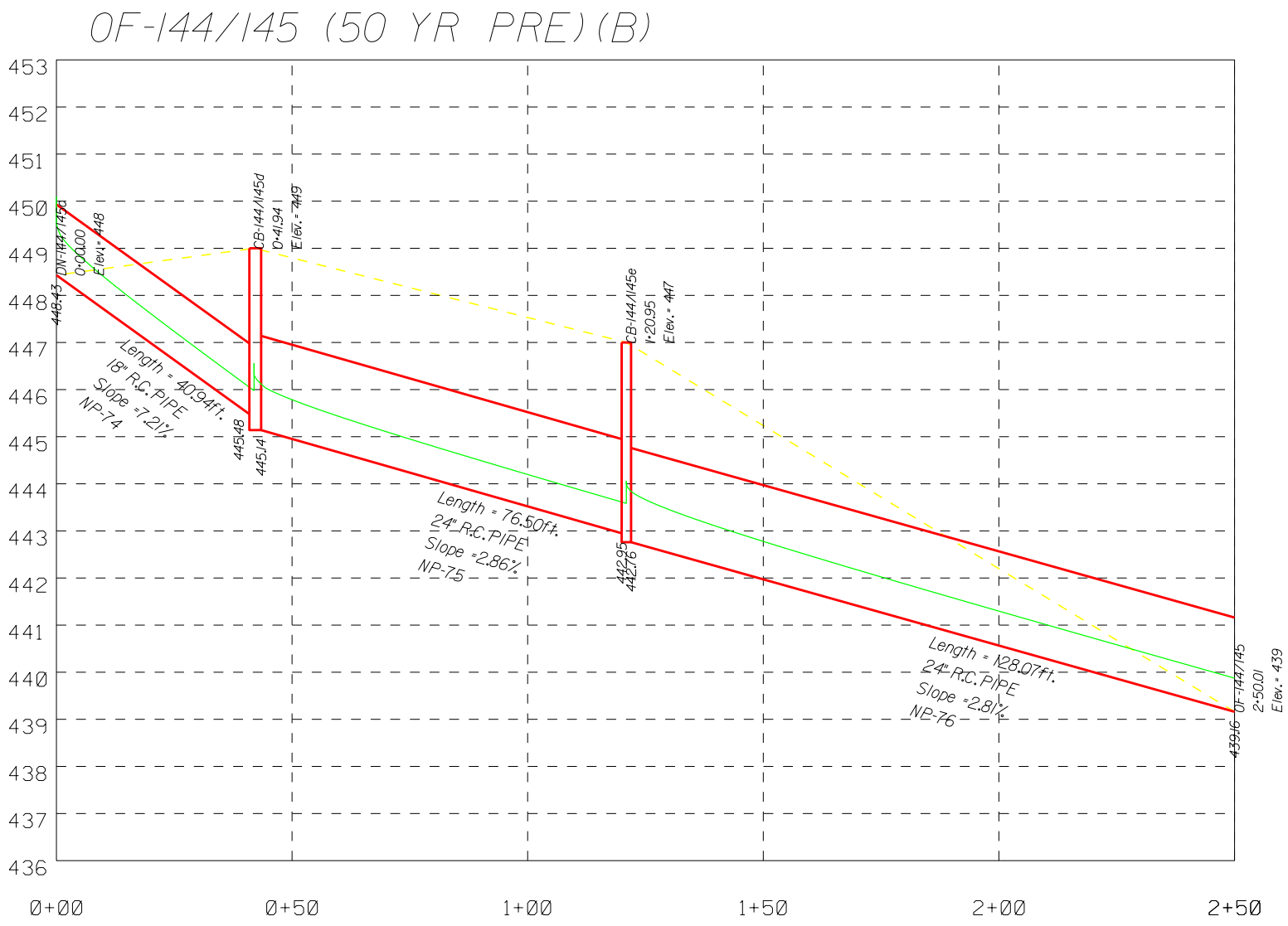
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1400+00.00 TO STA. 1415+00.00

$$$$$$$path$$$$$$$$$/filename$$$$$$$$$
$$$$$date$$$$


OF-144/145 (50 YR PRE)(A)
CB1144/145a
0+00.00
Elev. = 462
CB1144/145b
0+43.50
Elev. = 456
CB1144/145c
2+59.95
Elev. = 449
CB1144/145e
3+38.95
Elev. = 447
OF1144/145
4+68.01
Elev. = 439
452.50
451.90
451.36
445.38
445.41
442.95
442.76
439.96
Length = 41.50ft.
15" R.C. PIPE
Slope =1.45%
NP-72
Length = 213.44ft.
18" R.C. PIPE
Slope =2.80%
NP-73
Length = 76.50ft.
24" R.C. PIPE
Slope =2.86%
NP-75
Length = 128.07ft.
24" R.C. PIPE
Slope =2.81%
NP-76
465
464
463
462
461
460
459
458
457
456
455
454
453
452
451
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+68


OF-144/145 (50 YR PRE)(B)
453
452
451
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
0+00
0+50
1+00
1+50
2+00
2+50
DN-144/145a
0+00.00
Elev.= 448
448.43
CB-144/145d
0+41.94
Elev.= 449
445.48
445.14
Length = 40.94ft.
18" R.C. PIPE
Slope =7.21%
NP-74
CB-144/145e
1+20.95
Elev.= 447
442.95
442.76
Length = 76.50ft.
24" R.C. PIPE
Slope =2.86%
NP-75
Length = 128.07ft.
24" R.C. PIPE
Slope =2.81%
NP-76
439.46
OF-144/145
2+50.01
Elev.= 439

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-144/145	Outlet	OP	439.16	439.16	0.00	0.00	0.00	50.17	0.00	10.69	0.25	0.00
CB-144/145e	Other	C.B. TYPE 112	447.00	447.00	4.24	0.04	49.99	49.99	12.30	10.69	0.25	3.87
CB-144/145d	Other	C.B. TYPE 112	449.00	449.00	3.86	0.18	49.86	49.86	8.92	9.88	0.19	3.88
CB-144/145b	Other	C.B. TYPE 112	456.00	456.00	4.64	0.14	28.63	28.63	2.85	1.57	0.28	5.31
DN-144/145c	Other	DUMMY JOINT	448.43	448.43	0.00	0.00	49.81	49.81	6.36	7.99	0.17	3.88
CB-144/145a	Other	C.B. TYPE 112	461.88	461.88	9.38	0.00	28.46	28.46	0.82	0.78	0.16	5.33

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-76	CB-144/145e	OF-144/145	Circular	Concrete	1	2.00	128	2.81	12.30	44.20	0.75	11.43	444.76	444.09	441.16	439.92	442.76	439.16	5.56	11.22	1.33	0.76
NP-75	CB-144/145d	CB-144/145e	Circular	Concrete	1	2.00	77	2.86	8.92	44.60	0.63	10.53	447.14	446.46	444.95	443.60	445.14	442.95	4.05	10.12	1.32	0.65
NP-73	CB-144/145b	CB-144/145d	Circular	Concrete	1	1.50	213	2.80	2.85	20.49	0.39	7.75	452.86	452.22	446.88	445.77	451.36	445.38	2.71	7.75	0.86	0.39
NP-74	DN-144/145c	CB-144/145d	Circular	Concrete	1	1.50	41	7.21	6.36	32.86	0.46	13.65	449.93	449.96	446.98	445.98	448.43	445.48	3.60	12.40	1.50	0.50
NP-72	CB-144/145a	CB-144/145b	Circular	Concrete	1	1.25	42	1.45	0.82	9.05	0.26	4.34	453.75	452.96	453.15	452.16	452.50	451.90	1.99	4.32	0.46	0.26

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-144/145e	5.00	7.90	9.03	0.90	0.81	0.90	0.81	0.00	0.00
CB-144/145d	5.00	1.13	9.03	0.33	0.32	0.33	0.32	0.00	0.00
CB-144/145b	27.21	2.08	5.44	0.40	0.79	0.40	0.79	0.00	0.00
DN-144/145c	49.81	6.36	3.88	0.17	7.99	0.17	7.99	0.00	0.00
CB-144/145a	28.46	0.82	5.33	0.16	0.78	0.16	0.78	0.00	0.00


OF-144/145 (50 YR POST)(A)
CB1144/145a
0+00.00
Elev.= 462
452.50
CB1144/145b
0+43.50
Elev.= 456
451.36
Length = 41.58ft.
15" R.C. PIPE
Slope =1.45%
NP-72
Length = 213.44ft.
18" R.C. PIPE
Slope =2.80%
NP-73
CB1144/145c
2+59.95
Elev.= 449
445.38
445.41
CB1144/145e
3+38.95
Elev.= 447
442.95
442.76
Length = 76.50ft.
24" R.C. PIPE
Slope =2.86%
NP-75
Length = 128.07ft.
24" R.C. PIPE
Slope =2.81%
NP-76
439.96
OF-144/145
4+68.01
Elev.= 439
465
464
463
462
461
460
459
458
457
456
455
454
453
452
451
450
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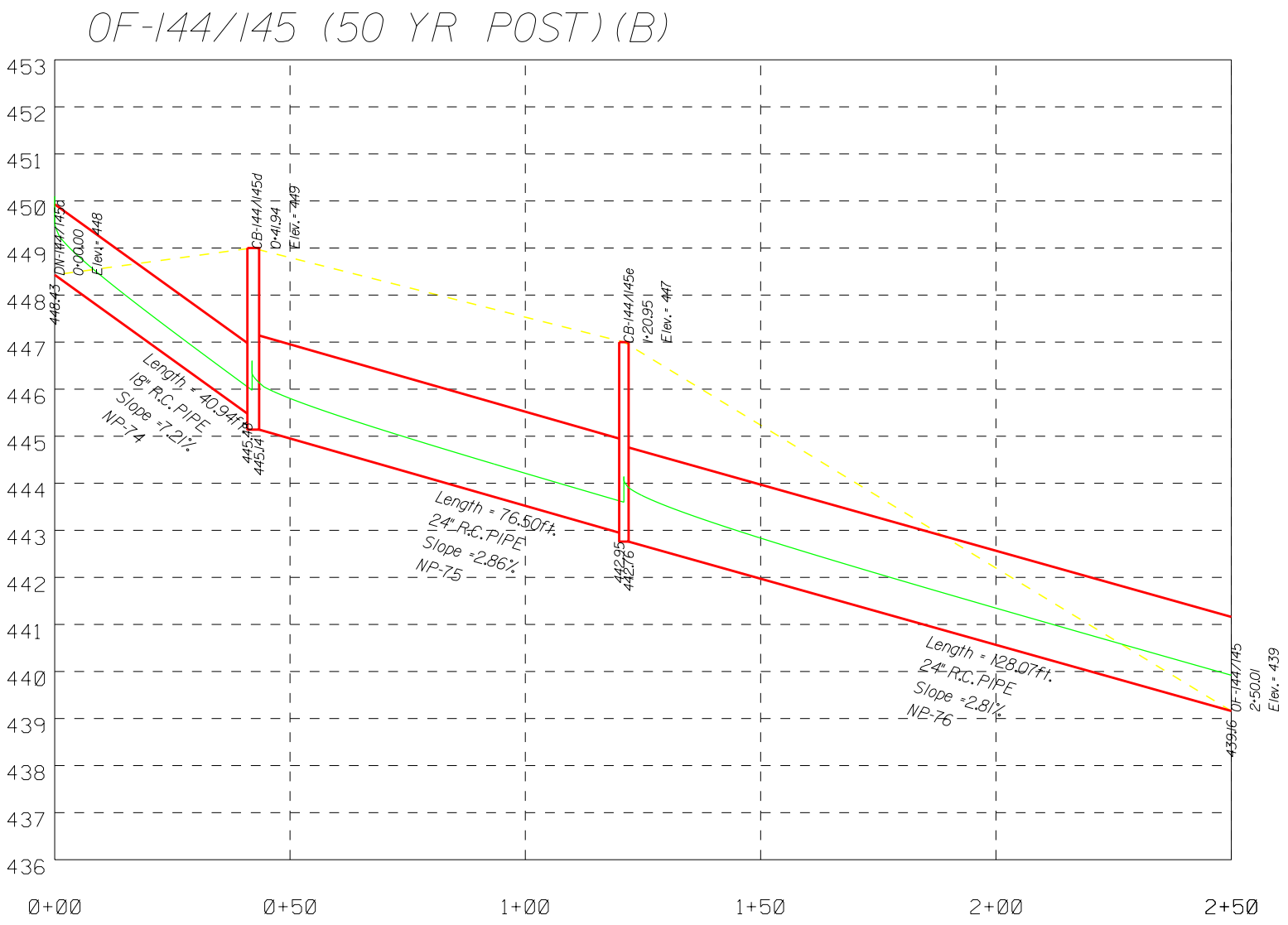
448
447
446
445
444
443
442
441
440
439
438
437
436
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+68


OF-144/145 (50 YR POST)(B)
453
452
451
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
0+00
0+50
1+00
1+50
2+00
2+50
DN-144/145a
0+00.00
Elev.= 448
448.43
CB-144/145d
0+41.94
Elev.= 449
445.43
445.43
CB-144/145e
1+20.95
Elev.= 447
442.95
442.76
OF-144/145
2+50.01
Elev.= 439
439.46
Length = 40.94ft.
18" R.C. PIPE
Slope =7.21%
NP-74
Length = 76.50ft.
24" R.C. PIPE
Slope =2.86%
NP-75
Length = 128.07ft.
24" R.C. PIPE
Slope =2.81%
NP-76

CULVERT 146

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 146a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.57	0.5090
Grass	0.25	0.43	0.1066
Woods	0.15	0.00	0.0000
	Σ	**0.99**	0.6155

$C_{ave} = \frac{0.6155}{0.99} = 0.62$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.78	0.6980
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.78**	0.6980

$C_{ave} = \frac{0.6980}{0.78} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.62	x	6.23	x	0.99	x	1	=	**3.84**	cfs
Q_{10} =	0.62	x	6.98	x	0.99	x	1	=	**4.30**	cfs
Q_{25} =	0.62	x	8.08	x	0.99	x	1.1	=	**5.47**	cfs
Q_{50} =	0.62	x	8.93	x	0.99	x	1.2	=	**6.59**	cfs
Q_{100} =	0.62	x	9.81	x	0.99	x	1.25	=	**7.55**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.78	x	1	=	**4.35**	cfs
Q_{10} =	0.90	x	6.98	x	0.78	x	1	=	**4.87**	cfs
Q_{25} =	0.90	x	8.08	x	0.78	x	1.1	=	**6.21**	cfs
Q_{50} =	0.90	x	8.93	x	0.78	x	1.2	=	**7.48**	cfs
Q_{100} =	0.90	x	9.81	x	0.78	x	1.25	=	**8.56**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 146b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.45	0.4060
Grass	0.25	0.28	0.0691
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.4751

$C_{ave} = \frac{0.4751}{0.73} = 0.65$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.67	0.6040
Grass	0.25	0.28	0.0691
Woods	0.15	0.00	0.0000
	Σ	**0.95**	0.6731

$C_{ave} = \frac{0.6731}{0.95} = 0.71$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.65	x	6.23	x	0.73	x	1	=	**2.96**	cfs
Q_{10} =	0.65	x	6.98	x	0.73	x	1	=	**3.32**	cfs
Q_{25} =	0.65	x	8.08	x	0.73	x	1.1	=	**4.22**	cfs
Q_{50} =	0.65	x	8.93	x	0.73	x	1.2	=	**5.09**	cfs
Q_{100} =	0.65	x	9.81	x	0.73	x	1.25	=	**5.82**	cfs

Post Construction Runoff:

Q_{05} =	0.71	x	6.23	x	0.95	x	1	=	**4.19**	cfs
Q_{10} =	0.71	x	6.98	x	0.95	x	1	=	**4.70**	cfs
Q_{25} =	0.71	x	8.08	x	0.95	x	1.1	=	**5.98**	cfs
Q_{50} =	0.71	x	8.93	x	0.95	x	1.2	=	**7.21**	cfs
Q_{100} =	0.71	x	9.81	x	0.95	x	1.25	=	**8.25**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-146		Outlet	OP	408.41	408.41	0.00	0.00	0.00	5.38	0.00	1.72	0.63	0.00
CB-146b		Other	C.B. TYPE 112	420.88	420.88	3.20	0.55	5.14	5.14	11.72	1.72	0.63	8.99
CB-146a		Other	C.B. TYPE 112	422.15	422.15	3.17	0.00	5.00	5.00	6.62	0.99	0.62	9.03

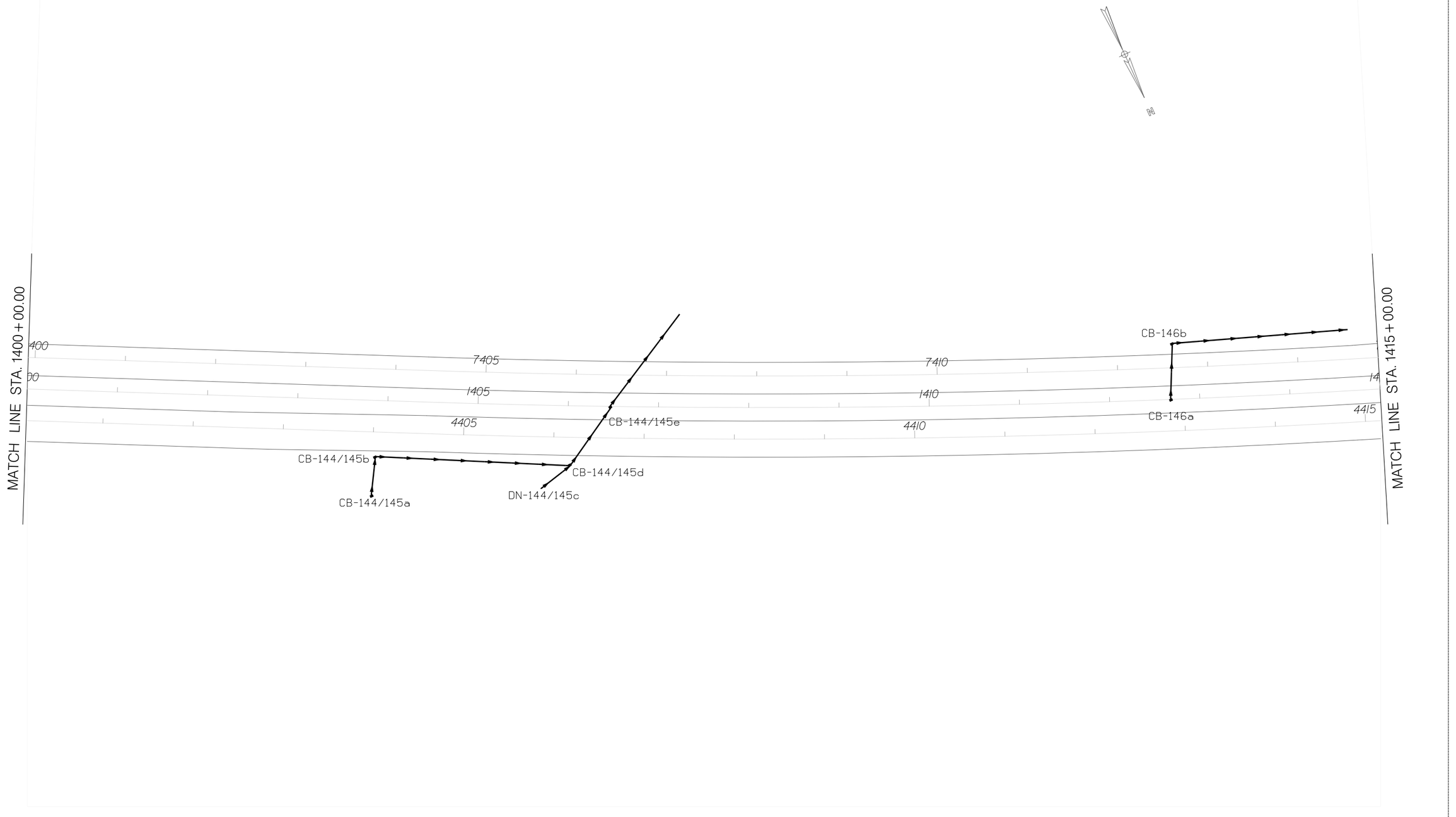
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-78	CB-146b	OF-146	Circular	Concrete	1	1.50	194	4.78	11.72	26.76	0.72	13.86	419.18	419.61	409.91	409.14	417.68	408.41	6.63	13.81	1.50	0.73
NP-77	CB-146a	CB-146b	Circular	Concrete	1	1.50	60	1.31	6.62	14.01	0.76	7.38	420.48	420.55	419.69	418.96	418.98	418.19	3.75	7.24	1.50	0.77

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-146b	5.00	5.15	9.03	0.65	0.73	0.65	0.73	0.00	0.00
CB-146a	5.00	6.62	9.03	0.62	0.99	0.62	0.99	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	61



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

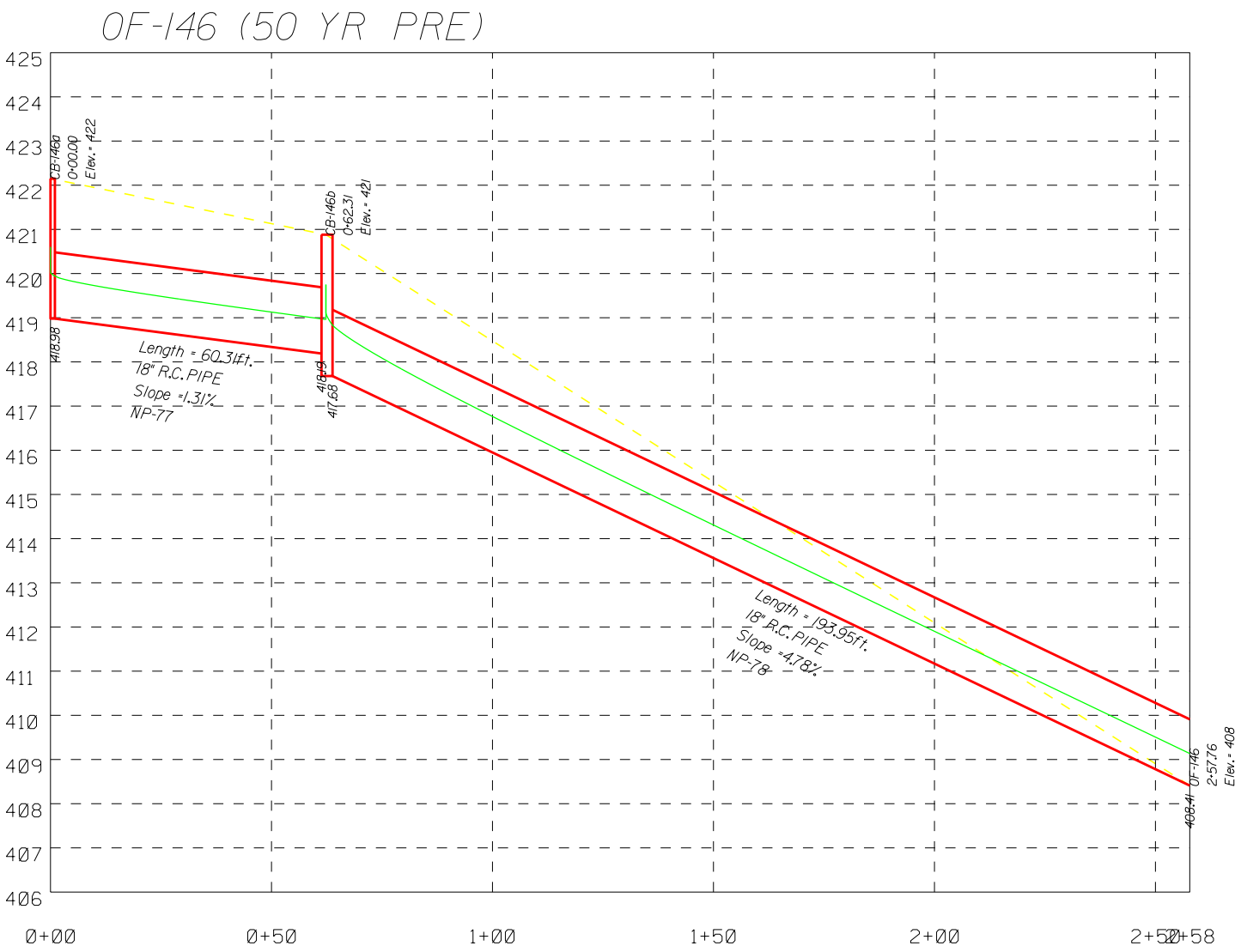
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1400+00.00 TO STA. 1415+00.00

$$$$$$$path$$$$$$$$$/filename$$$$$$$$$
$$$$$date$$$$


OF-146 (50 YR PRE)
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
0+00
0+50
1+00
1+50
2+00
2+50
2+58
CB-146a
0-00.00
Elev.- 422
418.98
CB-146b
0-62.31
Elev.- 421
418.99
417.68
Length = 60.31ft.
18" R.C. PIPE
Slope =1.31%
NP-77
Length = 193.95ft.
18" R.C. PIPE
Slope =4.78%
NP-78
OF-146
2-57.76
Elev.- 408
408.41

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

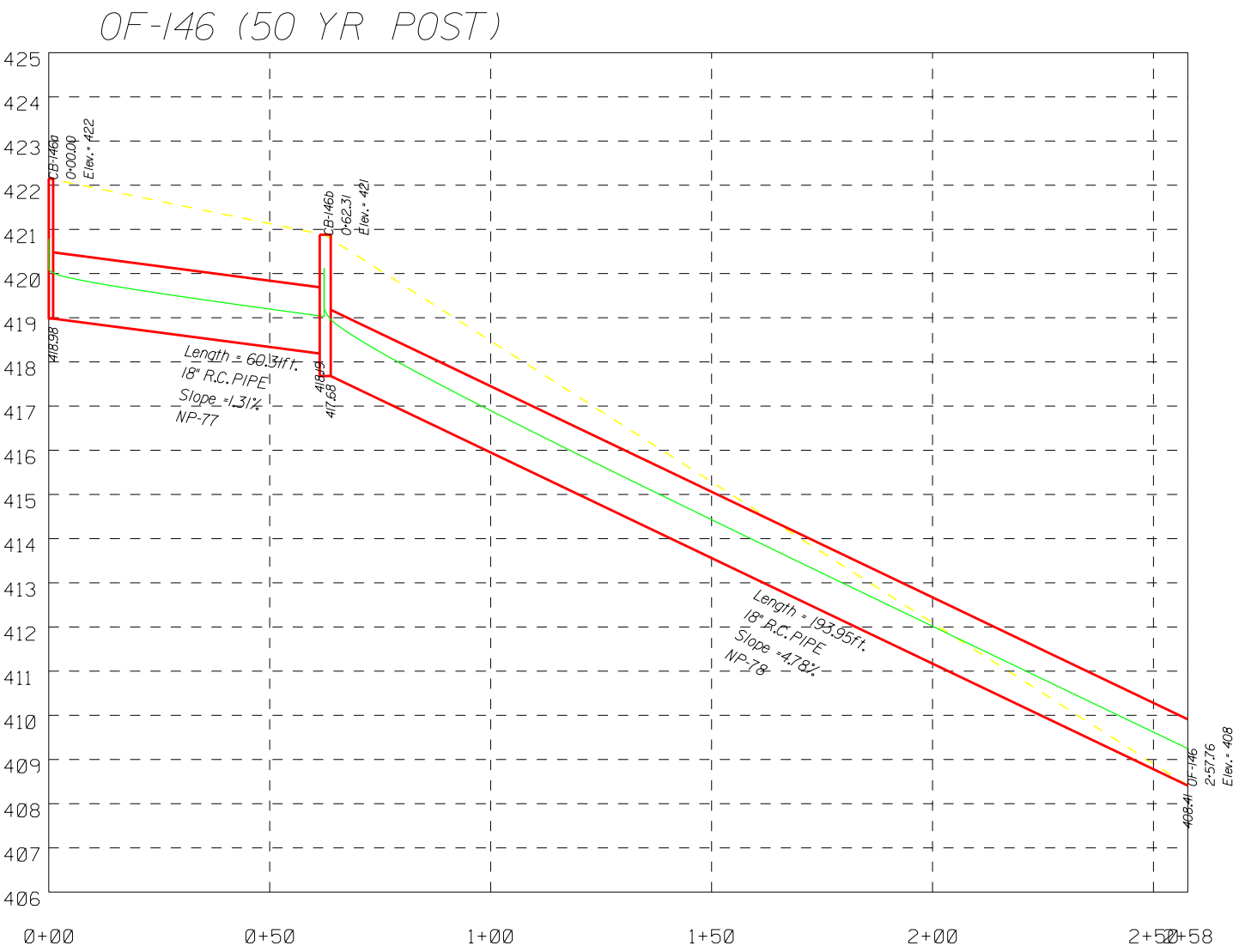
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-146	Outlet	OP	408.41	408.41	0.00	0.00	0.00	5.36	0.00	1.73	0.79	0.00
CB-146b	Other	C.B. TYPE 112	420.88	420.88	3.20	0.83	5.14	5.14	14.84	1.73	0.79	8.99
CB-146a	Other	C.B. TYPE 112	422.15	422.15	3.17	0.00	5.00	5.00	7.60	0.78	0.90	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-78	CB-146b	OF-146	Circular	Concrete	1	1.50	194	4.78	14.84	26.76	0.83	14.68	419.18	419.98	409.91	409.25	417.68	408.41	8.40	14.61	1.50	0.84
NP-77	CB-146a	CB-146b	Circular	Concrete	1	1.50	60	1.31	7.60	14.01	0.83	7.64	420.48	420.73	419.69	419.03	418.98	418.19	4.30	7.49	1.50	0.84

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-146b	5.00	7.29	9.03	0.71	0.95	0.71	0.95	0.00	0.00
CB-146a	5.00	7.60	9.03	0.90	0.78	0.90	0.78	0.00	0.00


OF-146 (50 YR POST)
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
0+00
0+50
1+00
1+50
2+00
2+58
CB-146a
0-00.00
Elev.- 422
418.98
CB-146b
0-62.31
Elev.- 421
418.99
417.68
Length = 60.31ft.
18" R.C. PIPE
Slope =1.31%
NP-77
Length = 193.95ft.
18" R.C. PIPE
Slope =4.78%
NP-78
OF-146
2-57.76
Elev.- 408
408.41

CULVERT 148

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 148, South_Carolina
User:
Date: Sunday, December 17, 2017 09:52 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 148
   Basin Drainage Area: 1.32 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 1.32 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

Results for: Site 148

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	190	109	331	35
PK5	351	203	607	34
PK10	472	269	831	35
PK25	635	349	1160	38
PK50	780	415	1470	40
PK100	915	470	1780	42
PK200	1050	521	2120	44
PK500	1260	595	2670	48

maximum: 6800 (for C&B region 2)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 635 cfs

Design Flow: 780 cfs

Maximum Flow: 915 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1418+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	9x9 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
392.29	635.00	635.00	0.00	1
392.53	663.00	663.00	0.00	1
392.77	691.00	691.00	0.00	1
393.01	719.00	719.00	0.00	1
393.25	747.00	747.00	0.00	1
393.48	775.00	775.00	0.00	1
393.52	780.00	780.00	0.00	1
393.95	831.00	831.00	0.00	1
394.19	859.00	859.00	0.00	1
394.43	887.00	887.00	0.00	1
394.66	915.00	915.00	0.00	1
411.00	2240.13	2240.13	0.00	Overtopping

Table 2 - Culvert Summary Table: 9x9 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
635.00	635.00	392.29	8.310	5.030	1-S2n	3.524	5.367	4.072	4.183	17.327	9.277
663.00	663.00	392.53	8.551	5.311	1-S2n	3.637	5.524	4.208	4.271	17.508	9.383
691.00	691.00	392.77	8.791	5.596	1-S2n	3.749	5.678	4.341	4.358	17.685	9.486
719.00	719.00	393.01	9.029	5.884	5-S2n	3.861	5.830	4.474	4.443	17.857	9.585
747.00	747.00	393.25	9.266	6.175	5-S2n	3.971	5.981	4.606	4.525	18.021	9.681
775.00	775.00	393.48	9.502	6.470	5-S2n	4.081	6.129	4.736	4.606	18.184	9.775
780.00	780.00	393.52	9.544	6.523	5-S2n	4.101	6.156	4.759	4.620	18.213	9.792
831.00	831.00	393.95	9.973	7.070	5-S2n	4.299	6.421	4.993	4.763	18.491	9.955
859.00	859.00	394.19	10.209	7.376	5-S2n	4.407	6.565	5.120	4.839	18.641	10.041
887.00	887.00	394.43	10.446	7.685	5-S2n	4.515	6.707	5.247	4.914	18.785	10.125
915.00	915.00	394.66	10.684	9.075	5-S2n	4.622	6.847	5.372	4.987	18.925	10.207

****

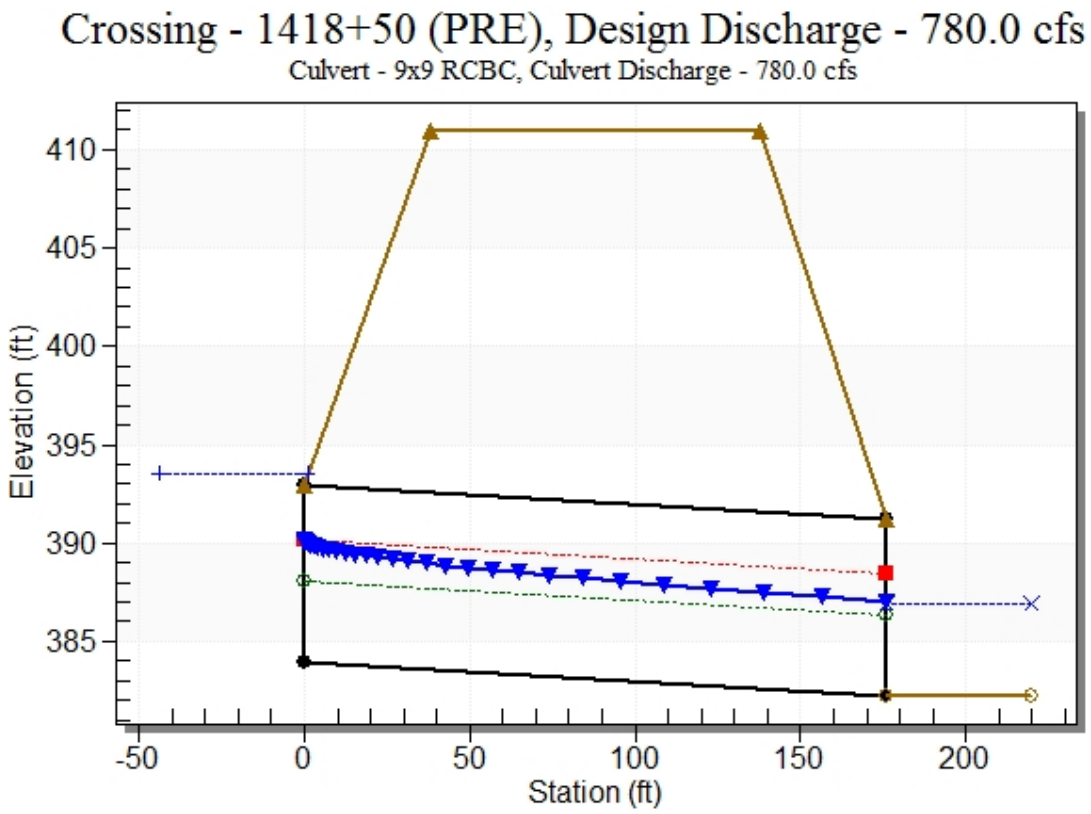
Straight Culvert

Inlet Elevation (invert): 383.98 ft, Outlet Elevation (invert): 382.26 ft

Culvert Length: 176.01 ft, Culvert Slope: 0.0098

****

Water Surface Profile Plot for Culvert: 9x9 RCBC



Site Data - 9x9 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 383.98 ft

Outlet Station: 176.00 ft

Outlet Elevation: 382.26 ft

Number of Barrels: 1

Culvert Data Summary - 9x9 RCBC

Barrel Shape: Concrete Box

Barrel Span: 9.00 ft

Barrel Rise: 9.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1418+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
635.00	386.44	4.18	9.28	10.44	0.98
663.00	386.53	4.27	9.38	10.66	0.99
691.00	386.62	4.36	9.49	10.88	0.99
719.00	386.70	4.44	9.58	11.09	0.99
747.00	386.79	4.53	9.68	11.30	0.99
775.00	386.87	4.61	9.77	11.50	0.99
780.00	386.88	4.62	9.79	11.53	0.99
831.00	387.02	4.76	9.95	11.89	1.00
859.00	387.10	4.84	10.04	12.08	1.00
887.00	387.17	4.91	10.12	12.27	1.00
915.00	387.25	4.99	10.21	12.45	1.00

Tailwater Channel Data - 1418+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 382.26 ft

Roadway Data for Crossing: 1418+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 411.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 635 cfs

Design Flow: 780 cfs

Maximum Flow: 915 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1418+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	9x9 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
392.29	635.00	635.00	0.00	1
392.53	663.00	663.00	0.00	1
392.77	691.00	691.00	0.00	1
393.01	719.00	719.00	0.00	1
393.25	747.00	747.00	0.00	1
393.48	775.00	775.00	0.00	1
393.52	780.00	780.00	0.00	1
393.95	831.00	831.00	0.00	1
394.19	859.00	859.00	0.00	1
394.43	887.00	887.00	0.00	1
394.66	915.00	915.00	0.00	1
411.00	2240.13	2240.13	0.00	Overtopping

Table 2 - Culvert Summary Table: 9x9 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
635.00	635.00	392.29	8.310	5.030	1-S2n	3.524	5.367	4.072	4.183	17.327	9.277
663.00	663.00	392.53	8.551	5.311	1-S2n	3.637	5.524	4.208	4.271	17.508	9.383
691.00	691.00	392.77	8.791	5.596	1-S2n	3.749	5.678	4.341	4.358	17.685	9.486
719.00	719.00	393.01	9.029	5.884	5-S2n	3.861	5.830	4.474	4.443	17.857	9.585
747.00	747.00	393.25	9.266	6.175	5-S2n	3.971	5.981	4.606	4.525	18.021	9.681
775.00	775.00	393.48	9.502	6.470	5-S2n	4.081	6.129	4.736	4.606	18.184	9.775
780.00	780.00	393.52	9.544	6.523	5-S2n	4.101	6.156	4.759	4.620	18.213	9.792
831.00	831.00	393.95	9.973	7.070	5-S2n	4.299	6.421	4.993	4.763	18.491	9.955
859.00	859.00	394.19	10.209	7.376	5-S2n	4.407	6.565	5.120	4.839	18.641	10.041
887.00	887.00	394.43	10.446	7.685	5-S2n	4.515	6.707	5.247	4.914	18.785	10.125
915.00	915.00	394.66	10.684	9.075	5-S2n	4.622	6.847	5.372	4.987	18.925	10.207

****

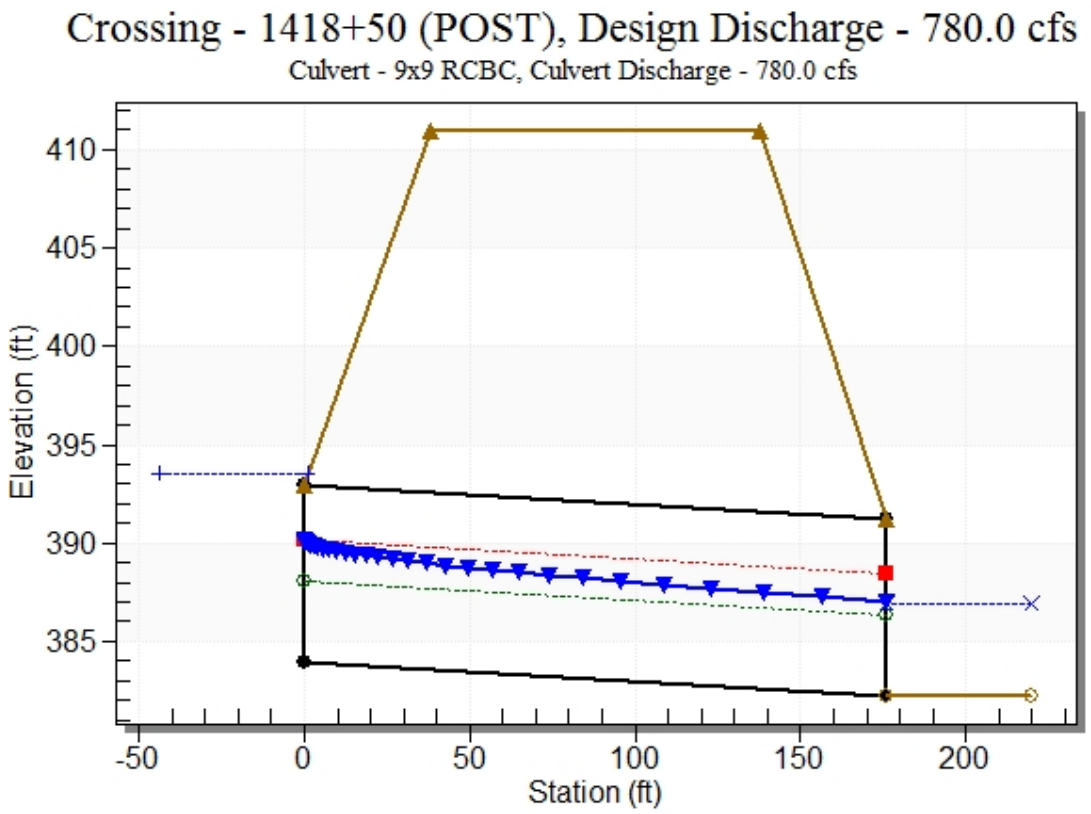
Straight Culvert

Inlet Elevation (invert): 383.98 ft, Outlet Elevation (invert): 382.26 ft

Culvert Length: 176.01 ft, Culvert Slope: 0.0098

****

Water Surface Profile Plot for Culvert: 9x9 RCBC



Site Data - 9x9 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 383.98 ft

Outlet Station: 176.00 ft

Outlet Elevation: 382.26 ft

Number of Barrels: 1

Culvert Data Summary - 9x9 RCBC

Barrel Shape: Concrete Box

Barrel Span: 9.00 ft

Barrel Rise: 9.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1418+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
635.00	386.44	4.18	9.28	10.44	0.98
663.00	386.53	4.27	9.38	10.66	0.99
691.00	386.62	4.36	9.49	10.88	0.99
719.00	386.70	4.44	9.58	11.09	0.99
747.00	386.79	4.53	9.68	11.30	0.99
775.00	386.87	4.61	9.77	11.50	0.99
780.00	386.88	4.62	9.79	11.53	0.99
831.00	387.02	4.76	9.95	11.89	1.00
859.00	387.10	4.84	10.04	12.08	1.00
887.00	387.17	4.91	10.12	12.27	1.00
915.00	387.25	4.99	10.21	12.45	1.00

Tailwater Channel Data - 1418+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 382.26 ft

Roadway Data for Crossing: 1418+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 411.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 149

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 149**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.97	2.6762
Grass	0.25	20.18	5.0457
Woods	0.15	12.89	1.9335
	Σ	**36.05**	9.6553

$C_{ave} = \frac{9.6553}{36.05} = 0.27$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.97	2.6762
Grass	0.25	20.18	5.0457
Woods	0.15	12.89	1.9335
	Σ	**36.05**	9.6553

$C_{ave} = \frac{9.6553}{36.05} = 0.27$

T_c =	26.48	min.
I_{05} =	3.95	in / hr
I_{10} =	4.38	in / hr
I_{25} =	5.00	in / hr
I_{50} =	5.46	in / hr
I_{100} =	5.94	in / hr

Pre Construction Runoff:

Q_{05} =	0.27	x	3.95	x	36.05	x	1	=	**38.14**	cfs
Q_{10} =	0.27	x	4.38	x	36.05	x	1	=	**42.27**	cfs
Q_{25} =	0.27	x	5.00	x	36.05	x	1.1	=	**53.08**	cfs
Q_{50} =	0.27	x	5.46	x	36.05	x	1.2	=	**63.27**	cfs
Q_{100} =	0.27	x	5.94	x	36.05	x	1.25	=	**71.63**	cfs

Post Construction Runoff:

Q_{05} =	0.27	x	3.95	x	36.05	x	1	=	**38.14**	cfs
Q_{10} =	0.27	x	4.38	x	36.05	x	1	=	**42.27**	cfs
Q_{25} =	0.27	x	5.00	x	36.05	x	1.1	=	**53.08**	cfs
Q_{50} =	0.27	x	5.46	x	36.05	x	1.2	=	**63.27**	cfs
Q_{100} =	0.27	x	5.94	x	36.05	x	1.25	=	**71.63**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 149	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**650**				
9	Watercourse slope, s	----------	ft/ft	**0.1154**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.48**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.033**	+		=	**0.033**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.441**
							min	**26.48**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 53.08 cfs

Design Flow: 63.27 cfs

Maximum Flow: 71.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1421+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
417.62	53.08	53.08	0.00	1
417.74	54.93	54.93	0.00	1
417.87	56.79	56.79	0.00	1
418.01	58.64	58.64	0.00	1
418.14	60.50	60.50	0.00	1
418.29	62.35	62.35	0.00	1
418.36	63.27	63.27	0.00	1
418.59	66.06	66.06	0.00	1
418.75	67.92	67.92	0.00	1
418.91	69.77	69.77	0.00	1
419.08	71.63	71.63	0.00	1
440.00	188.06	188.06	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
53.08	53.08	417.62	3.829	1.043	5-S2n	1.529	2.365	1.612	1.072	13.284	6.080
54.93	54.93	417.74	3.953	1.215	5-S2n	1.561	2.403	1.648	1.092	13.379	6.144
56.79	56.79	417.87	4.083	1.392	5-S2n	1.593	2.440	1.683	1.113	13.480	6.205
58.64	58.64	418.01	4.216	1.573	5-S2n	1.625	2.475	1.717	1.133	13.579	6.265
60.50	60.50	418.14	4.355	1.759	5-S2n	1.657	2.509	1.752	1.152	13.683	6.324
62.35	62.35	418.29	4.498	1.949	5-S2n	1.688	2.541	1.785	1.171	13.784	6.381
63.27	63.27	418.36	4.571	2.044	5-S2n	1.704	2.556	1.802	1.181	13.834	6.409
66.06	66.06	418.59	4.799	2.343	5-S2n	1.753	2.601	1.851	1.209	14.004	6.492
67.92	67.92	418.75	4.958	2.546	5-S2n	1.785	2.628	1.887	1.227	14.070	6.546
69.77	69.77	418.91	5.120	2.754	5-S2n	1.817	2.654	1.924	1.246	14.139	6.597
71.63	71.63	419.08	5.288	2.966	5-S2n	1.850	2.679	1.960	1.263	14.211	6.649

****

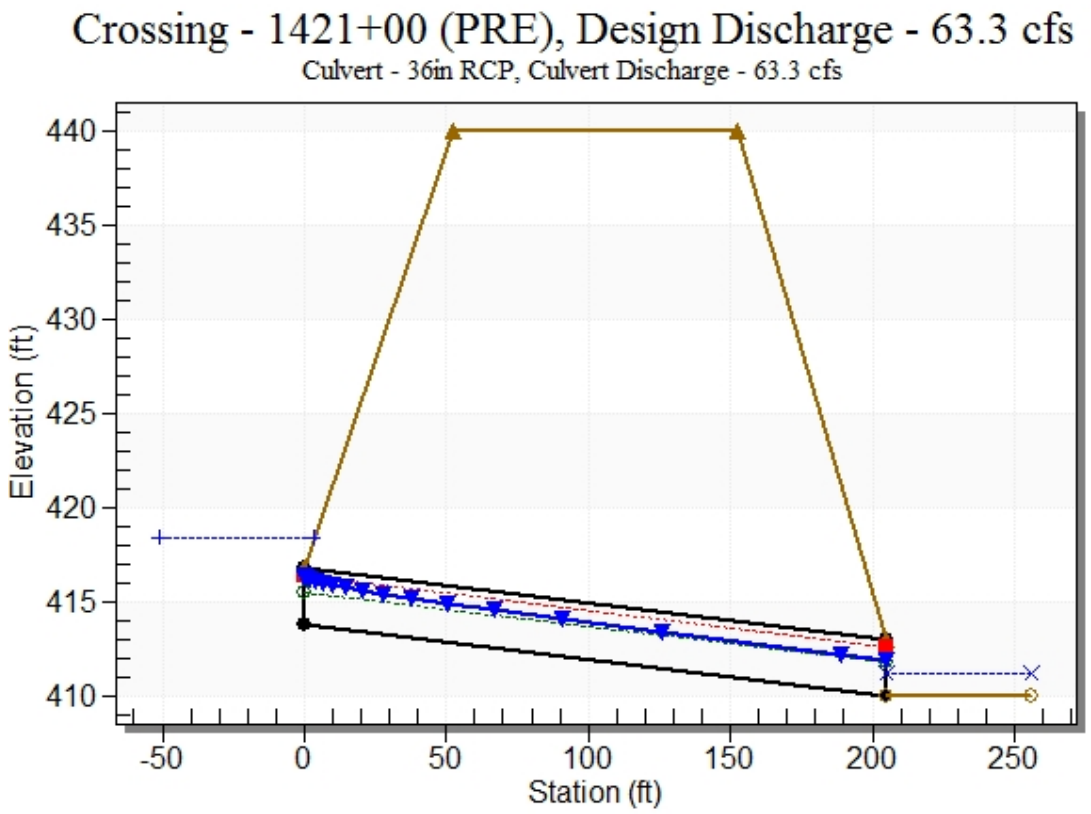
Straight Culvert

Inlet Elevation (invert): 413.79 ft, Outlet Elevation (invert): 410.00 ft

Culvert Length: 205.04 ft, Culvert Slope: 0.0185

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 413.79 ft

Outlet Station: 205.00 ft

Outlet Elevation: 410.00 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1421+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
53.08	411.07	1.07	6.08	5.35	1.16
54.93	411.09	1.09	6.14	5.45	1.17
56.79	411.11	1.11	6.21	5.55	1.17
58.64	411.13	1.13	6.27	5.65	1.17
60.50	411.15	1.15	6.32	5.75	1.17
62.35	411.17	1.17	6.38	5.85	1.18
63.27	411.18	1.18	6.41	5.89	1.18
66.06	411.21	1.21	6.49	6.03	1.18
67.92	411.23	1.23	6.55	6.13	1.18
69.77	411.25	1.25	6.60	6.22	1.18
71.63	411.26	1.26	6.65	6.31	1.19

Tailwater Channel Data - 1421+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 410.00 ft

Roadway Data for Crossing: 1421+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 440.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 53.08 cfs

Design Flow: 63.27 cfs

Maximum Flow: 71.63 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1421+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
417.62	53.08	53.08	0.00	1
417.74	54.93	54.93	0.00	1
417.87	56.79	56.79	0.00	1
418.01	58.64	58.64	0.00	1
418.14	60.50	60.50	0.00	1
418.29	62.35	62.35	0.00	1
418.36	63.27	63.27	0.00	1
418.59	66.06	66.06	0.00	1
418.75	67.92	67.92	0.00	1
418.91	69.77	69.77	0.00	1
419.08	71.63	71.63	0.00	1
440.00	188.06	188.06	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
53.08	53.08	417.62	3.829	1.043	5-S2n	1.529	2.365	1.612	1.072	13.284	6.080
54.93	54.93	417.74	3.953	1.215	5-S2n	1.561	2.403	1.648	1.092	13.379	6.144
56.79	56.79	417.87	4.083	1.392	5-S2n	1.593	2.440	1.683	1.113	13.480	6.205
58.64	58.64	418.01	4.216	1.573	5-S2n	1.625	2.475	1.717	1.133	13.579	6.265
60.50	60.50	418.14	4.355	1.759	5-S2n	1.657	2.509	1.752	1.152	13.683	6.324
62.35	62.35	418.29	4.498	1.949	5-S2n	1.688	2.541	1.785	1.171	13.784	6.381
63.27	63.27	418.36	4.571	2.044	5-S2n	1.704	2.556	1.802	1.181	13.834	6.409
66.06	66.06	418.59	4.799	2.343	5-S2n	1.753	2.601	1.851	1.209	14.004	6.492
67.92	67.92	418.75	4.958	2.546	5-S2n	1.785	2.628	1.887	1.227	14.070	6.546
69.77	69.77	418.91	5.120	2.754	5-S2n	1.817	2.654	1.924	1.246	14.139	6.597
71.63	71.63	419.08	5.288	2.966	5-S2n	1.850	2.679	1.960	1.263	14.211	6.649

****

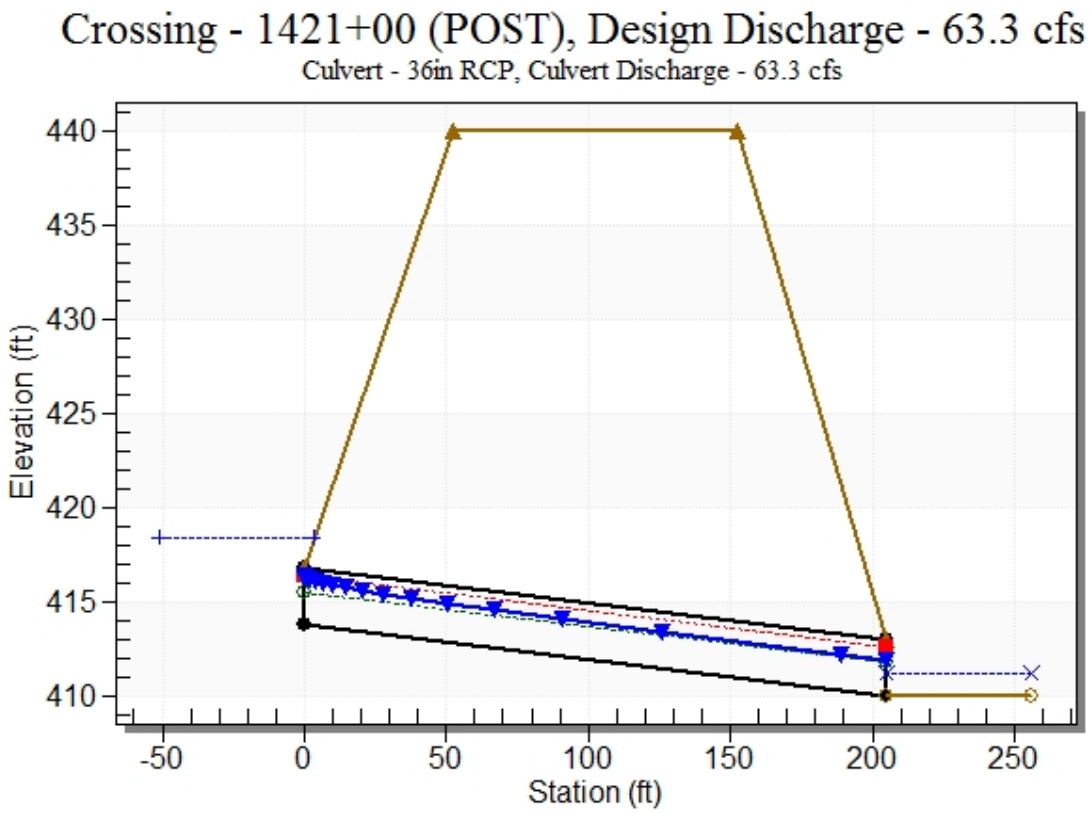
Straight Culvert

Inlet Elevation (invert): 413.79 ft, Outlet Elevation (invert): 410.00 ft

Culvert Length: 205.04 ft, Culvert Slope: 0.0185

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 413.79 ft

Outlet Station: 205.00 ft

Outlet Elevation: 410.00 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1421+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
53.08	411.07	1.07	6.08	5.35	1.16
54.93	411.09	1.09	6.14	5.45	1.17
56.79	411.11	1.11	6.21	5.55	1.17
58.64	411.13	1.13	6.27	5.65	1.17
60.50	411.15	1.15	6.32	5.75	1.17
62.35	411.17	1.17	6.38	5.85	1.18
63.27	411.18	1.18	6.41	5.89	1.18
66.06	411.21	1.21	6.49	6.03	1.18
67.92	411.23	1.23	6.55	6.13	1.18
69.77	411.25	1.25	6.60	6.22	1.18
71.63	411.26	1.26	6.65	6.31	1.19

Tailwater Channel Data - 1421+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0800

Channel Manning's n: 0.0600

Channel Invert Elevation: 410.00 ft

Roadway Data for Crossing: 1421+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 440.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 150/152

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 150**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.12	0.1050
Grass	0.25	0.05	0.0122
Woods	0.15	0.07	0.0101
	Σ	**0.23**	0.1273

$C_{ave} = \frac{0.1273}{0.23} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.12	0.1050
Grass	0.25	0.05	0.0122
Woods	0.15	0.07	0.0101
	Σ	**0.23**	0.1273

$C_{ave} = \frac{0.1273}{0.23} = 0.55$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.55	x	6.23	x	0.23	x	1	=	**0.79**	cfs
Q_{10} =	0.55	x	6.98	x	0.23	x	1	=	**0.89**	cfs
Q_{25} =	0.55	x	8.08	x	0.23	x	1.1	=	**1.13**	cfs
Q_{50} =	0.55	x	8.93	x	0.23	x	1.2	=	**1.36**	cfs
Q_{100} =	0.55	x	9.81	x	0.23	x	1.25	=	**1.56**	cfs

Post Construction Runoff:

Q_{05} =	0.55	x	6.23	x	0.23	x	1	=	**0.79**	cfs
Q_{10} =	0.55	x	6.98	x	0.23	x	1	=	**0.89**	cfs
Q_{25} =	0.55	x	8.08	x	0.23	x	1.1	=	**1.13**	cfs
Q_{50} =	0.55	x	8.93	x	0.23	x	1.2	=	**1.36**	cfs
Q_{100} =	0.55	x	9.81	x	0.23	x	1.25	=	**1.56**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 152**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.30	0.2678
Grass	0.25	0.84	0.2111
Woods	0.15	0.00	0.0000
	Σ	**1.14**	0.4789

$C_{ave} = \frac{0.4789}{1.14} = 0.42$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3938
Grass	0.25	0.84	0.2111
Woods	0.15	0.00	0.0000
	Σ	**1.28**	0.6049

$C_{ave} = \frac{0.6049}{1.28} = 0.47$

T_c =	5.00 min.
I_{05} =	6.23 in / hr
I_{10} =	6.98 in / hr
I_{25} =	8.08 in / hr
I_{50} =	8.93 in / hr
I_{100} =	9.81 in / hr

Pre Construction Runoff:

Q_{05} =	0.42	x	6.23	x	1.14	x	1	=	**2.98**	cfs
Q_{10} =	0.42	x	6.98	x	1.14	x	1	=	**3.34**	cfs
Q_{25} =	0.42	x	8.08	x	1.14	x	1.1	=	**4.26**	cfs
Q_{50} =	0.42	x	8.93	x	1.14	x	1.2	=	**5.13**	cfs
Q_{100} =	0.42	x	9.81	x	1.14	x	1.25	=	**5.87**	cfs

Post Construction Runoff:

Q_{05} =	0.47	x	6.23	x	1.28	x	1	=	**3.77**	cfs
Q_{10} =	0.47	x	6.98	x	1.28	x	1	=	**4.22**	cfs
Q_{25} =	0.47	x	8.08	x	1.28	x	1.1	=	**5.38**	cfs
Q_{50} =	0.47	x	8.93	x	1.28	x	1.2	=	**6.48**	cfs
Q_{100} =	0.47	x	9.81	x	1.28	x	1.25	=	**7.42**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-150/152		Outlet	OP	407.30	407.30	0.00	0.48	0.00	5.73	0.00	1.37	0.44	0.00
CB-150		Other	C.B. TYPE 112	425.04	425.04	3.55	0.14	5.10	5.10	6.58	1.37	0.44	9.00
CB-152		Other	C.B. TYPE 112	429.15	429.15	2.36	0.00	5.00	5.00	5.20	1.14	0.42	9.03

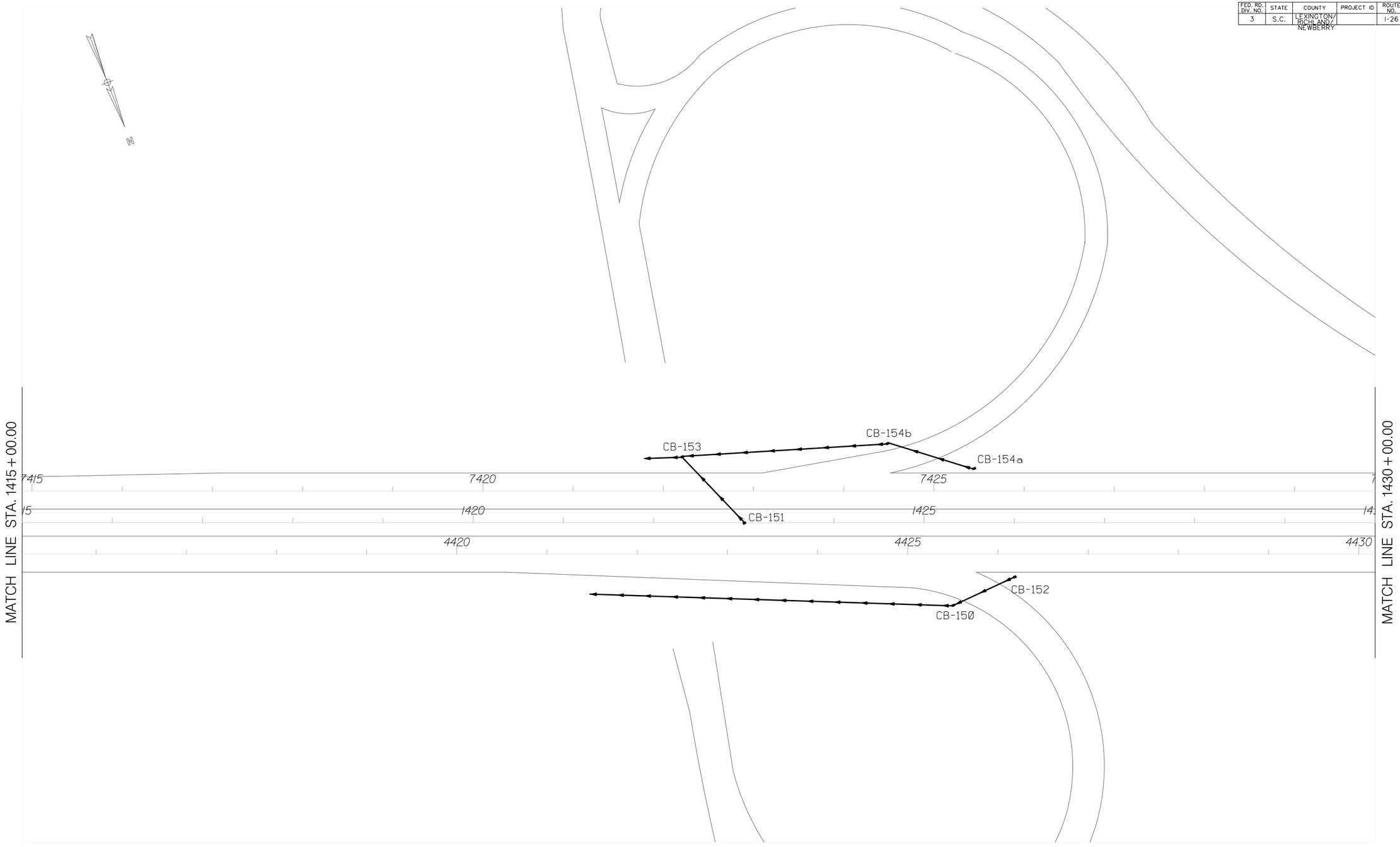
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-84	CB-150	OF-150/152	Circular	Concrete	1	1.50	402	3.53	6.58	22.99	0.57	10.65	422.99	422.67	408.80	407.87	421.49	407.30	4.40	10.64	1.18	0.57
NP-83	CB-152	CB-150	Circular	Concrete	1	1.50	72	6.72	5.20	31.74	0.43	12.58	428.29	428.12	423.44	422.37	426.79	421.94	3.13	12.34	1.33	0.43

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-150	5.00	1.40	9.03	0.56	0.23	0.56	0.23	0.00	0.00
CB-152	5.00	5.20	9.03	0.42	1.14	0.42	1.14	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	62



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1415+00.00 TO STA. 1430+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$$
$$$$date$$$$


OF-150/152 (50 YR PRE)
CB-152
0+00.00
Elev.= 429
426.79
CB-150
0+75.12
Elev.= 425
421.84
421.49
Length = 72.12Ft.
18" R.C.PIPE
Slope =6.72%
NP-83
Length = 402.17Ft.
18" R.C.PIPE
Slope =3.53%
NP-84
407.36
OF-150/152
4+78.79
Elev.= 407
432
431
430
429
428
427
426
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+79

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-150/152	Outlet	OP	407.30	407.30	0.00	0.48	0.00	5.69	0.00	1.51	0.49	0.00
CB-150	Other	C.B. TYPE 112	425.04	425.04	3.55	0.16	5.09	5.09	7.95	1.51	0.49	9.00
CB-152	Other	C.B. TYPE 112	429.15	429.15	2.36	0.00	5.00	5.00	6.56	1.28	0.47	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-84	CB-150	OF-150/152	Circular	Concrete	1	1.50	402	3.53	7.95	22.99	0.63	11.21	422.99	422.80	408.80	407.93	421.49	407.30	4.86	11.21	1.31	0.63
NP-83	CB-152	CB-150	Circular	Concrete	1	1.50	72	6.72	6.56	31.74	0.48	13.43	428.29	428.35	423.44	422.43	426.79	421.94	3.71	13.04	1.50	0.49

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-150	5.00	1.40	9.03	0.56	0.23	0.56	0.23	0.00	0.00
CB-152	5.00	6.56	9.03	0.47	1.28	0.47	1.28	0.00	0.00


OF-150/152 (50 YR POST)
CB/152
0+00.00
Elev.= 429
426.79
Length = 72.12Ft.
18" R.C.PIPE
Slope =6.72%
NP-83
CB/150
0+75.12
Elev.= 425
421.84
421.49
Length = 402.17Ft.
18" R.C.PIPE
Slope =3.53%
NP-84
407.38
OF-150/152
4+78.79
Elev.= 407
432
431
430
429
428
427
426
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+79

CULVERT 151/153/154

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 151**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3972
Grass	0.25	0.52	0.1308
Woods	0.15	0.00	0.0000
	Σ	**0.96**	0.5279

$C_{ave} = \frac{0.5279}{0.96} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.53	0.4770
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.53**	0.4770

$C_{ave} = \frac{0.4770}{0.53} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.55	x	6.23	x	0.96	x	1	=	**3.29**	cfs
Q_{10} =	0.55	x	6.98	x	0.96	x	1	=	**3.68**	cfs
Q_{25} =	0.55	x	8.08	x	0.96	x	1.1	=	**4.69**	cfs
Q_{50} =	0.55	x	8.93	x	0.96	x	1.2	=	**5.65**	cfs
Q_{100} =	0.55	x	9.81	x	0.96	x	1.25	=	**6.47**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.53	x	1	=	**2.97**	cfs
Q_{10} =	0.90	x	6.98	x	0.53	x	1	=	**3.33**	cfs
Q_{25} =	0.90	x	8.08	x	0.53	x	1.1	=	**4.24**	cfs
Q_{50} =	0.90	x	8.93	x	0.53	x	1.2	=	**5.11**	cfs
Q_{100} =	0.90	x	9.81	x	0.53	x	1.25	=	**5.85**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 153**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.36	0.3231
Grass	0.25	0.38	0.0959
Woods	0.15	1.61	0.2415
	Σ	**2.35**	0.6605

$C_{ave} = \frac{0.6605}{2.35} =$ **0.28**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3861
Grass	0.25	0.38	0.0959
Woods	0.15	1.61	0.2415
	Σ	**2.42**	0.7235

$C_{ave} = \frac{0.7235}{2.42} =$ **0.30**

T_c =	23.69	min.
I_{05} =	4.15	in / hr
I_{10} =	4.60	in / hr
I_{25} =	5.26	in / hr
I_{50} =	5.75	in / hr
I_{100} =	6.25	in / hr

Pre Construction Runoff:

Q_{05} =	0.28	x	4.15	x	2.35	x	1	=	**2.74**	cfs
Q_{10} =	0.28	x	4.60	x	2.35	x	1	=	**3.04**	cfs
Q_{25} =	0.28	x	5.26	x	2.35	x	1.1	=	**3.82**	cfs
Q_{50} =	0.28	x	5.75	x	2.35	x	1.2	=	**4.56**	cfs
Q_{100} =	0.28	x	6.25	x	2.35	x	1.25	=	**5.16**	cfs

Post Construction Runoff:

Q_{05} =	0.30	x	4.15	x	2.42	x	1	=	**3.00**	cfs
Q_{10} =	0.30	x	4.60	x	2.42	x	1	=	**3.33**	cfs
Q_{25} =	0.30	x	5.26	x	2.42	x	1.1	=	**4.18**	cfs
Q_{50} =	0.30	x	5.75	x	2.42	x	1.2	=	**4.99**	cfs
Q_{100} =	0.30	x	6.25	x	2.42	x	1.25	=	**5.66**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 154a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.53	0.4742
Grass	0.25	2.39	0.5981
Woods	0.15	0.16	0.0243
	Σ	**3.08**	1.0966

$C_{ave} = \frac{1.0966}{3.08} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5912
Grass	0.25	2.39	0.5981
Woods	0.15	0.16	0.0243
	Σ	**3.21**	1.2136

$C_{ave} = \frac{1.2136}{3.21} = 0.38$

T_c =	11.93	min.
I_{05} =	5.26	in / hr
I_{10} =	5.86	in / hr
I_{25} =	6.74	in / hr
I_{50} =	7.41	in / hr
I_{100} =	8.10	in / hr

Pre Construction Runoff:

Q_{05} =	0.36	x	5.26	x	3.08	x	1	=	**5.76**	cfs
Q_{10} =	0.36	x	5.86	x	3.08	x	1	=	**6.42**	cfs
Q_{25} =	0.36	x	6.74	x	3.08	x	1.1	=	**8.13**	cfs
Q_{50} =	0.36	x	7.41	x	3.08	x	1.2	=	**9.75**	cfs
Q_{100} =	0.36	x	8.10	x	3.08	x	1.25	=	**11.10**	cfs

Post Construction Runoff:

Q_{05} =	0.38	x	5.26	x	3.21	x	1	=	**6.38**	cfs
Q_{10} =	0.38	x	5.86	x	3.21	x	1	=	**7.11**	cfs
Q_{25} =	0.38	x	6.74	x	3.21	x	1.1	=	**9.00**	cfs
Q_{50} =	0.38	x	7.41	x	3.21	x	1.2	=	**10.79**	cfs
Q_{100} =	0.38	x	8.10	x	3.21	x	1.25	=	**12.28**	cfs

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Columbia, South Carolina 29201
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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 154b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.63	0.5699
Grass	0.25	0.31	0.0781
Woods	0.15	1.25	0.1868
	Σ	**2.19**	0.8347

$C_{ave} = \frac{0.8347}{2.19} = 0.38$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.65	0.5850
Grass	0.25	0.31	0.0781
Woods	0.15	1.25	0.1868
	Σ	**2.21**	0.8499

$C_{ave} = \frac{0.8499}{2.21} = 0.38$

T_c =	22.32	min.
I_{05} =	4.25	in / hr
I_{10} =	4.72	in / hr
I_{25} =	5.40	in / hr
I_{50} =	5.90	in / hr
I_{100} =	6.42	in / hr

Pre Construction Runoff:

Q_{05} =	0.38	x	4.25	x	2.19	x	1	=	**3.55**	cfs
Q_{10} =	0.38	x	4.72	x	2.19	x	1	=	**3.94**	cfs
Q_{25} =	0.38	x	5.40	x	2.19	x	1.1	=	**4.96**	cfs
Q_{50} =	0.38	x	5.90	x	2.19	x	1.2	=	**5.91**	cfs
Q_{100} =	0.38	x	6.42	x	2.19	x	1.25	=	**6.70**	cfs

Post Construction Runoff:

Q_{05} =	0.38	x	4.25	x	2.21	x	1	=	**3.61**	cfs
Q_{10} =	0.38	x	4.72	x	2.21	x	1	=	**4.01**	cfs
Q_{25} =	0.38	x	5.40	x	2.21	x	1.1	=	**5.05**	cfs
Q_{50} =	0.38	x	5.90	x	2.21	x	1.2	=	**6.02**	cfs
Q_{100} =	0.38	x	6.42	x	2.21	x	1.25	=	**6.83**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 153	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0600**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.380**	+		=	**0.380**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**340**				
9	Watercourse slope, s		ft/ft	**0.1500**				
10	Average velocity, V (figure 3-1)		ft/s	**6.25**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.015**	+		=	**0.015**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft	**0.0000**				
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.395**
							min	**23.69**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 154a Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Grass				
2 Manning's roughness coeff., n (table 3-1)				**0.240**				
3 Flow length, L (total L < or = 100)		ft		**100**				
4 Two-yr 24-hr rainfall, P_2		in		**3.58**				
5 Land slope, s		ft/ft		**0.0700**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr		**0.136**	+		=	**0.136**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)								
8 Flow length, L		ft						
9 Watercourse slope, s		ft/ft						
10 Average velocity, V (figure 3-1)		ft/s						
11 $T_t = L / (3600\ V)$	Compute T_t	hr			+		=	**0.000**
Channel Flow			Segment ID					
Front Slope, (_ : 1)				**6**				
Back Slope, (_ : 1)				**4**				
Bottom Width		ft		**2**				
Flow Depth		ft		**0.5**				
12 Cross sectional flow area, a		ft^2		**2.25**		**0.00**		
13 Wetted perimeter, p_w		ft		**7.10**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	ft		**0.32**		**#DIV/0!**		
15 Channel Slope, s		ft/ft		**0.0300**				
16 Manning's roughness coeff., n				**0.06**				
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s		**2.00**		**#DIV/0!**		
18 Flow length, L		ft		**450**				
19 $T_t = L / (3600\ V)$	Compute T_t	hr		**0.063**	+	**0.000**	=	**0.063**
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.199**
							min	**11.93**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 154b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0700**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.357**	+		=	**0.357**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**340**				
9	Watercourse slope, s		ft/ft	**0.1500**				
10	Average velocity, V (figure 3-1)		ft/s	**6.25**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.015**	+		=	**0.015**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.372**
							min	**22.32**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-151/153/154		Outlet	OP	410.73	410.73	0.00	0.48	0.00	23.75	0.00	8.41	0.37	0.00
CB-153		Other	C.B. TYPE 112	414.51	414.51	3.00	0.28	23.69	23.69	21.55	8.41	0.37	5.81
CB-154b		Other	C.B. TYPE 112	421.67	421.67	2.70	0.24	22.32	22.32	13.82	5.27	0.37	5.96
CB-151		Other	C.B. TYPE 112	417.38	417.38	2.35	0.00	5.00	5.00	5.70	0.96	0.55	9.03
CB-154a		Other	C.B. TYPE 112	427.72	427.72	2.49	0.00	11.93	11.93	9.87	3.08	0.36	7.49

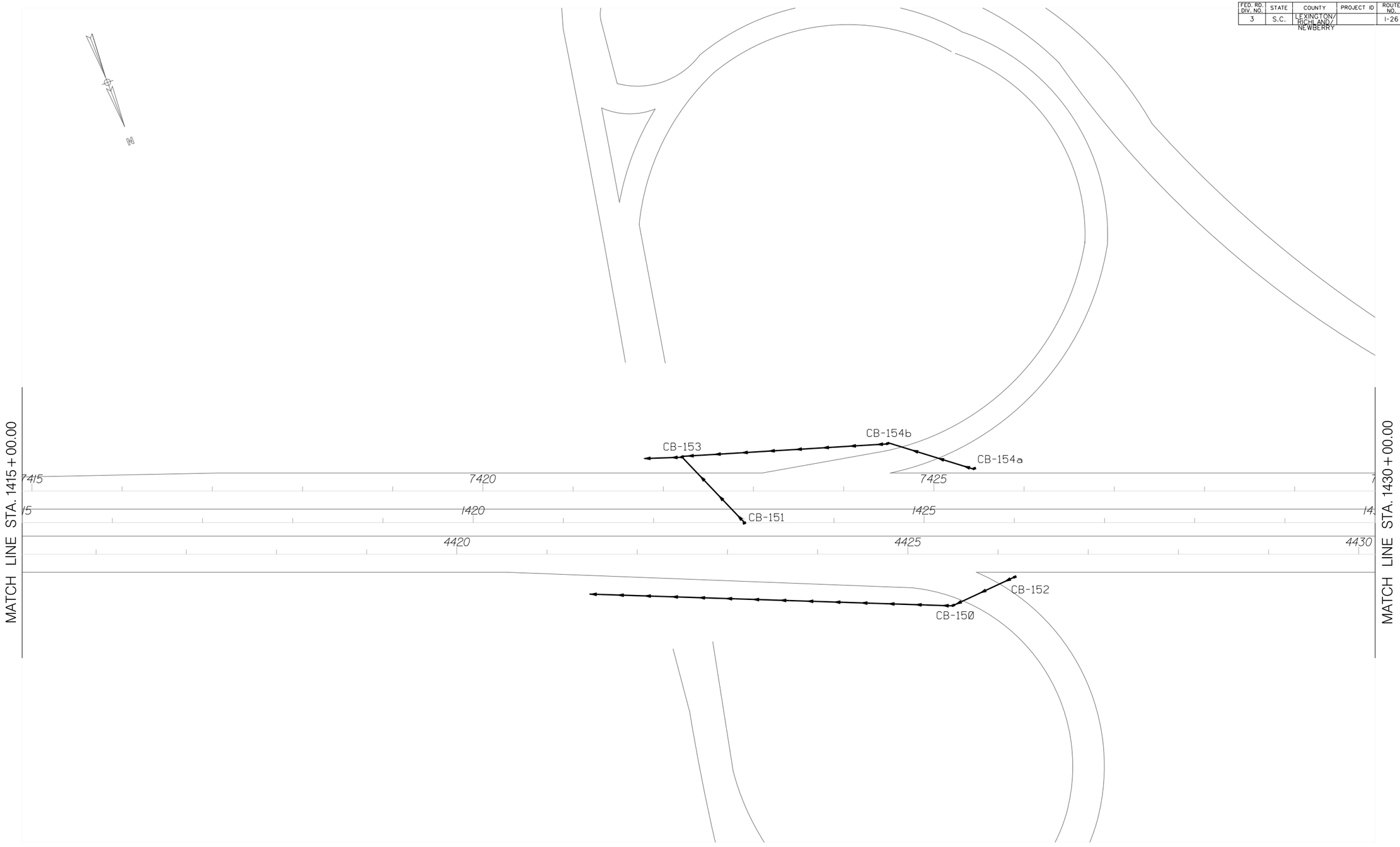
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-82	CB-153	OF-151/153/154	Circular	Concrete	1	2.00	40	1.93	21.55	36.64	1.16	11.46	413.51	413.48	412.73	412.00	411.51	410.73	6.88	10.22	1.97	1.27
NP-80	CB-154b	CB-153	Circular	Concrete	1	1.50	225	3.16	13.82	21.78	0.91	12.31	420.47	420.68	413.34	412.75	418.97	411.84	7.82	12.30	1.50	0.91
NP-81	CB-151	CB-153	Circular	Concrete	1	1.50	99	2.34	5.70	18.71	0.59	8.80	416.53	416.45	414.22	413.32	415.03	412.72	3.30	8.73	1.42	0.60
NP-79	CB-154a	CB-154b	Circular	Concrete	1	1.25	98	6.02	9.87	18.47	0.68	14.48	426.48	428.63	420.60	420.04	425.23	419.35	8.04	14.16	1.25	0.69

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-153	23.69	4.43	5.81	0.29	2.18	0.29	2.18	0.00	0.00
CB-154b	22.32	5.95	5.96	0.38	2.19	0.38	2.19	0.00	0.00
CB-151	5.00	5.70	9.03	0.55	0.96	0.55	0.96	0.00	0.00
CB-154a	11.93	9.87	7.49	0.36	3.08	0.36	3.08	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	62



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

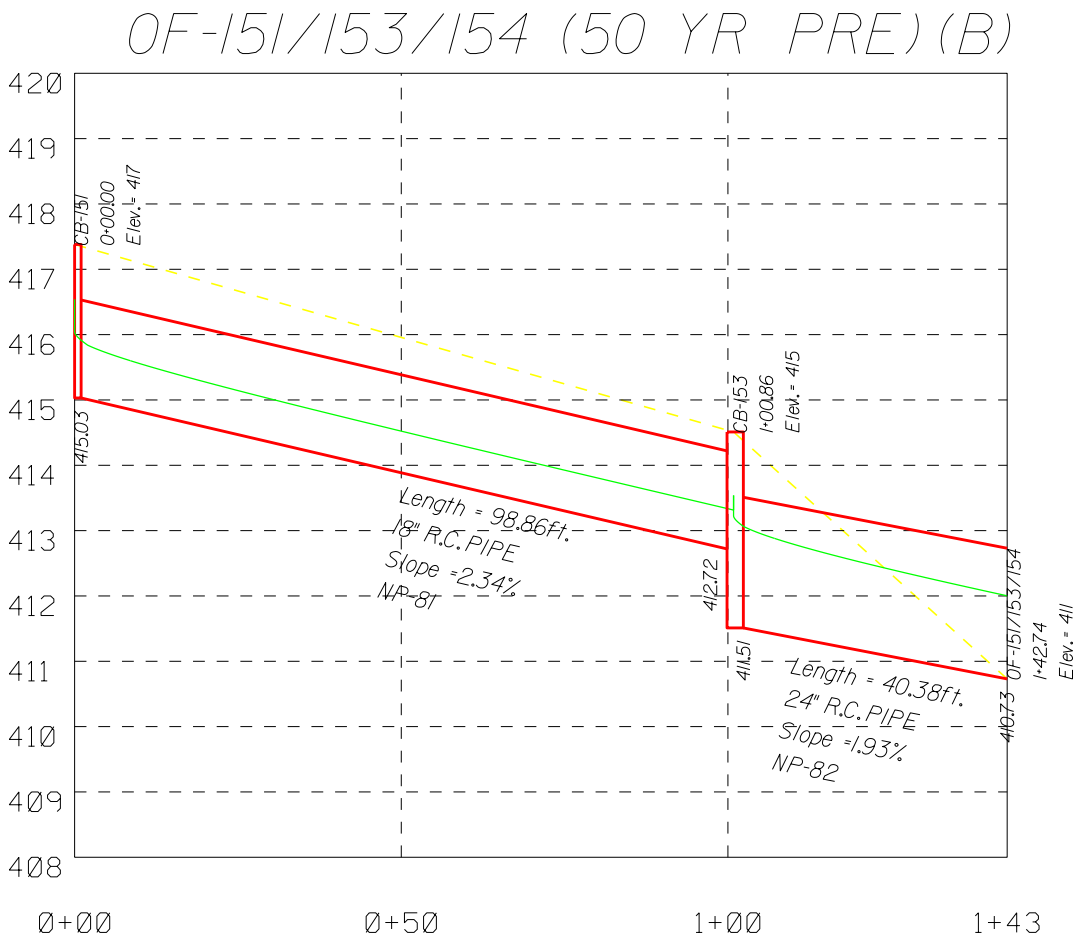
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1415+00.00 TO STA. 1430+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$$
$$$$date$$$$


OF-151/153/154 (50 YR PRE)(A)
430
429
428
427
426
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
3+71
CB-154a
0+00.00
Elev.= 428
425.23
Length = 97.68ft.
15" R.C. PIPE
Slope =6.02%
NP-79
CB-154b
1+00.68
Elev.= 422
419.35
418.97
Length = 225.31ft.
18" R.C. PIPE
Slope =3.16%
NP-80
CB-153
3+28.99
Elev.= 415
411.84
411.51
Length = 40.38ft.
24" R.C. PIPE
Slope =1.93%
NP-82
OF-151/153/154
3+70.87
Elev.= 411
410.73


OF-151/153/154 (50 YR PRE)(B)
420
419
418
417
416
415
414
413
412
411
410
409
408
0+00
0+50
1+00
1+43
CB-151
0+00.00
Elev.= 417
415.03
Length = 98.86ft.
18" R.C.PIPE
Slope =2.34%
NP-81
CB-153
1+00.86
Elev. = 415
412.72
411.51
Length = 40.38ft.
24" R.C.PIPE
Slope =1.93%
NP-82
409.73
OF-151/153/154
1+42.74
Elev. = 411

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-151/153/154	Outlet	OP	410.73	410.73	0.00	0.48	0.00	23.75	0.00	8.37	0.39	0.00
CB-153	Other	C.B. TYPE 112	414.51	414.51	3.00	0.26	23.69	23.69	22.77	8.37	0.39	5.81
CB-154b	Other	C.B. TYPE 112	421.67	421.67	2.70	0.27	22.32	22.32	14.78	5.42	0.38	5.96
CB-151	Other	C.B. TYPE 112	417.38	417.38	2.35	0.00	5.00	5.00	5.17	0.53	0.90	9.03
CB-154a	Other	C.B. TYPE 112	427.72	427.72	2.49	0.00	11.93	11.93	10.92	3.21	0.38	7.49

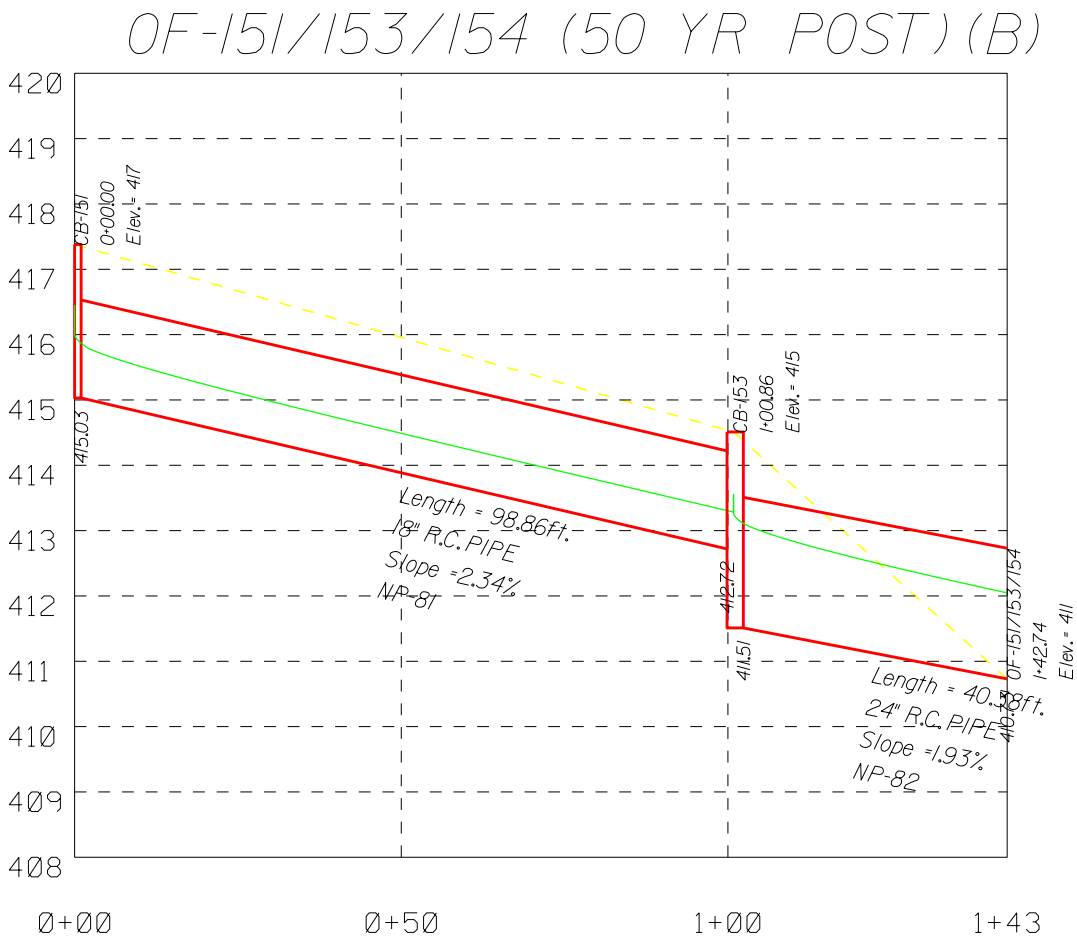
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-82	CB-153	OF-151/153/154	Circular	Concrete	1	2.00	40	1.93	22.77	36.64	1.20	11.62	413.51	413.50	412.73	412.05	411.51	410.73	7.25	10.37	1.99	1.32
NP-80	CB-154b	CB-153	Circular	Concrete	1	1.50	225	3.16	14.78	21.78	0.95	12.50	420.47	420.74	413.34	412.79	418.97	411.84	8.37	12.47	1.50	0.95
NP-81	CB-151	CB-153	Circular	Concrete	1	1.50	99	2.34	5.17	18.71	0.56	8.58	416.53	416.36	414.22	413.28	415.03	412.72	3.12	8.50	1.33	0.56
NP-79	CB-154a	CB-154b	Circular	Concrete	1	1.25	98	6.02	10.92	18.47	0.72	14.82	426.48	429.23	420.60	420.09	425.23	419.35	8.90	14.46	1.25	0.74

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-153	23.69	5.04	5.81	0.30	2.42	0.30	2.42	0.00	0.00
CB-154b	22.32	6.08	5.96	0.38	2.21	0.38	2.21	0.00	0.00
CB-151	5.00	5.17	9.03	0.90	0.53	0.90	0.53	0.00	0.00
CB-154a	11.93	10.92	7.49	0.38	3.21	0.38	3.21	0.00	0.00


OF-151/153/154 (50 YR POST)(A)
CB-154a
0+00.00
Elev.= 428
425.23
Length = 97.68ft.
15" R.C. PIPE
Slope =6.02%
NP-79
CB-154b
1+00.68
Elev.= 422
419.35
418.97
Length = 225.31ft.
18" R.C. PIPE
Slope =3.16%
NP-80
CB-153
3+28.99
Elev.= 415
411.84
411.51
Length = 40.58ft.
24" R.C. PIPE
Slope =1.93%
NP-82
OF-151/153/154
3+70.87
Elev.= 411
410.88
430
429
428
427
426
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
3+71


OF-151/153/154 (50 YR POST)(B)
420
419
418
417
416
415
414
413
412
411
410
409
408
0+00
0+50
1+00
1+43
CB-151
0+00.00
Elev.= 417
415.03
Length = 98.86ft.
18" R.C. PIPE
Slope =2.34%
NP-81
CB-153
1+00.86
Elev. = 415
412.72
411.51
Length = 40.38ft.
24" R.C. PIPE
Slope =1.93%
NP-82
OF-151/153/154
1+42.74
Elev. = 411

CULVERT 155

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 155**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.52	0.4722
Grass	0.25	0.52	0.1296
Woods	0.15	0.26	0.0384
	Σ	**1.30**	0.6402

$C_{ave} = \frac{0.6402}{1.30} = 0.49$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.56	0.5040
Grass	0.25	0.52	0.1296
Woods	0.15	0.26	0.0384
	Σ	**1.33**	0.6719

$C_{ave} = \frac{0.6719}{1.33} = 0.50$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.49	x	6.23	x	1.30	x	1	=	**3.99**	cfs
Q_{10} =	0.49	x	6.98	x	1.30	x	1	=	**4.47**	cfs
Q_{25} =	0.49	x	8.08	x	1.30	x	1.1	=	**5.69**	cfs
Q_{50} =	0.49	x	8.93	x	1.30	x	1.2	=	**6.86**	cfs
Q_{100} =	0.49	x	9.81	x	1.30	x	1.25	=	**7.85**	cfs

Post Construction Runoff:

Q_{05} =	0.50	x	6.23	x	1.33	x	1	=	**4.19**	cfs
Q_{10} =	0.50	x	6.98	x	1.33	x	1	=	**4.69**	cfs
Q_{25} =	0.50	x	8.08	x	1.33	x	1.1	=	**5.97**	cfs
Q_{50} =	0.50	x	8.93	x	1.33	x	1.2	=	**7.20**	cfs
Q_{100} =	0.50	x	9.81	x	1.33	x	1.25	=	**8.24**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.69 cfs

Design Flow: 6.86 cfs

Maximum Flow: 7.85 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1433+00 (PRE) 155

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
435.07	5.69	5.69	0.00	1
435.11	5.91	5.91	0.00	1
435.14	6.12	6.12	0.00	1
435.18	6.34	6.34	0.00	1
435.22	6.55	6.55	0.00	1
435.25	6.77	6.77	0.00	1
435.27	6.86	6.86	0.00	1
435.33	7.20	7.20	0.00	1
435.37	7.42	7.42	0.00	1
435.41	7.63	7.63	0.00	1
435.45	7.85	7.85	0.00	1
436.89	13.27	13.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.69	5.69	435.07	1.390	0.0*	1-S2n	0.528	0.917	0.528	0.244	9.904	9.360
5.91	5.91	435.11	1.426	0.0*	1-S2n	0.539	0.934	0.539	0.249	10.007	9.474
6.12	6.12	435.14	1.462	0.0*	1-S2n	0.549	0.951	0.549	0.255	10.117	9.581
6.34	6.34	435.18	1.499	0.0*	1-S2n	0.559	0.968	0.559	0.260	10.195	9.686
6.55	6.55	435.22	1.536	0.0*	5-S2n	0.570	0.988	0.570	0.265	10.290	9.790
6.77	6.77	435.25	1.574	0.0*	5-S2n	0.580	1.004	0.580	0.270	10.384	9.892
6.86	6.86	435.27	1.589	0.0*	5-S2n	0.584	1.011	0.584	0.272	10.424	9.932
7.20	7.20	435.33	1.651	0.0*	5-S2n	0.600	1.036	0.600	0.279	10.550	10.085
7.42	7.42	435.37	1.691	0.0*	5-S2n	0.610	1.052	0.610	0.284	10.635	10.181
7.63	7.63	435.41	1.731	0.0*	5-S2n	0.619	1.067	0.647	0.288	10.126	10.272
7.85	7.85	435.45	1.773	0.0*	5-S2n	0.629	1.082	0.629	0.293	10.791	10.363

* Full Flow Headwater elevation is below inlet invert.

****

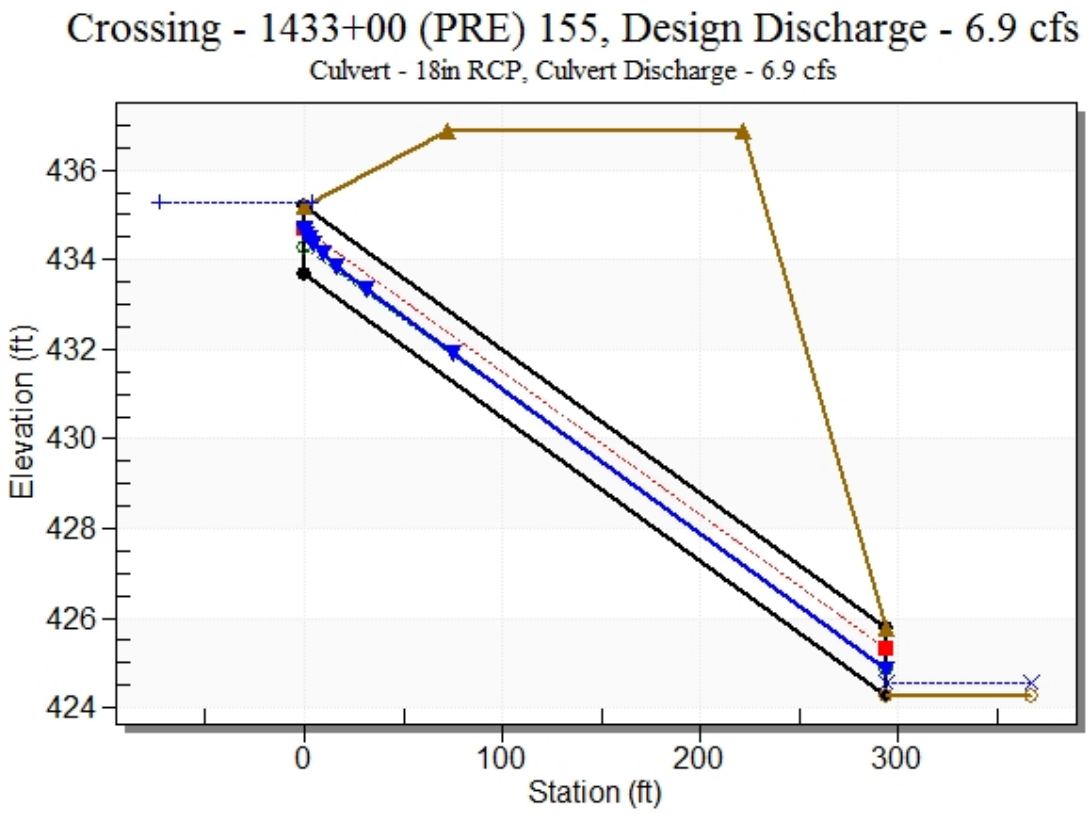
Straight Culvert

Inlet Elevation (invert): 433.68 ft, Outlet Elevation (invert): 424.28 ft

Culvert Length: 294.15 ft, Culvert Slope: 0.0320

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 433.68 ft

Outlet Station: 294.00 ft

Outlet Elevation: 424.28 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1433+00 (PRE) 155)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.69	424.52	0.24	9.36	0.76	3.65
5.91	424.53	0.25	9.47	0.78	3.66
6.12	424.53	0.25	9.58	0.79	3.67
6.34	424.54	0.26	9.69	0.81	3.68
6.55	424.54	0.26	9.79	0.83	3.69
6.77	424.55	0.27	9.89	0.84	3.70
6.86	424.55	0.27	9.93	0.85	3.70
7.20	424.56	0.28	10.09	0.87	3.71
7.42	424.56	0.28	10.18	0.89	3.72
7.63	424.57	0.29	10.27	0.90	3.73
7.85	424.57	0.29	10.36	0.91	3.74

Tailwater Channel Data - 1433+00 (PRE) 155

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0120

Channel Invert Elevation: 424.28 ft

Roadway Data for Crossing: 1433+00 (PRE) 155

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.89 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.97 cfs

Design Flow: 7.2 cfs

Maximum Flow: 8.24 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1433+00 (POST) 155

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
435.12	5.97	5.97	0.00	1
435.15	6.20	6.20	0.00	1
435.19	6.42	6.42	0.00	1
435.23	6.65	6.65	0.00	1
435.27	6.88	6.88	0.00	1
435.31	7.11	7.11	0.00	1
435.33	7.20	7.20	0.00	1
435.40	7.56	7.56	0.00	1
435.44	7.79	7.79	0.00	1
435.49	8.01	8.01	0.00	1
435.53	8.24	8.24	0.00	1
436.89	13.27	13.27	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.97	5.97	435.12	1.437	0.0*	1-S2n	0.542	0.939	0.542	0.251	10.040	9.507
6.20	6.20	435.15	1.475	0.0*	1-S2n	0.553	0.957	0.553	0.256	10.130	9.620
6.42	6.42	435.19	1.513	0.0*	5-S2n	0.563	0.978	0.563	0.262	10.233	9.730
6.65	6.65	435.23	1.553	0.0*	5-S2n	0.574	0.995	0.574	0.267	10.332	9.838
6.88	6.88	435.27	1.593	0.0*	5-S2n	0.585	1.012	0.585	0.272	10.432	9.939
7.11	7.11	435.31	1.633	0.0*	5-S2n	0.595	1.029	0.595	0.277	10.511	10.044
7.20	7.20	435.33	1.651	0.0*	5-S2n	0.600	1.036	0.600	0.279	10.550	10.087
7.56	7.56	435.40	1.717	0.0*	5-S2n	0.616	1.062	0.654	0.287	9.886	10.241
7.79	7.79	435.44	1.761	0.0*	5-S2n	0.626	1.077	0.632	0.292	10.631	10.334
8.01	8.01	435.49	1.805	0.0*	5-S2n	0.636	1.093	0.636	0.296	10.851	10.427
8.24	8.24	435.53	1.851	0.0*	5-S2n	0.646	1.108	0.646	0.301	10.932	10.519

* Full Flow Headwater elevation is below inlet invert.

****

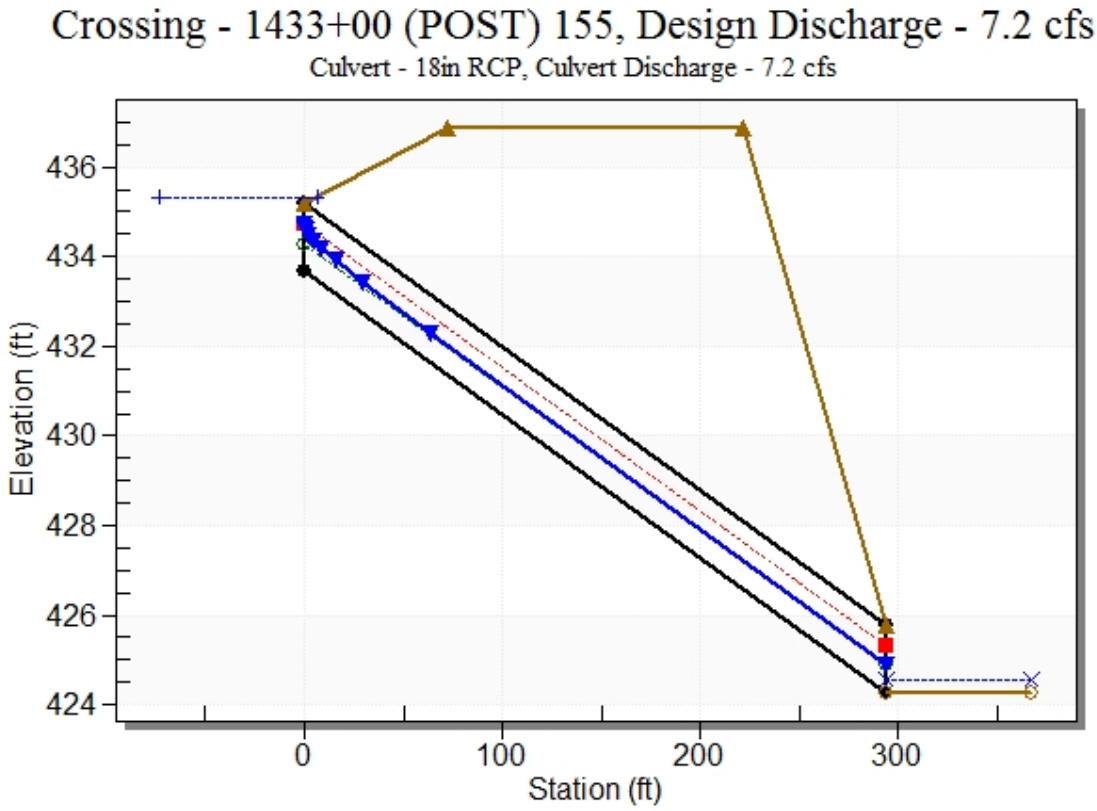
Straight Culvert

Inlet Elevation (invert): 433.68 ft, Outlet Elevation (invert): 424.28 ft

Culvert Length: 294.15 ft, Culvert Slope: 0.0320

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 433.68 ft

Outlet Station: 294.00 ft

Outlet Elevation: 424.28 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1433+00 (POST) 155)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.97	424.53	0.25	9.51	0.78	3.66
6.20	424.54	0.26	9.62	0.80	3.67
6.42	424.54	0.26	9.73	0.82	3.68
6.65	424.55	0.27	9.84	0.83	3.69
6.88	424.55	0.27	9.94	0.85	3.70
7.11	424.56	0.28	10.04	0.86	3.71
7.20	424.56	0.28	10.09	0.87	3.71
7.56	424.57	0.29	10.24	0.89	3.73
7.79	424.57	0.29	10.33	0.91	3.73
8.01	424.58	0.30	10.43	0.92	3.74
8.24	424.58	0.30	10.52	0.94	3.75

Tailwater Channel Data - 1433+00 (POST) 155

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0120

Channel Invert Elevation: 424.28 ft

Roadway Data for Crossing: 1433+00 (POST) 155

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.89 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

CULVERT 156

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 156**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.30	0.2691
Grass	0.25	0.53	0.1318
Woods	0.15	0.00	0.0000
	Σ	**0.83**	0.4009

$C_{ave} = \frac{0.4009}{0.83} = 0.49$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.35	0.3150
Grass	0.25	0.53	0.1318
Woods	0.15	0.00	0.0000
	Σ	**0.88**	0.4468

$C_{ave} = \frac{0.4468}{0.88} = 0.51$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.49	x	6.23	x	0.83	x	1	=	**2.50**	cfs
Q_{10} =	0.49	x	6.98	x	0.83	x	1	=	**2.80**	cfs
Q_{25} =	0.49	x	8.08	x	0.83	x	1.1	=	**3.56**	cfs
Q_{50} =	0.49	x	8.93	x	0.83	x	1.2	=	**4.29**	cfs
Q_{100} =	0.49	x	9.81	x	0.83	x	1.25	=	**4.92**	cfs

Post Construction Runoff:

Q_{05} =	0.51	x	6.23	x	0.88	x	1	=	**2.78**	cfs
Q_{10} =	0.51	x	6.98	x	0.88	x	1	=	**3.12**	cfs
Q_{25} =	0.51	x	8.08	x	0.88	x	1.1	=	**3.97**	cfs
Q_{50} =	0.51	x	8.93	x	0.88	x	1.2	=	**4.79**	cfs
Q_{100} =	0.51	x	9.81	x	0.88	x	1.25	=	**5.48**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.56 cfs

Design Flow: 4.29 cfs

Maximum Flow: 4.92 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1433+00 (PRE) 156

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
434.50	3.56	3.56	0.00	1
434.52	3.70	3.70	0.00	1
434.55	3.83	3.83	0.00	1
434.57	3.97	3.97	0.00	1
434.59	4.10	4.10	0.00	1
434.62	4.24	4.24	0.00	1
434.62	4.29	4.29	0.00	1
434.66	4.51	4.51	0.00	1
434.68	4.65	4.65	0.00	1
434.71	4.78	4.78	0.00	1
434.73	4.92	4.92	0.00	1
436.58	12.99	12.99	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.56	3.56	434.50	1.037	0.0*	1-S2n	0.442	0.720	0.457	0.199	7.569	7.457
3.70	3.70	434.52	1.062	0.0*	1-S2n	0.450	0.735	0.465	0.203	7.662	7.550
3.83	3.83	434.55	1.086	0.0*	1-S2n	0.459	0.748	0.473	0.208	7.734	7.638
3.97	3.97	434.57	1.109	0.0*	1-S2n	0.467	0.762	0.467	0.212	8.175	7.725
4.10	4.10	434.59	1.133	0.0*	1-S2n	0.476	0.775	0.492	0.216	7.866	7.812
4.24	4.24	434.62	1.156	0.0*	1-S2n	0.484	0.788	0.501	0.220	7.939	7.894
4.29	4.29	434.62	1.165	0.0*	1-S2n	0.487	0.793	0.504	0.222	7.968	7.927
4.51	4.51	434.66	1.202	0.0*	1-S2n	0.500	0.813	0.517	0.228	8.078	8.053
4.65	4.65	434.68	1.224	0.0*	1-S2n	0.508	0.825	0.526	0.232	8.130	8.131
4.78	4.78	434.71	1.247	0.0*	1-S2n	0.516	0.837	0.534	0.236	8.189	8.210
4.92	4.92	434.73	1.269	0.0*	1-S2n	0.524	0.849	0.543	0.240	8.253	8.281

* Full Flow Headwater elevation is below inlet invert.

****

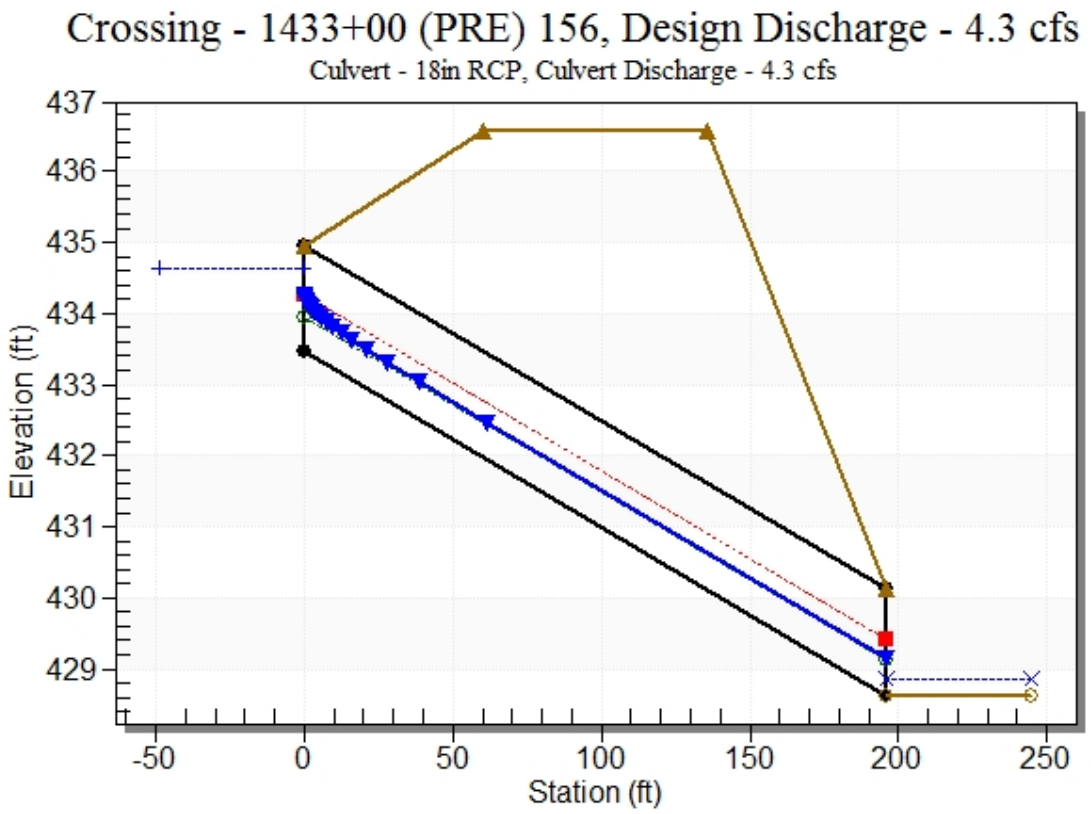
Straight Culvert

Inlet Elevation (invert): 433.46 ft, Outlet Elevation (invert): 428.63 ft

Culvert Length: 196.06 ft, Culvert Slope: 0.0246

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 433.46 ft

Outlet Station: 196.00 ft

Outlet Elevation: 428.63 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1433+00 (PRE) 156)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.56	428.83	0.20	7.46	0.50	3.18
3.70	428.83	0.20	7.55	0.51	3.19
3.83	428.84	0.21	7.64	0.52	3.20
3.97	428.84	0.21	7.72	0.53	3.21
4.10	428.85	0.22	7.81	0.54	3.21
4.24	428.85	0.22	7.89	0.55	3.22
4.29	428.85	0.22	7.93	0.55	3.23
4.51	428.86	0.23	8.05	0.57	3.24
4.65	428.86	0.23	8.13	0.58	3.24
4.78	428.87	0.24	8.21	0.59	3.25
4.92	428.87	0.24	8.28	0.60	3.26

Tailwater Channel Data - 1433+00 (PRE) 156

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 428.63 ft

Roadway Data for Crossing: 1433+00 (PRE) 156

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.58 ft

Roadway Surface: Paved

Roadway Top Width: 75.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.97 cfs

Design Flow: 4.79 cfs

Maximum Flow: 5.48 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1433+00 (POST) 156

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
434.57	3.97	3.97	0.00	1
434.60	4.12	4.12	0.00	1
434.62	4.27	4.27	0.00	1
434.65	4.42	4.42	0.00	1
434.67	4.57	4.57	0.00	1
434.70	4.73	4.73	0.00	1
434.71	4.79	4.79	0.00	1
434.75	5.03	5.03	0.00	1
434.77	5.18	5.18	0.00	1
434.80	5.33	5.33	0.00	1
434.82	5.48	5.48	0.00	1
436.58	12.99	12.99	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.97	3.97	434.57	1.110	0.0*	1-S2n	0.468	0.762	0.468	0.212	8.176	7.729
4.12	4.12	434.60	1.136	0.0*	1-S2n	0.477	0.777	0.493	0.217	7.875	7.821
4.27	4.27	434.62	1.161	0.0*	1-S2n	0.486	0.791	0.503	0.221	7.957	7.912
4.42	4.42	434.65	1.187	0.0*	1-S2n	0.495	0.805	0.512	0.226	8.024	8.002
4.57	4.57	434.67	1.212	0.0*	1-S2n	0.504	0.819	0.521	0.230	8.101	8.091
4.73	4.73	434.70	1.237	0.0*	1-S2n	0.512	0.832	0.531	0.234	8.163	8.176
4.79	4.79	434.71	1.248	0.0*	1-S2n	0.516	0.838	0.535	0.236	8.192	8.211
5.03	5.03	434.75	1.287	0.0*	1-S2n	0.530	0.858	0.549	0.243	8.306	8.339
5.18	5.18	434.77	1.312	0.0*	1-S2n	0.538	0.870	0.558	0.247	8.364	8.419
5.33	5.33	434.80	1.336	0.0*	1-S2n	0.546	0.887	0.566	0.251	8.431	8.495
5.48	5.48	434.82	1.361	0.0*	1-S2n	0.555	0.899	0.555	0.255	8.912	8.572

* Full Flow Headwater elevation is below inlet invert.

****

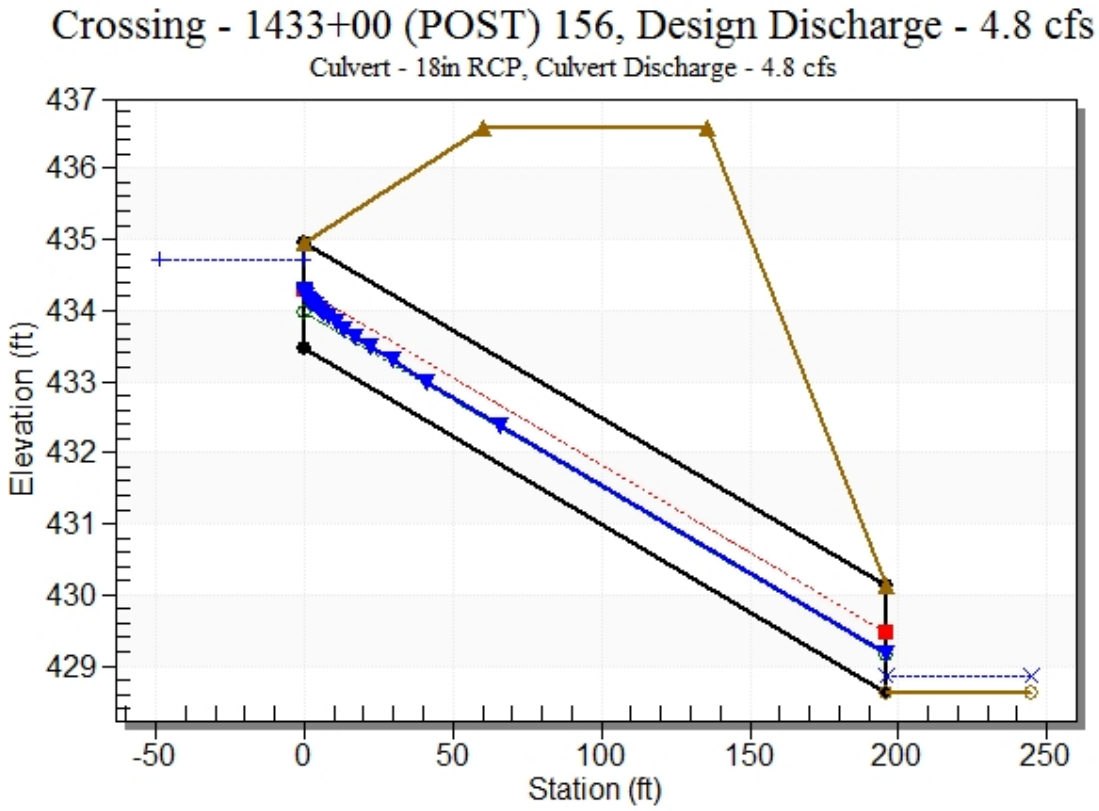
Straight Culvert

Inlet Elevation (invert): 433.46 ft, Outlet Elevation (invert): 428.63 ft

Culvert Length: 196.06 ft, Culvert Slope: 0.0246

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 433.46 ft

Outlet Station: 196.00 ft

Outlet Elevation: 428.63 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1433+00 (POST) 156)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.97	428.84	0.21	7.73	0.53	3.21
4.12	428.85	0.22	7.82	0.54	3.21
4.27	428.85	0.22	7.91	0.55	3.22
4.42	428.86	0.23	8.00	0.56	3.23
4.57	428.86	0.23	8.09	0.57	3.24
4.73	428.86	0.23	8.18	0.58	3.25
4.79	428.87	0.24	8.21	0.59	3.25
5.03	428.87	0.24	8.34	0.61	3.26
5.18	428.88	0.25	8.42	0.62	3.27
5.33	428.88	0.25	8.50	0.63	3.28
5.48	428.88	0.25	8.57	0.64	3.28

Tailwater Channel Data - 1433+00 (POST) 156

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0120

Channel Invert Elevation: 428.63 ft

Roadway Data for Crossing: 1433+00 (POST) 156

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.58 ft

Roadway Surface: Paved

Roadway Top Width: 75.00 ft

CULVERT 157

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 157**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.20	0.1832
Grass	0.25	0.24	0.0595
Woods	0.15	0.00	0.0000
	Σ	**0.44**	0.2427

$C_{ave} = \frac{0.2427}{0.44} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2250
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.25**	0.2250

$C_{ave} = \frac{0.2250}{0.25} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.55	**x**	6.23	**x**	0.44	**x**	1	=	**1.51**	cfs
Q_{10} =	0.55	**x**	6.98	**x**	0.44	**x**	1	=	**1.69**	cfs
Q_{25} =	0.55	**x**	8.08	**x**	0.44	**x**	1.1	=	**2.16**	cfs
Q_{50} =	0.55	**x**	8.93	**x**	0.44	**x**	1.2	=	**2.60**	cfs
Q_{100} =	0.55	**x**	9.81	**x**	0.44	**x**	1.25	=	**2.97**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.25	**x**	1	=	**1.40**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.25	**x**	1	=	**1.57**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.25	**x**	1.1	=	**2.00**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.25	**x**	1.2	=	**2.41**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.25	**x**	1.25	=	**2.76**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.16 cfs

Design Flow: 2.6 cfs

Maximum Flow: 2.97 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1434+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
430.00	2.16	2.16	0.00	1
430.02	2.24	2.24	0.00	1
430.04	2.32	2.32	0.00	1
430.06	2.40	2.40	0.00	1
430.07	2.48	2.48	0.00	1
430.09	2.57	2.57	0.00	1
430.10	2.60	2.60	0.00	1
430.13	2.73	2.73	0.00	1
430.15	2.81	2.81	0.00	1
430.16	2.89	2.89	0.00	1
430.18	2.97	2.97	0.00	1
432.86	10.45	10.45	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.16	2.16	430.00	0.828	0.0*	1-S2n	0.313	0.587	0.313	0.350	8.686	2.286
2.24	2.24	430.02	0.848	0.0*	1-S2n	0.319	0.598	0.319	0.357	8.781	2.311
2.32	2.32	430.04	0.867	0.0*	1-S2n	0.325	0.609	0.325	0.364	8.886	2.335
2.40	2.40	430.06	0.886	0.0*	1-S2n	0.331	0.620	0.344	0.371	8.469	2.360
2.48	2.48	430.07	0.905	0.0*	1-S2n	0.336	0.631	0.336	0.378	9.090	2.384
2.57	2.57	430.09	0.923	0.0*	1-S2n	0.342	0.641	0.342	0.385	9.112	2.406
2.60	2.60	430.10	0.931	0.0*	1-S2n	0.344	0.646	0.344	0.388	9.149	2.417
2.73	2.73	430.13	0.959	0.0*	1-S2n	0.353	0.662	0.353	0.398	9.278	2.450
2.81	2.81	430.15	0.977	0.0*	1-S2n	0.358	0.671	0.358	0.404	9.370	2.472
2.89	2.89	430.16	0.995	0.0*	1-S2n	0.363	0.681	0.363	0.411	9.457	2.493
2.97	2.97	430.18	1.013	0.0*	1-S2n	0.369	0.690	0.377	0.417	9.211	2.514

* Full Flow Headwater elevation is below inlet invert.

****

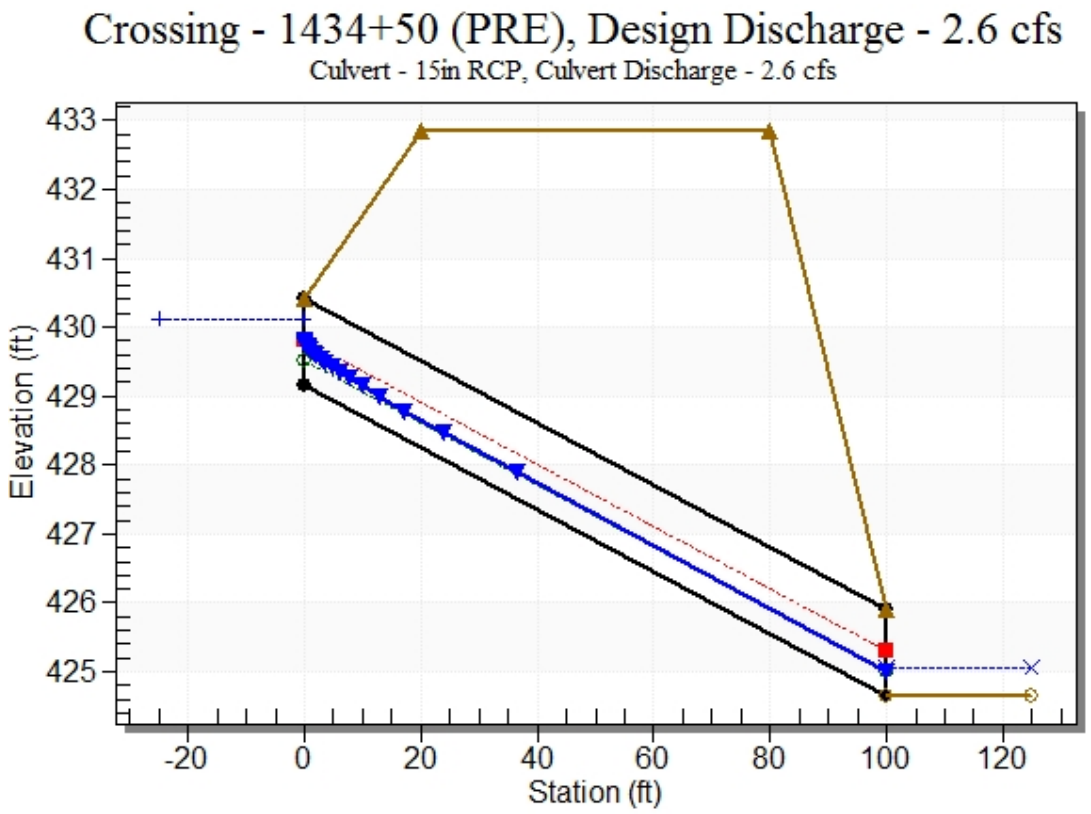
Straight Culvert

Inlet Elevation (invert): 429.17 ft, Outlet Elevation (invert): 424.66 ft

Culvert Length: 100.10 ft, Culvert Slope: 0.0451

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 429.17 ft

Outlet Station: 100.00 ft

Outlet Elevation: 424.66 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1434+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.16	425.01	0.35	2.29	1.09	0.76
2.24	425.02	0.36	2.31	1.11	0.77
2.32	425.02	0.36	2.34	1.14	0.77
2.40	425.03	0.37	2.36	1.16	0.77
2.48	425.04	0.38	2.38	1.18	0.77
2.57	425.04	0.38	2.41	1.20	0.77
2.60	425.05	0.39	2.42	1.21	0.77
2.73	425.06	0.40	2.45	1.24	0.78
2.81	425.06	0.40	2.47	1.26	0.78
2.89	425.07	0.41	2.49	1.28	0.78
2.97	425.08	0.42	2.51	1.30	0.78

Tailwater Channel Data - 1434+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 424.66 ft

Roadway Data for Crossing: 1434+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.86 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2 cfs

Design Flow: 2.41 cfs

Maximum Flow: 2.76 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1434+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
429.96	2.00	2.00	0.00	1
429.98	2.08	2.08	0.00	1
430.00	2.15	2.15	0.00	1
430.01	2.23	2.23	0.00	1
430.03	2.30	2.30	0.00	1
430.05	2.38	2.38	0.00	1
430.06	2.41	2.41	0.00	1
430.09	2.53	2.53	0.00	1
430.10	2.61	2.61	0.00	1
430.12	2.68	2.68	0.00	1
430.14	2.76	2.76	0.00	1
432.86	10.45	10.45	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.00	2.00	429.96	0.789	0.0*	1-S2n	0.301	0.563	0.301	0.335	8.560	2.232
2.08	2.08	429.98	0.808	0.0*	1-S2n	0.307	0.575	0.307	0.342	8.581	2.258
2.15	2.15	430.00	0.826	0.0*	1-S2n	0.313	0.586	0.313	0.349	8.676	2.282
2.23	2.23	430.01	0.845	0.0*	1-S2n	0.318	0.596	0.318	0.356	8.766	2.307
2.30	2.30	430.03	0.863	0.0*	1-S2n	0.324	0.607	0.324	0.363	8.863	2.330
2.38	2.38	430.05	0.881	0.0*	1-S2n	0.329	0.617	0.329	0.369	8.961	2.353
2.41	2.41	430.06	0.888	0.0*	1-S2n	0.331	0.621	0.331	0.372	8.999	2.362
2.53	2.53	430.09	0.916	0.0*	1-S2n	0.339	0.637	0.339	0.382	9.077	2.398
2.61	2.61	430.10	0.933	0.0*	1-S2n	0.345	0.647	0.345	0.388	9.157	2.419
2.68	2.68	430.12	0.950	0.0*	1-S2n	0.350	0.656	0.350	0.395	9.235	2.439
2.76	2.76	430.14	0.967	0.0*	1-S2n	0.355	0.666	0.355	0.401	9.316	2.459

* Full Flow Headwater elevation is below inlet invert.

****

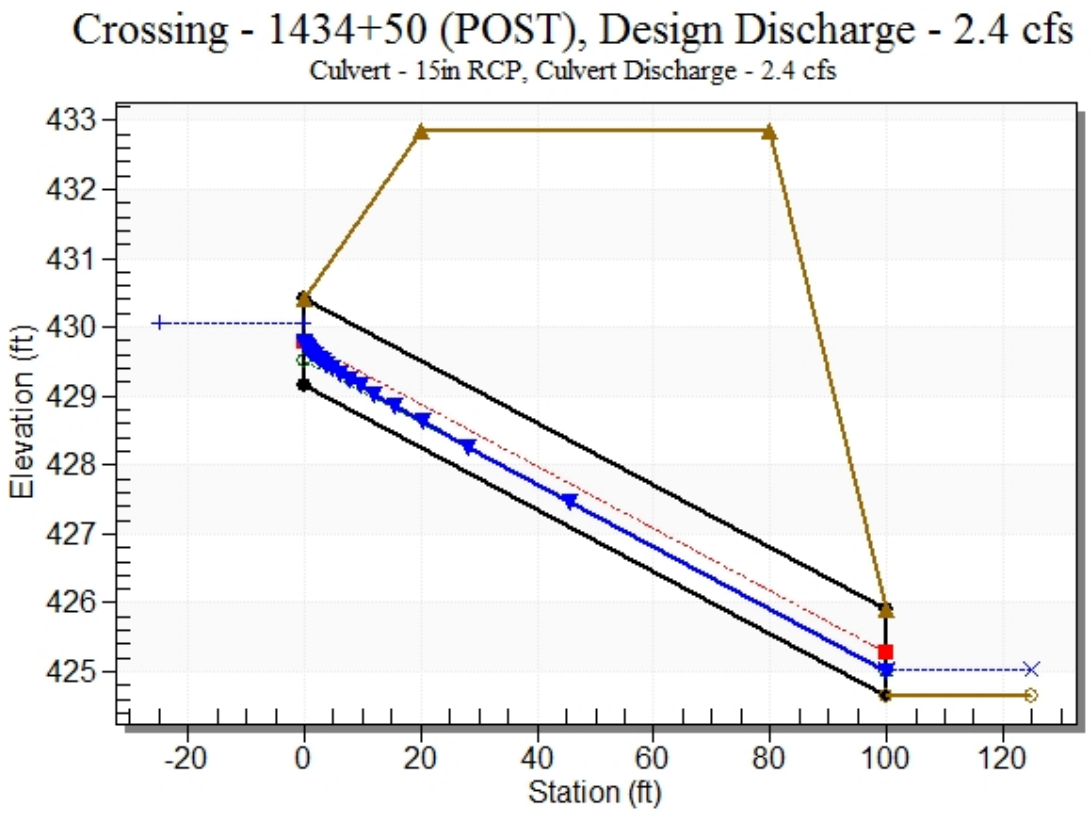
Straight Culvert

Inlet Elevation (invert): 429.17 ft, Outlet Elevation (invert): 424.66 ft

Culvert Length: 100.10 ft, Culvert Slope: 0.0451

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 429.17 ft

Outlet Station: 100.00 ft

Outlet Elevation: 424.66 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1434+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.00	425.00	0.34	2.23	1.05	0.76
2.08	425.00	0.34	2.26	1.07	0.76
2.15	425.01	0.35	2.28	1.09	0.76
2.23	425.02	0.36	2.31	1.11	0.77
2.30	425.02	0.36	2.33	1.13	0.77
2.38	425.03	0.37	2.35	1.15	0.77
2.41	425.03	0.37	2.36	1.16	0.77
2.53	425.04	0.38	2.40	1.19	0.77
2.61	425.05	0.39	2.42	1.21	0.77
2.68	425.05	0.39	2.44	1.23	0.77
2.76	425.06	0.40	2.46	1.25	0.78

Tailwater Channel Data - 1434+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 424.66 ft

Roadway Data for Crossing: 1434+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.86 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

CULVERT 158

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 158**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.45	2.2013
Grass	0.25	9.07	2.2670
Woods	0.15	19.43	2.9139
	Σ	**30.94**	7.3822

$C_{ave} = \frac{7.3822}{30.94} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.90	2.6135
Grass	0.25	8.83	2.2075
Woods	0.15	19.43	2.9139
	Σ	**31.16**	7.7349

$C_{ave} = \frac{7.7349}{31.16} = 0.25$

T_c =	32.46	min.								
I_{05} =	3.58	in / hr								
I_{10} =	3.97	in / hr								
I_{25} =	4.52	in / hr								
I_{50} =	4.93	in / hr								
I_{100} =	5.35	in / hr								

Pre Construction Runoff:

Q_{05} =	0.24	**x**	3.58	**x**	30.94	**x**	1	=	**26.45**	cfs
Q_{10} =	0.24	**x**	3.97	**x**	30.94	**x**	1	=	**29.28**	cfs
Q_{25} =	0.24	**x**	4.52	**x**	30.94	**x**	1.1	=	**36.69**	cfs
Q_{50} =	0.24	**x**	4.93	**x**	30.94	**x**	1.2	=	**43.67**	cfs
Q_{100} =	0.24	**x**	5.35	**x**	30.94	**x**	1.25	=	**49.37**	cfs

Post Construction Runoff:

Q_{05} =	0.25	**x**	3.58	**x**	31.16	**x**	1	=	**27.72**	cfs
Q_{10} =	0.25	**x**	3.97	**x**	31.16	**x**	1	=	**30.68**	cfs
Q_{25} =	0.25	**x**	4.52	**x**	31.16	**x**	1.1	=	**38.44**	cfs
Q_{50} =	0.25	**x**	4.93	**x**	31.16	**x**	1.2	=	**45.75**	cfs
Q_{100} =	0.25	**x**	5.35	**x**	31.16	**x**	1.25	=	**51.73**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 158	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**1275**				
9	Watercourse slope, s	----------	ft/ft	**0.0540**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.75**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.094**	+		=	**0.094**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.541**
							min	**32.46**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 36.69 cfs

Design Flow: 43.67 cfs

Maximum Flow: 49.37 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1437+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
403.34	36.69	36.69	0.00	1
403.40	37.96	37.96	0.00	1
403.47	39.23	39.23	0.00	1
403.53	40.49	40.49	0.00	1
403.60	41.76	41.76	0.00	1
403.67	43.03	43.03	0.00	1
403.71	43.67	43.67	0.00	1
403.81	45.57	45.57	0.00	1
403.89	46.83	46.83	0.00	1
403.96	48.10	48.10	0.00	1
404.04	49.37	49.37	0.00	1
425.00	179.40	179.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
36.69	36.69	403.34	2.876	0.0*	1-S2n	1.122	1.965	1.122	1.508	14.692	3.467
37.96	37.96	403.40	2.942	0.0*	1-S2n	1.143	2.000	1.143	1.535	14.814	3.499
39.23	39.23	403.47	3.007	0.0*	5-S2n	1.164	2.033	1.220	1.560	14.038	3.531
40.49	40.49	403.53	3.074	0.0*	5-S2n	1.184	2.070	1.230	1.586	14.333	3.561
41.76	41.76	403.60	3.142	0.0*	5-S2n	1.205	2.103	1.205	1.611	15.201	3.591
43.03	43.03	403.67	3.212	0.0*	5-S2n	1.225	2.134	1.225	1.635	15.320	3.620
43.67	43.67	403.71	3.247	0.0*	5-S2n	1.235	2.150	1.296	1.647	14.432	3.635
45.57	45.57	403.81	3.355	0.0*	5-S2n	1.264	2.196	1.323	1.683	14.656	3.676
46.83	46.83	403.89	3.428	0.0*	5-S2n	1.284	2.226	1.338	1.706	14.845	3.704
48.10	48.10	403.96	3.504	0.0*	5-S2n	1.304	2.256	1.304	1.729	15.777	3.730
49.37	49.37	404.04	3.581	0.0*	5-S2n	1.323	2.284	1.323	1.752	15.887	3.756

* Full Flow Headwater elevation is below inlet invert.

****

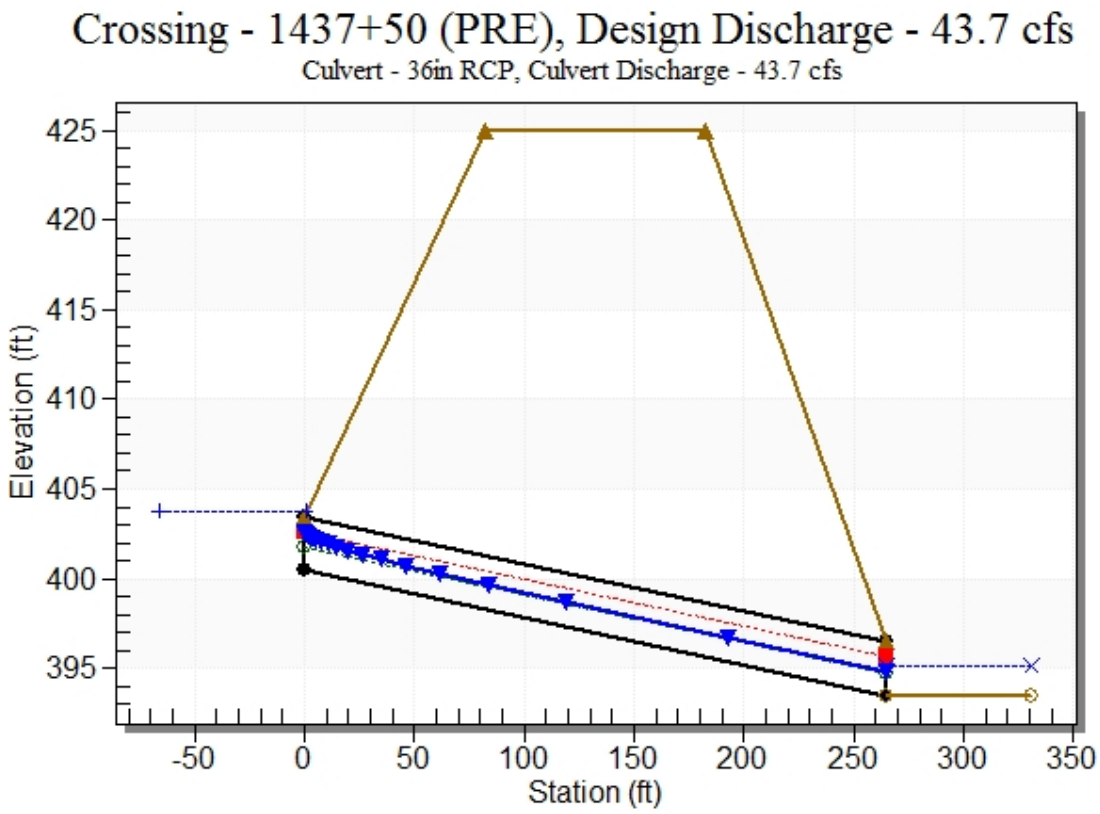
Straight Culvert

Inlet Elevation (invert): 400.46 ft, Outlet Elevation (invert): 393.50 ft

Culvert Length: 265.09 ft, Culvert Slope: 0.0263

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 400.46 ft

Outlet Station: 265.00 ft

Outlet Elevation: 393.50 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1437+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
36.69	395.01	1.51	3.47	1.88	0.59
37.96	395.03	1.53	3.50	1.92	0.60
39.23	395.06	1.56	3.53	1.95	0.60
40.49	395.09	1.59	3.56	1.98	0.60
41.76	395.11	1.61	3.59	2.01	0.60
43.03	395.13	1.63	3.62	2.04	0.60
43.67	395.15	1.65	3.63	2.06	0.60
45.57	395.18	1.68	3.68	2.10	0.60
46.83	395.21	1.71	3.70	2.13	0.60
48.10	395.23	1.73	3.73	2.16	0.60
49.37	395.25	1.75	3.76	2.19	0.61

Tailwater Channel Data - 1437+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 393.50 ft

Roadway Data for Crossing: 1437+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 425.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 38.44 cfs

Design Flow: 45.75 cfs

Maximum Flow: 51.73 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1437+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
403.43	38.44	38.44	0.00	1
403.50	39.77	39.77	0.00	1
403.57	41.10	41.10	0.00	1
403.64	42.43	42.43	0.00	1
403.71	43.76	43.76	0.00	1
403.79	45.08	45.08	0.00	1
403.83	45.75	45.75	0.00	1
403.94	47.74	47.74	0.00	1
404.02	49.07	49.07	0.00	1
404.10	50.40	50.40	0.00	1
404.19	51.73	51.73	0.00	1
425.00	179.40	179.40	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.44	38.44	403.43	2.966	0.0*	1-S2n	1.151	2.013	1.209	1.544	13.922	3.511
39.77	39.77	403.50	3.036	0.0*	5-S2n	1.173	2.051	1.224	1.571	14.176	3.544
41.10	41.10	403.57	3.107	0.0*	5-S2n	1.194	2.086	1.194	1.598	15.144	3.575
42.43	42.43	403.64	3.179	0.0*	5-S2n	1.215	2.119	1.215	1.623	15.264	3.606
43.76	43.76	403.71	3.252	0.0*	5-S2n	1.236	2.152	1.297	1.649	14.440	3.637
45.08	45.08	403.79	3.327	0.0*	5-S2n	1.257	2.185	1.317	1.674	14.591	3.666
45.75	45.75	403.83	3.365	0.0*	5-S2n	1.267	2.201	1.326	1.686	14.682	3.680
47.74	47.74	403.94	3.482	0.0*	5-S2n	1.298	2.247	1.348	1.723	14.990	3.723
49.07	49.07	404.02	3.562	0.0*	5-S2n	1.318	2.278	1.318	1.746	15.861	3.750
50.40	50.40	404.10	3.645	0.0*	5-S2n	1.338	2.307	1.404	1.770	15.011	3.777
51.73	51.73	404.19	3.729	0.0*	5-S2n	1.358	2.336	1.426	1.793	15.101	3.803

* Full Flow Headwater elevation is below inlet invert.

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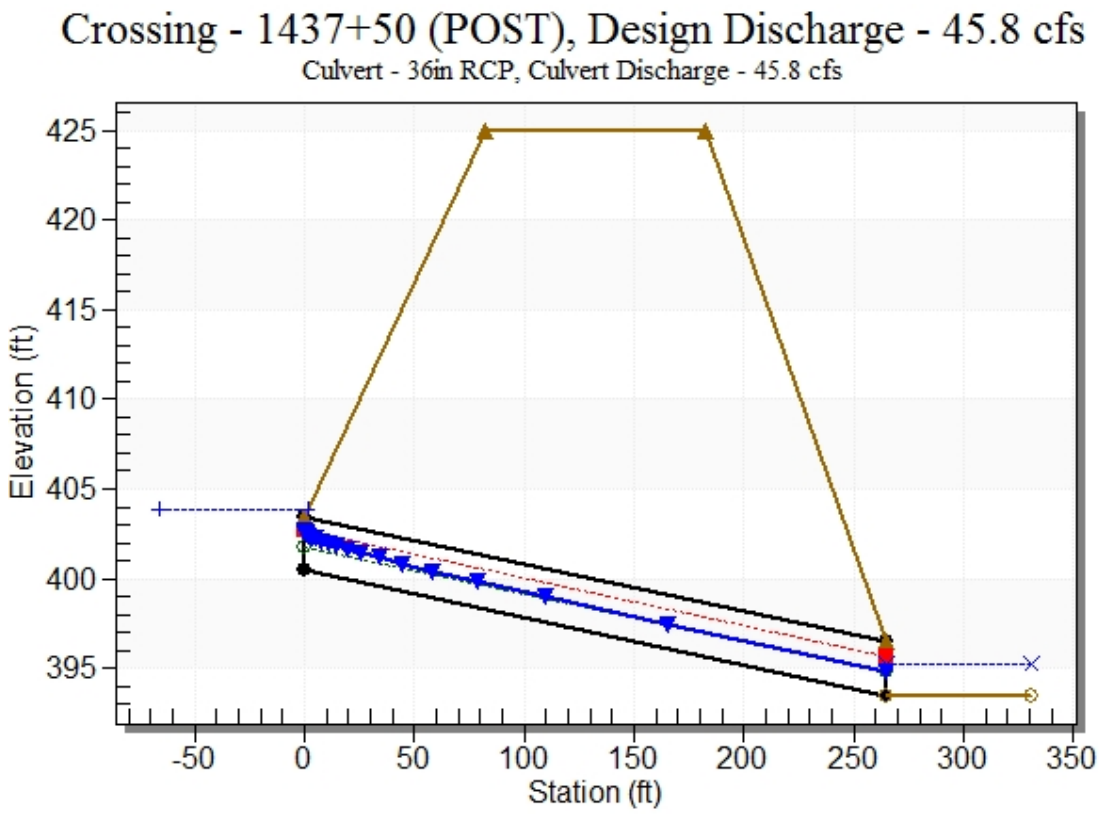
Straight Culvert

Inlet Elevation (invert): 400.46 ft, Outlet Elevation (invert): 393.50 ft

Culvert Length: 265.09 ft, Culvert Slope: 0.0263

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 400.46 ft

Outlet Station: 265.00 ft

Outlet Elevation: 393.50 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1437+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
38.44	395.04	1.54	3.51	1.93	0.60
39.77	395.07	1.57	3.54	1.96	0.60
41.10	395.10	1.60	3.58	1.99	0.60
42.43	395.12	1.62	3.61	2.03	0.60
43.76	395.15	1.65	3.64	2.06	0.60
45.08	395.17	1.67	3.67	2.09	0.60
45.75	395.19	1.69	3.68	2.10	0.60
47.74	395.22	1.72	3.72	2.15	0.60
49.07	395.25	1.75	3.75	2.18	0.61
50.40	395.27	1.77	3.78	2.21	0.61
51.73	395.29	1.79	3.80	2.24	0.61

Tailwater Channel Data - 1437+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 393.50 ft

Roadway Data for Crossing: 1437+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 425.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 159

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 159**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4312
Grass	0.25	0.65	0.1633
Woods	0.15	0.00	0.0000
	Σ	**1.13**	0.5944

$C_{ave} = \frac{0.5944}{1.13} = 0.53$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.61	0.5482
Grass	0.25	0.65	0.1633
Woods	0.15	0.00	0.0000
	Σ	**1.26**	0.7114

$C_{ave} = \frac{0.7114}{1.26} = 0.56$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.53	x	6.23	x	1.13	x	1	=	**3.70**	cfs
Q_{10} =	0.53	x	6.98	x	1.13	x	1	=	**4.15**	cfs
Q_{25} =	0.53	x	8.08	x	1.13	x	1.1	=	**5.29**	cfs
Q_{50} =	0.53	x	8.93	x	1.13	x	1.2	=	**6.37**	cfs
Q_{100} =	0.53	x	9.81	x	1.13	x	1.25	=	**7.29**	cfs

Post Construction Runoff:

Q_{05} =	0.56	x	6.23	x	1.26	x	1	=	**4.43**	cfs
Q_{10} =	0.56	x	6.98	x	1.26	x	1	=	**4.96**	cfs
Q_{25} =	0.56	x	8.08	x	1.26	x	1.1	=	**6.33**	cfs
Q_{50} =	0.56	x	8.93	x	1.26	x	1.2	=	**7.62**	cfs
Q_{100} =	0.56	x	9.81	x	1.26	x	1.25	=	**8.72**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.29 cfs

Design Flow: 6.37 cfs

Maximum Flow: 7.29 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1440+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
411.60	5.29	5.29	0.00	1
411.65	5.49	5.49	0.00	1
411.71	5.69	5.69	0.00	1
411.77	5.89	5.89	0.00	1
411.83	6.09	6.09	0.00	1
411.90	6.29	6.29	0.00	1
411.92	6.37	6.37	0.00	1
412.03	6.69	6.69	0.00	1
412.10	6.89	6.89	0.00	1
412.17	7.09	7.09	0.00	1
412.25	7.29	7.29	0.00	1
413.45	9.92	9.92	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.29	5.29	411.60	1.519	0.0*	5-S2n	0.407	0.929	0.407	0.472	14.729	3.802
5.49	5.49	411.65	1.574	0.0*	5-S2n	0.416	0.946	0.416	0.482	14.885	3.843
5.69	5.69	411.71	1.631	0.0*	5-S2n	0.423	0.962	0.423	0.491	15.051	3.883
5.89	5.89	411.77	1.690	0.0*	5-S2n	0.431	0.978	0.453	0.500	14.183	3.922
6.09	6.09	411.83	1.752	0.0*	5-S2n	0.439	0.994	0.439	0.509	15.308	3.960
6.29	6.29	411.90	1.815	0.0*	5-S2n	0.447	1.008	0.447	0.518	15.447	3.997
6.37	6.37	411.92	1.841	0.0*	5-S2n	0.450	1.014	0.450	0.522	15.503	4.011
6.69	6.69	412.03	1.949	0.0*	5-S2n	0.462	1.037	0.462	0.536	15.734	4.067
6.89	6.89	412.10	2.020	0.0*	5-S2n	0.469	1.050	0.469	0.544	15.827	4.101
7.09	7.09	412.17	2.092	0.0*	5-S2n	0.476	1.063	0.476	0.552	15.953	4.135
7.29	7.29	412.25	2.168	0.0*	5-S2n	0.484	1.075	0.525	0.560	14.439	4.167

* Full Flow Headwater elevation is below inlet invert.

****

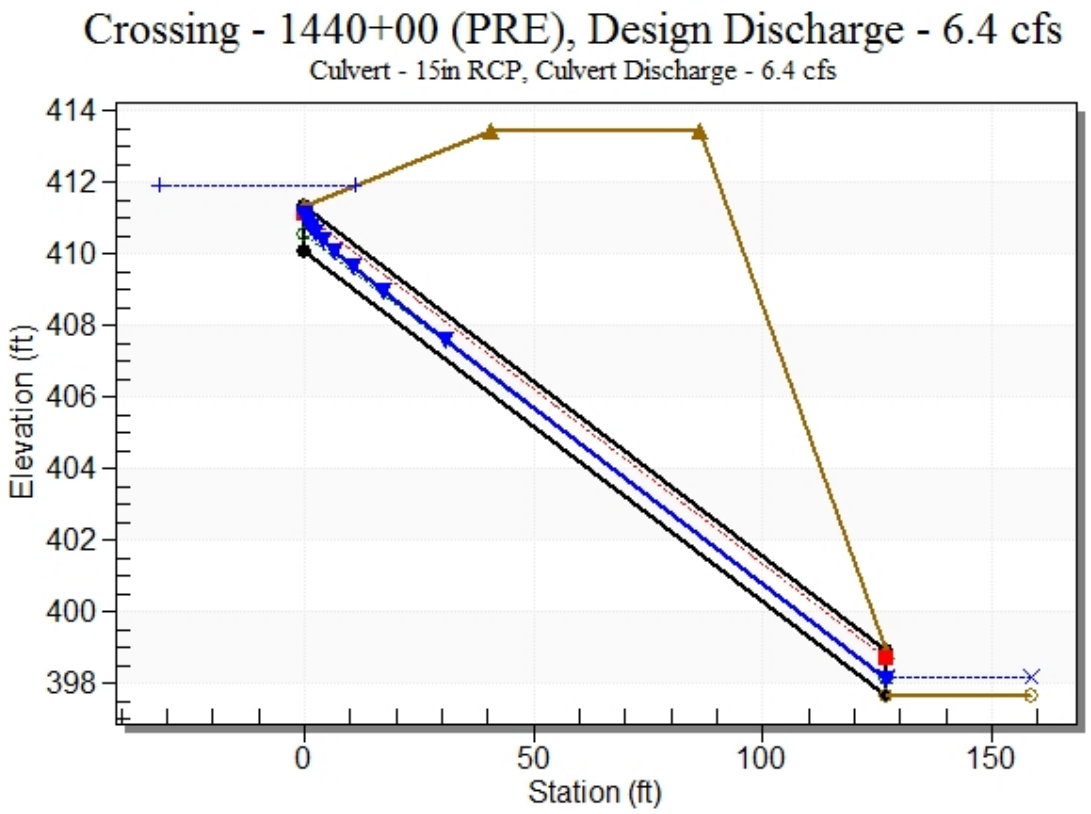
Straight Culvert

Inlet Elevation (invert): 410.08 ft, Outlet Elevation (invert): 397.68 ft

Culvert Length: 127.60 ft, Culvert Slope: 0.0976

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 410.08 ft

Outlet Station: 127.00 ft

Outlet Elevation: 397.68 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1440+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.29	398.15	0.47	3.80	2.95	1.12
5.49	398.16	0.48	3.84	3.01	1.12
5.69	398.17	0.49	3.88	3.07	1.13
5.89	398.18	0.50	3.92	3.12	1.13
6.09	398.19	0.51	3.96	3.18	1.13
6.29	398.20	0.52	4.00	3.23	1.13
6.37	398.20	0.52	4.01	3.26	1.13
6.69	398.22	0.54	4.07	3.34	1.14
6.89	398.22	0.54	4.10	3.39	1.14
7.09	398.23	0.55	4.14	3.45	1.14
7.29	398.24	0.56	4.17	3.50	1.14

Tailwater Channel Data - 1440+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 397.68 ft

Roadway Data for Crossing: 1440+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 413.45 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.33 cfs

Design Flow: 7.62 cfs

Maximum Flow: 8.72 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1440+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
411.91	6.33	6.33	0.00	1
411.99	6.57	6.57	0.00	1
412.07	6.81	6.81	0.00	1
412.16	7.05	7.05	0.00	1
412.25	7.29	7.29	0.00	1
412.34	7.53	7.53	0.00	1
412.38	7.62	7.62	0.00	1
412.54	8.00	8.00	0.00	1
412.64	8.24	8.24	0.00	1
412.74	8.48	8.48	0.00	1
412.85	8.72	8.72	0.00	1
413.45	9.92	9.92	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.33	6.33	411.91	1.828	0.0*	5-S2n	0.448	1.011	0.448	0.520	15.474	4.003
6.57	6.57	411.99	1.908	0.0*	5-S2n	0.457	1.028	0.457	0.530	15.648	4.046
6.81	6.81	412.07	1.990	0.0*	5-S2n	0.466	1.045	0.466	0.541	15.815	4.088
7.05	7.05	412.16	2.077	0.0*	5-S2n	0.475	1.060	0.475	0.551	15.926	4.127
7.29	7.29	412.25	2.166	0.0*	5-S2n	0.484	1.075	0.525	0.560	14.430	4.167
7.53	7.53	412.34	2.259	0.0*	5-S2n	0.492	1.089	0.524	0.570	14.941	4.205
7.62	7.62	412.38	2.297	0.0*	5-S2n	0.496	1.095	0.523	0.574	15.137	4.220
8.00	8.00	412.54	2.455	0.0*	5-S2n	0.509	1.115	0.525	0.589	15.841	4.279
8.24	8.24	412.64	2.558	0.0*	5-S2n	0.518	1.126	0.528	0.598	16.179	4.314
8.48	8.48	412.74	2.664	0.0*	5-S2n	0.526	1.136	0.526	0.607	16.745	4.348
8.72	8.72	412.85	2.774	0.0*	5-S2n	0.534	1.146	0.534	0.616	16.849	4.383

* Full Flow Headwater elevation is below inlet invert.

****

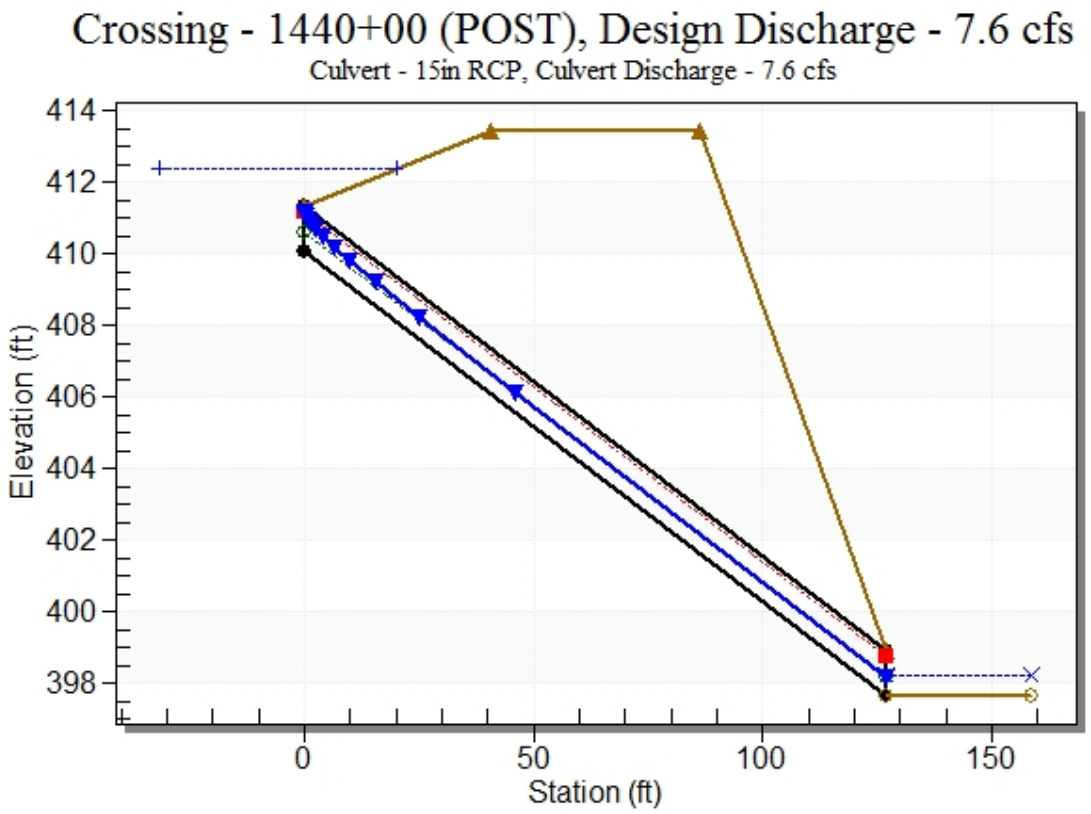
Straight Culvert

Inlet Elevation (invert): 410.08 ft, Outlet Elevation (invert): 397.68 ft

Culvert Length: 127.60 ft, Culvert Slope: 0.0976

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 410.08 ft

Outlet Station: 127.00 ft

Outlet Elevation: 397.68 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1440+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.33	398.20	0.52	4.00	3.25	1.13
6.57	398.21	0.53	4.05	3.31	1.14
6.81	398.22	0.54	4.09	3.37	1.14
7.05	398.23	0.55	4.13	3.44	1.14
7.29	398.24	0.56	4.17	3.50	1.14
7.53	398.25	0.57	4.21	3.56	1.15
7.62	398.25	0.57	4.22	3.58	1.15
8.00	398.27	0.59	4.28	3.67	1.15
8.24	398.28	0.60	4.31	3.73	1.15
8.48	398.29	0.61	4.35	3.79	1.15
8.72	398.30	0.62	4.38	3.84	1.16

Tailwater Channel Data - 1440+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 397.68 ft

Roadway Data for Crossing: 1440+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 413.45 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 160

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 160, South_Carolina
User:
Date: Sunday, December 17, 2017 09:54 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 160
   Basin Drainage Area: 2.03 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 2.03 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

Results for: Site 160

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	251	144	437	35
PK5	460	266	795	34
PK10	616	351	1080	35
PK25	825	453	1500	38
PK50	1010	538	1900	40
PK100	1180	608	2300	42
PK200	1350	672	2720	44
PK500	1620	766	3420	48

maximum: 9110 (for C&B region 2)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 825 cfs

Design Flow: 1010 cfs

Maximum Flow: 1180 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1447+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	(2) 8x8 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
389.78	825.00	825.00	0.00	1
389.98	860.50	860.50	0.00	1
390.16	896.00	896.00	0.00	1
390.35	931.50	931.50	0.00	1
390.53	967.00	967.00	0.00	1
390.71	1002.50	1002.50	0.00	1
390.75	1010.00	1010.00	0.00	1
391.07	1073.50	1073.50	0.00	1
391.25	1109.00	1109.00	0.00	1
391.43	1144.50	1144.50	0.00	1
391.61	1180.00	1180.00	0.00	1
400.00	2521.49	2521.49	0.00	Overtopping

Table 2 - Culvert Summary Table: (2) 8x8 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
825.00	825.00	389.78	6.755	4.767	1-S2n	3.111	4.354	3.403	5.341	15.152	5.789
860.50	860.50	389.98	6.945	4.971	1-S2n	3.208	4.479	3.513	5.459	15.307	5.856
896.00	896.00	390.16	7.133	5.176	1-S2n	3.305	4.601	3.622	5.574	15.463	5.922
931.50	931.50	390.35	7.318	5.383	1-S2n	3.400	4.722	3.728	5.686	15.618	5.985
967.00	967.00	390.53	7.502	5.590	1-S2n	3.496	4.841	3.834	5.796	15.763	6.047
1002.50	1002.50	390.71	7.684	5.799	1-S2n	3.590	4.959	3.940	5.904	15.902	6.107
1010.00	1010.00	390.75	7.722	5.844	1-S2n	3.610	4.983	3.962	5.926	15.931	6.119
1073.50	1073.50	391.07	8.045	6.222	5-S2n	3.778	5.190	4.148	6.113	16.176	6.222
1109.00	1109.00	391.25	8.224	6.436	5-S2n	3.871	5.304	4.251	6.215	16.307	6.277
1144.50	1144.50	391.43	8.403	6.652	5-S2n	3.964	5.416	4.354	6.315	16.431	6.331
1180.00	1180.00	391.61	8.581	6.870	5-S2n	4.056	5.528	4.455	6.413	16.553	6.383

****

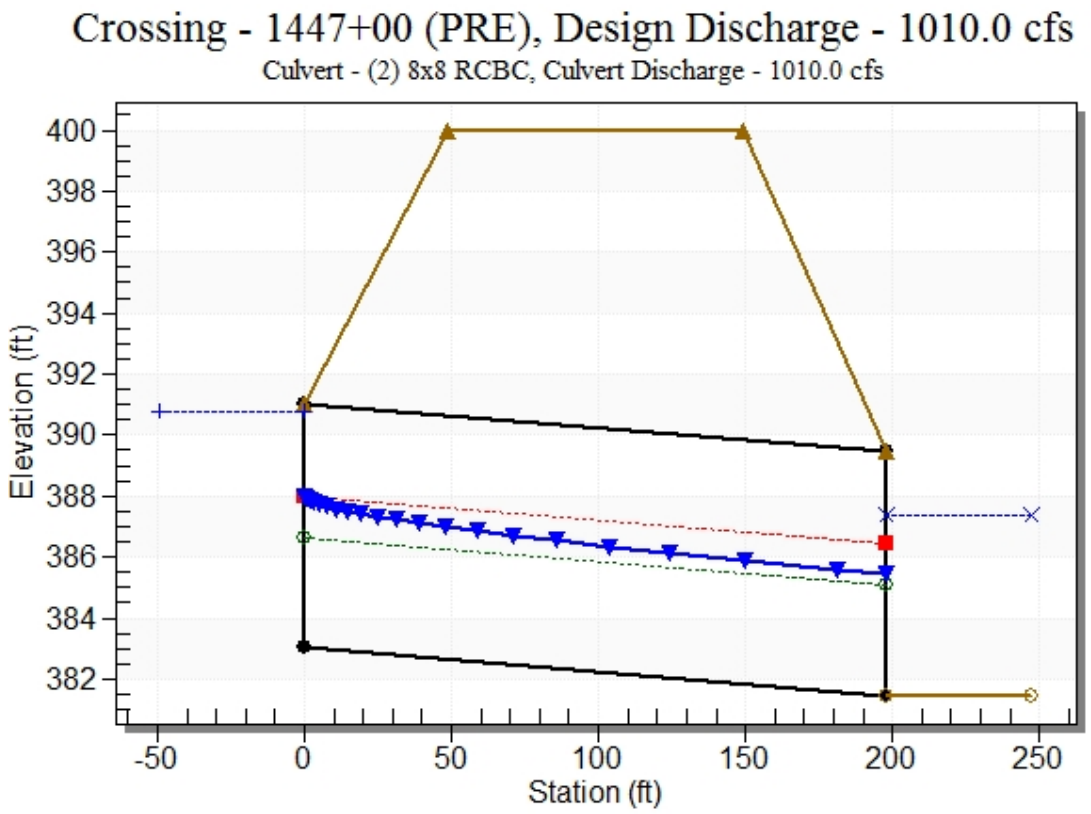
Straight Culvert

Inlet Elevation (invert): 383.03 ft, Outlet Elevation (invert): 381.47 ft

Culvert Length: 198.01 ft, Culvert Slope: 0.0079

****

Water Surface Profile Plot for Culvert: (2) 8x8 RCBC



Site Data - (2) 8x8 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 383.03 ft

Outlet Station: 198.00 ft

Outlet Elevation: 381.47 ft

Number of Barrels: 2

Culvert Data Summary - (2) 8x8 RCBC

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 8.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1447+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
825.00	386.81	5.34	5.79	3.33	0.52
860.50	386.93	5.46	5.86	3.41	0.52
896.00	387.04	5.57	5.92	3.48	0.52
931.50	387.16	5.69	5.99	3.55	0.53
967.00	387.27	5.80	6.05	3.62	0.53
1002.50	387.37	5.90	6.11	3.68	0.53
1010.00	387.40	5.93	6.12	3.70	0.53
1073.50	387.58	6.11	6.22	3.81	0.53
1109.00	387.68	6.21	6.28	3.88	0.53
1144.50	387.78	6.31	6.33	3.94	0.53
1180.00	387.88	6.41	6.38	4.00	0.53

Tailwater Channel Data - 1447+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 16.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 381.47 ft

Roadway Data for Crossing: 1447+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 400.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 825 cfs

Design Flow: 1010 cfs

Maximum Flow: 1180 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1447+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	(2) 8x8 RCBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
389.78	825.00	825.00	0.00	1
389.98	860.50	860.50	0.00	1
390.16	896.00	896.00	0.00	1
390.35	931.50	931.50	0.00	1
390.53	967.00	967.00	0.00	1
390.71	1002.50	1002.50	0.00	1
390.75	1010.00	1010.00	0.00	1
391.07	1073.50	1073.50	0.00	1
391.25	1109.00	1109.00	0.00	1
391.43	1144.50	1144.50	0.00	1
391.61	1180.00	1180.00	0.00	1
400.00	2521.49	2521.49	0.00	Overtopping

Table 2 - Culvert Summary Table: (2) 8x8 RCBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
825.00	825.00	389.78	6.755	4.767	1-S2n	3.111	4.354	3.403	5.341	15.152	5.789
860.50	860.50	389.98	6.945	4.971	1-S2n	3.208	4.479	3.513	5.459	15.307	5.856
896.00	896.00	390.16	7.133	5.176	1-S2n	3.305	4.601	3.622	5.574	15.463	5.922
931.50	931.50	390.35	7.318	5.383	1-S2n	3.400	4.722	3.728	5.686	15.618	5.985
967.00	967.00	390.53	7.502	5.590	1-S2n	3.496	4.841	3.834	5.796	15.763	6.047
1002.50	1002.50	390.71	7.684	5.799	1-S2n	3.590	4.959	3.940	5.904	15.902	6.107
1010.00	1010.00	390.75	7.722	5.844	1-S2n	3.610	4.983	3.962	5.926	15.931	6.119
1073.50	1073.50	391.07	8.045	6.222	5-S2n	3.778	5.190	4.148	6.113	16.176	6.222
1109.00	1109.00	391.25	8.224	6.436	5-S2n	3.871	5.304	4.251	6.215	16.307	6.277
1144.50	1144.50	391.43	8.403	6.652	5-S2n	3.964	5.416	4.354	6.315	16.431	6.331
1180.00	1180.00	391.61	8.581	6.870	5-S2n	4.056	5.528	4.455	6.413	16.553	6.383

****

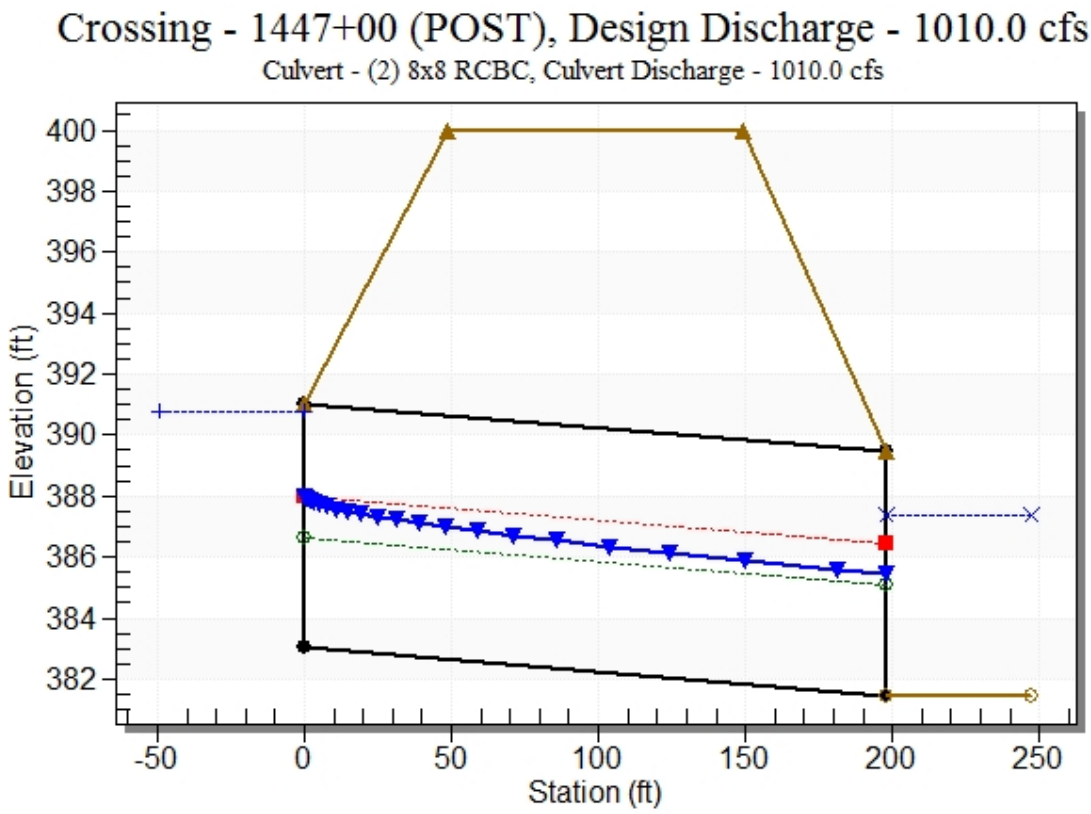
Straight Culvert

Inlet Elevation (invert): 383.03 ft, Outlet Elevation (invert): 381.47 ft

Culvert Length: 198.01 ft, Culvert Slope: 0.0079

****

Water Surface Profile Plot for Culvert: (2) 8x8 RCBC



Site Data - (2) 8x8 RCBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 383.03 ft

Outlet Station: 198.00 ft

Outlet Elevation: 381.47 ft

Number of Barrels: 2

Culvert Data Summary - (2) 8x8 RCBC

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 8.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1447+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
825.00	386.81	5.34	5.79	3.33	0.52
860.50	386.93	5.46	5.86	3.41	0.52
896.00	387.04	5.57	5.92	3.48	0.52
931.50	387.16	5.69	5.99	3.55	0.53
967.00	387.27	5.80	6.05	3.62	0.53
1002.50	387.37	5.90	6.11	3.68	0.53
1010.00	387.40	5.93	6.12	3.70	0.53
1073.50	387.58	6.11	6.22	3.81	0.53
1109.00	387.68	6.21	6.28	3.88	0.53
1144.50	387.78	6.31	6.33	3.94	0.53
1180.00	387.88	6.41	6.38	4.00	0.53

Tailwater Channel Data - 1447+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 16.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0600

Channel Invert Elevation: 381.47 ft

Roadway Data for Crossing: 1447+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 400.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 161

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 161**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.29	0.2622
Grass	0.25	0.33	0.0836
Woods	0.15	0.00	0.0000
	Σ	**0.63**	0.3458

$C_{ave} = \frac{0.3458}{0.63} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.36	0.3240
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.36**	0.3240

$C_{ave} = \frac{0.3240}{0.36} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.55	x	6.23	x	0.63	x	1	=	**2.15**	cfs
Q_{10} =	0.55	x	6.98	x	0.63	x	1	=	**2.41**	cfs
Q_{25} =	0.55	x	8.08	x	0.63	x	1.1	=	**3.07**	cfs
Q_{50} =	0.55	x	8.93	x	0.63	x	1.2	=	**3.70**	cfs
Q_{100} =	0.55	x	9.81	x	0.63	x	1.25	=	**4.24**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.36	x	1	=	**2.02**	cfs
Q_{10} =	0.90	x	6.98	x	0.36	x	1	=	**2.26**	cfs
Q_{25} =	0.90	x	8.08	x	0.36	x	1.1	=	**2.88**	cfs
Q_{50} =	0.90	x	8.93	x	0.36	x	1.2	=	**3.47**	cfs
Q_{100} =	0.90	x	9.81	x	0.36	x	1.25	=	**3.97**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.07 cfs

Design Flow: 3.7 cfs

Maximum Flow: 4.24 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1451+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
399.41	3.07	3.07	0.00	1
399.43	3.19	3.19	0.00	1
399.46	3.30	3.30	0.00	1
399.48	3.42	3.42	0.00	1
399.51	3.54	3.54	0.00	1
399.53	3.66	3.66	0.00	1
399.54	3.70	3.70	0.00	1
399.58	3.89	3.89	0.00	1
399.61	4.01	4.01	0.00	1
399.64	4.12	4.12	0.00	1
399.66	4.24	4.24	0.00	1
401.68	9.73	9.73	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.07	3.07	399.41	1.027	0.0*	1-S2n	0.353	0.702	0.353	0.451	10.435	2.346
3.19	3.19	399.43	1.052	0.0*	1-S2n	0.360	0.715	0.360	0.460	10.566	2.371
3.30	3.30	399.46	1.077	0.0*	1-S2n	0.367	0.728	0.367	0.469	10.690	2.396
3.42	3.42	399.48	1.103	0.0*	1-S2n	0.373	0.744	0.373	0.478	10.744	2.421
3.54	3.54	399.51	1.128	0.0*	1-S2n	0.380	0.757	0.380	0.487	10.850	2.444
3.66	3.66	399.53	1.153	0.0*	1-S2n	0.387	0.769	0.387	0.495	10.955	2.467
3.70	3.70	399.54	1.163	0.0*	1-S2n	0.389	0.774	0.389	0.499	10.999	2.476
3.89	3.89	399.58	1.205	0.0*	1-S2n	0.399	0.793	0.399	0.512	11.174	2.511
4.01	4.01	399.61	1.231	0.0*	1-S2n	0.405	0.805	0.423	0.520	10.605	2.532
4.12	4.12	399.64	1.257	0.0*	5-S2n	0.412	0.817	0.412	0.528	11.317	2.553
4.24	4.24	399.66	1.284	0.0*	5-S2n	0.418	0.828	0.418	0.536	11.409	2.574

* Full Flow Headwater elevation is below inlet invert.

****

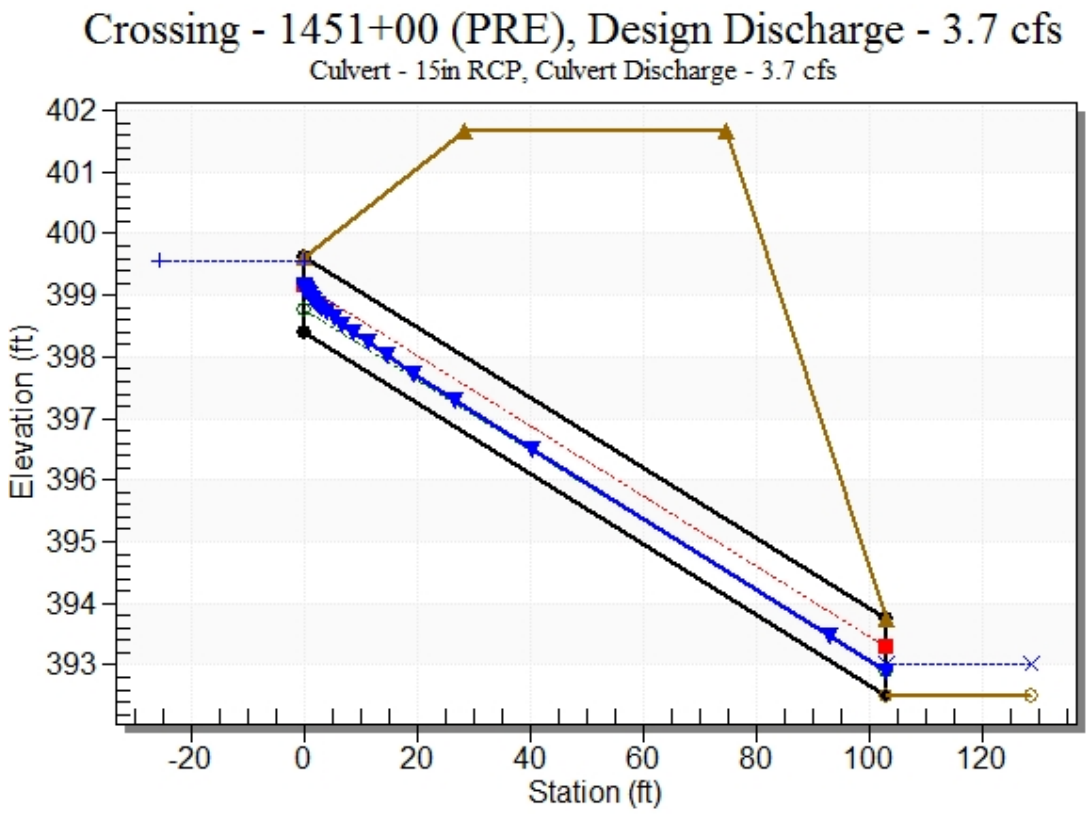
Straight Culvert

Inlet Elevation (invert): 398.38 ft, Outlet Elevation (invert): 392.51 ft

Culvert Length: 103.17 ft, Culvert Slope: 0.0570

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 398.38 ft

Outlet Station: 103.00 ft

Outlet Elevation: 392.51 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1451+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.07	392.96	0.45	2.35	1.13	0.70
3.19	392.97	0.46	2.37	1.15	0.71
3.30	392.98	0.47	2.40	1.17	0.71
3.42	392.99	0.48	2.42	1.19	0.71
3.54	393.00	0.49	2.44	1.22	0.71
3.66	393.01	0.50	2.47	1.24	0.71
3.70	393.01	0.50	2.48	1.24	0.71
3.89	393.02	0.51	2.51	1.28	0.72
4.01	393.03	0.52	2.53	1.30	0.72
4.12	393.04	0.53	2.55	1.32	0.72
4.24	393.05	0.54	2.57	1.34	0.72

Tailwater Channel Data - 1451+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 392.51 ft

Roadway Data for Crossing: 1451+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 401.68 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.88 cfs

Design Flow: 3.47 cfs

Maximum Flow: 3.97 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1451+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
399.37	2.88	2.88	0.00	1
399.39	2.99	2.99	0.00	1
399.41	3.10	3.10	0.00	1
399.44	3.21	3.21	0.00	1
399.46	3.32	3.32	0.00	1
399.48	3.42	3.42	0.00	1
399.49	3.47	3.47	0.00	1
399.53	3.64	3.64	0.00	1
399.55	3.75	3.75	0.00	1
399.58	3.86	3.86	0.00	1
399.60	3.97	3.97	0.00	1
401.68	9.74	9.74	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.88	2.88	399.37	0.986	0.0*	1-S2n	0.342	0.680	0.342	0.436	10.239	2.302
2.99	2.99	399.39	1.009	0.0*	1-S2n	0.348	0.693	0.348	0.445	10.353	2.327
3.10	3.10	399.41	1.033	0.0*	1-S2n	0.355	0.705	0.355	0.453	10.467	2.352
3.21	3.21	399.44	1.057	0.0*	1-S2n	0.361	0.717	0.361	0.462	10.588	2.376
3.32	3.32	399.46	1.080	0.0*	1-S2n	0.367	0.729	0.367	0.470	10.703	2.399
3.42	3.42	399.48	1.104	0.0*	1-S2n	0.374	0.744	0.374	0.478	10.748	2.421
3.47	3.47	399.49	1.113	0.0*	1-S2n	0.376	0.749	0.376	0.482	10.789	2.430
3.64	3.64	399.53	1.151	0.0*	1-S2n	0.386	0.768	0.386	0.495	10.944	2.465
3.75	3.75	399.55	1.175	0.0*	1-S2n	0.392	0.779	0.392	0.502	11.048	2.486
3.86	3.86	399.58	1.198	0.0*	1-S2n	0.398	0.791	0.413	0.510	10.543	2.506
3.97	3.97	399.60	1.223	0.0*	1-S2n	0.403	0.802	0.403	0.518	11.195	2.526

* Full Flow Headwater elevation is below inlet invert.

****

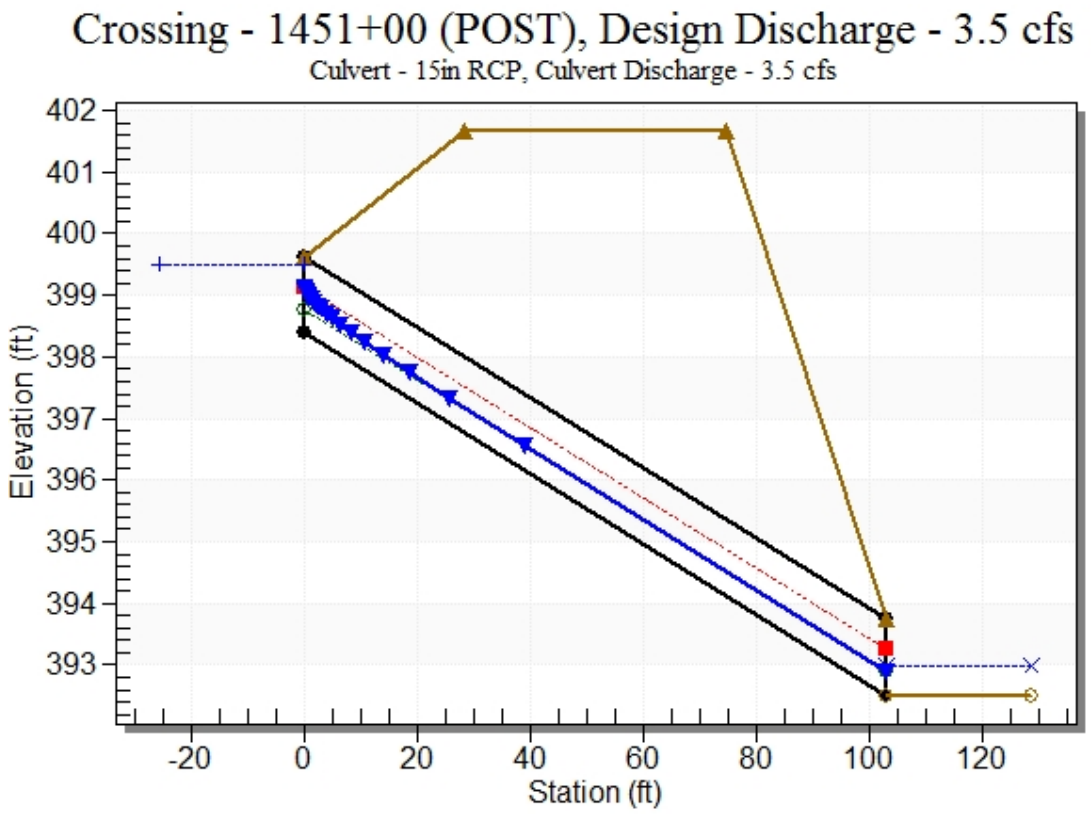
Straight Culvert

Inlet Elevation (invert): 398.38 ft, Outlet Elevation (invert): 392.51 ft

Culvert Length: 103.17 ft, Culvert Slope: 0.0570

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 398.38 ft

Outlet Station: 103.00 ft

Outlet Elevation: 392.51 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1451+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.88	392.95	0.44	2.30	1.09	0.70
2.99	392.95	0.44	2.33	1.11	0.70
3.10	392.96	0.45	2.35	1.13	0.71
3.21	392.97	0.46	2.38	1.15	0.71
3.32	392.98	0.47	2.40	1.17	0.71
3.42	392.99	0.48	2.42	1.19	0.71
3.47	392.99	0.48	2.43	1.20	0.71
3.64	393.00	0.49	2.46	1.23	0.71
3.75	393.01	0.50	2.49	1.25	0.71
3.86	393.02	0.51	2.51	1.27	0.72
3.97	393.03	0.52	2.53	1.29	0.72

Tailwater Channel Data - 1451+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 392.51 ft

Roadway Data for Crossing: 1451+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 401.68 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 162

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 162**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.00	2.6983
Grass	0.25	30.95	7.7383
Woods	0.15	11.41	1.7110
	Σ	**45.36**	12.1476

$C_{ave} = \frac{12.1476}{45.36} = 0.27$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.00	2.6983
Grass	0.25	30.95	7.7383
Woods	0.15	11.41	1.7110
	Σ	**45.36**	12.1476

$C_{ave} = \frac{12.1476}{45.36} = 0.27$

T_c =	48.49	min.
I_{05} =	2.87	in / hr
I_{10} =	3.17	in / hr
I_{25} =	3.59	in / hr
I_{50} =	3.91	in / hr
I_{100} =	4.23	in / hr

Pre Construction Runoff:

Q_{05} =	0.27	x	2.87	x	45.36	x	1	=	**34.83**	cfs
Q_{10} =	0.27	x	3.17	x	45.36	x	1	=	**38.45**	cfs
Q_{25} =	0.27	x	3.59	x	45.36	x	1.1	=	**48.02**	cfs
Q_{50} =	0.27	x	3.91	x	45.36	x	1.2	=	**57.01**	cfs
Q_{100} =	0.27	x	4.23	x	45.36	x	1.25	=	**64.30**	cfs

Post Construction Runoff:

Q_{05} =	0.27	x	2.87	x	45.36	x	1	=	**34.83**	cfs
Q_{10} =	0.27	x	3.17	x	45.36	x	1	=	**38.45**	cfs
Q_{25} =	0.27	x	3.59	x	45.36	x	1.1	=	**48.02**	cfs
Q_{50} =	0.27	x	3.91	x	45.36	x	1.2	=	**57.01**	cfs
Q_{100} =	0.27	x	4.23	x	45.36	x	1.25	=	**64.30**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 162	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**1930**				
9	Watercourse slope, s		ft/ft	**0.0230**				
10	Average velocity, V (figure 3-1)		ft/s	**2.45**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.219**	+		=	**0.219**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.808**
							min	**48.49**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 48.02 cfs

Design Flow: 57.01 cfs

Maximum Flow: 64.3 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1456+00 (PRE) 162

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
406.23	48.02	31.08	16.82	10
406.25	49.65	31.15	18.40	3
406.26	51.28	31.21	19.98	3
406.28	52.90	31.28	21.55	3
406.29	54.53	31.34	23.13	3
406.30	56.16	31.41	24.70	3
406.31	57.01	31.44	25.54	3
406.33	59.42	31.53	27.84	3
406.34	61.04	31.58	29.43	3
406.35	62.67	31.64	31.00	3
406.36	64.30	31.70	32.58	3
406.00	29.90	29.90	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
48.02	31.08	406.23	4.454	2.629	5-S2n	1.150	1.876	1.338	1.450	13.516	4.800
49.65	31.15	406.25	4.468	2.642	5-S2n	1.152	1.877	1.340	1.475	13.523	4.845
51.28	31.21	406.26	4.482	2.654	5-S2n	1.153	1.878	1.342	1.499	13.530	4.887
52.90	31.28	406.28	4.495	2.666	5-S2n	1.155	1.878	1.344	1.523	13.537	4.929
54.53	31.34	406.29	4.508	2.677	5-S2n	1.156	1.879	1.346	1.547	13.544	4.970
56.16	31.41	406.30	4.521	2.688	5-S2n	1.158	1.880	1.347	1.570	13.550	5.010
57.01	31.44	406.31	4.528	2.694	5-S2n	1.158	1.880	1.348	1.582	13.554	5.030
59.42	31.53	406.33	4.546	2.709	5-S2n	1.161	1.881	1.351	1.615	13.563	5.087
61.04	31.58	406.34	4.558	2.720	5-S2n	1.162	1.881	1.352	1.638	13.570	5.124
62.67	31.64	406.35	4.569	2.730	5-S2n	1.163	1.882	1.354	1.659	13.576	5.160
64.30	31.70	406.36	4.581	2.740	5-S2n	1.165	1.882	1.356	1.681	13.583	5.196

****

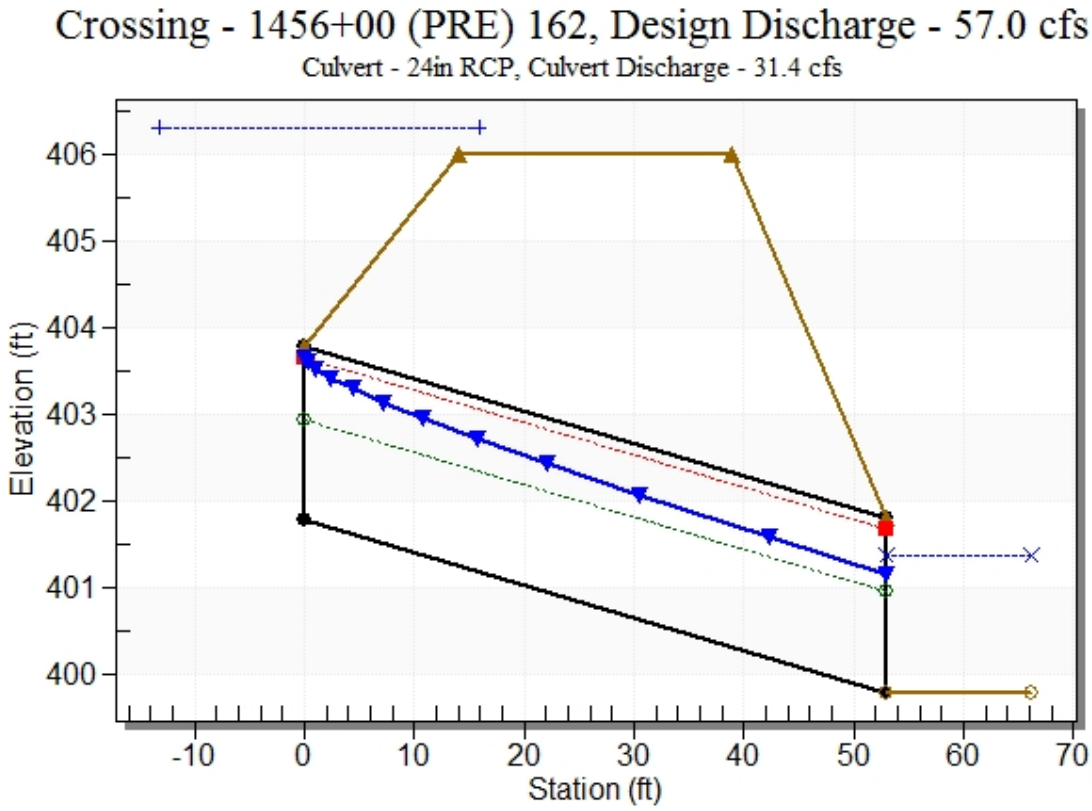
Straight Culvert

Inlet Elevation (invert): 401.78 ft, Outlet Elevation (invert): 399.80 ft

Culvert Length: 53.04 ft, Culvert Slope: 0.0374

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 401.78 ft

Outlet Station: 53.00 ft

Outlet Elevation: 399.80 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1456+00 (PRE) 162)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
48.02	401.25	1.45	4.80	3.62	0.84
49.65	401.27	1.47	4.84	3.68	0.84
51.28	401.30	1.50	4.89	3.74	0.84
52.90	401.32	1.52	4.93	3.80	0.84
54.53	401.35	1.55	4.97	3.86	0.84
56.16	401.37	1.57	5.01	3.92	0.85
57.01	401.38	1.58	5.03	3.95	0.85
59.42	401.42	1.62	5.09	4.03	0.85
61.04	401.44	1.64	5.12	4.09	0.85
62.67	401.46	1.66	5.16	4.14	0.85
64.30	401.48	1.68	5.20	4.20	0.85

Tailwater Channel Data - 1456+00 (PRE) 162

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 399.80 ft

Roadway Data for Crossing: 1456+00 (PRE) 162

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 406.00 ft

Roadway Surface: Paved

Roadway Top Width: 25.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 48.02 cfs

Design Flow: 57.01 cfs

Maximum Flow: 64.3 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1456+00 (POST) 162

Headwater Elevation (ft)	Total Discharge (cfs)	24in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
406.23	48.02	31.08	16.82	10
406.25	49.65	31.15	18.40	3
406.26	51.28	31.21	19.98	3
406.28	52.90	31.28	21.55	3
406.29	54.53	31.34	23.13	3
406.30	56.16	31.41	24.70	3
406.31	57.01	31.44	25.54	3
406.33	59.42	31.53	27.84	3
406.34	61.04	31.58	29.43	3
406.35	62.67	31.64	31.00	3
406.36	64.30	31.70	32.58	3
406.00	29.90	29.90	0.00	Overtopping

Table 2 - Culvert Summary Table: 24in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
48.02	31.08	406.23	4.454	2.629	5-S2n	1.150	1.876	1.338	1.450	13.516	4.800
49.65	31.15	406.25	4.468	2.642	5-S2n	1.152	1.877	1.340	1.475	13.523	4.845
51.28	31.21	406.26	4.482	2.654	5-S2n	1.153	1.878	1.342	1.499	13.530	4.887
52.90	31.28	406.28	4.495	2.666	5-S2n	1.155	1.878	1.344	1.523	13.537	4.929
54.53	31.34	406.29	4.508	2.677	5-S2n	1.156	1.879	1.346	1.547	13.544	4.970
56.16	31.41	406.30	4.521	2.688	5-S2n	1.158	1.880	1.347	1.570	13.550	5.010
57.01	31.44	406.31	4.528	2.694	5-S2n	1.158	1.880	1.348	1.582	13.554	5.030
59.42	31.53	406.33	4.546	2.709	5-S2n	1.161	1.881	1.351	1.615	13.563	5.087
61.04	31.58	406.34	4.558	2.720	5-S2n	1.162	1.881	1.352	1.638	13.570	5.124
62.67	31.64	406.35	4.569	2.730	5-S2n	1.163	1.882	1.354	1.659	13.576	5.160
64.30	31.70	406.36	4.581	2.740	5-S2n	1.165	1.882	1.356	1.681	13.583	5.196

****

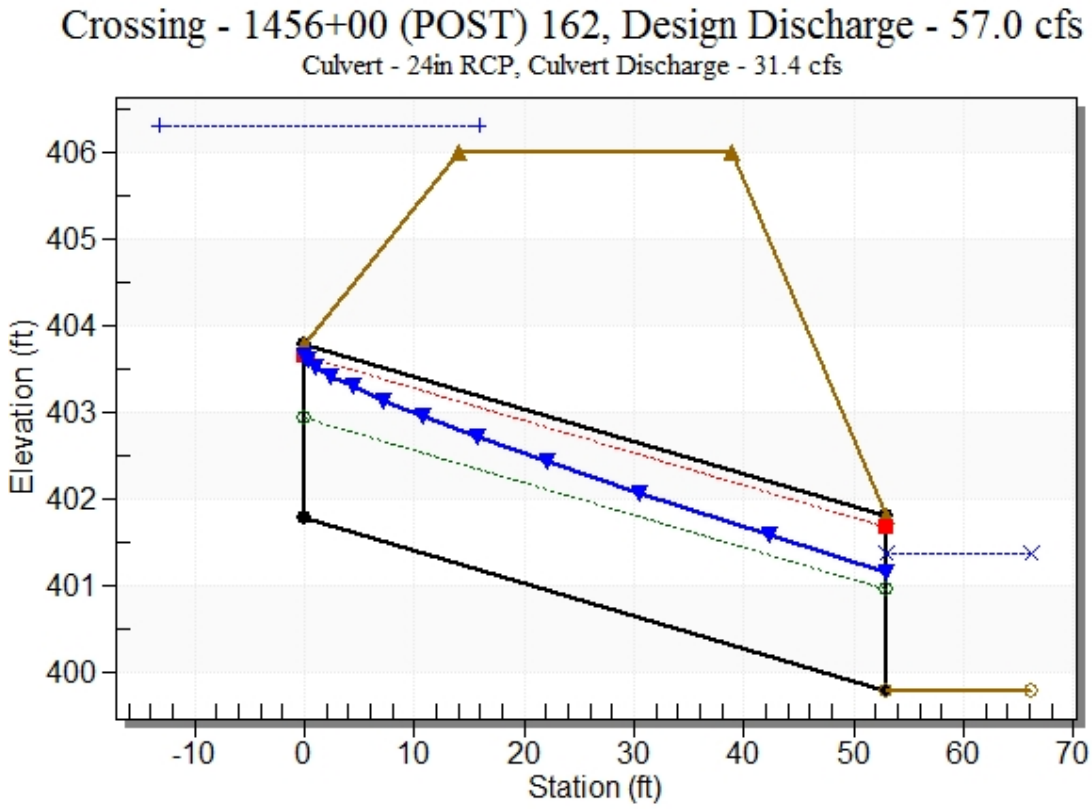
Straight Culvert

Inlet Elevation (invert): 401.78 ft, Outlet Elevation (invert): 399.80 ft

Culvert Length: 53.04 ft, Culvert Slope: 0.0374

****

Water Surface Profile Plot for Culvert: 24in RCP



Site Data - 24in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 401.78 ft

Outlet Station: 53.00 ft

Outlet Elevation: 399.80 ft

Number of Barrels: 1

Culvert Data Summary - 24in RCP

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1456+00 (POST) 162)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
48.02	401.25	1.45	4.80	3.62	0.84
49.65	401.27	1.47	4.84	3.68	0.84
51.28	401.30	1.50	4.89	3.74	0.84
52.90	401.32	1.52	4.93	3.80	0.84
54.53	401.35	1.55	4.97	3.86	0.84
56.16	401.37	1.57	5.01	3.92	0.85
57.01	401.38	1.58	5.03	3.95	0.85
59.42	401.42	1.62	5.09	4.03	0.85
61.04	401.44	1.64	5.12	4.09	0.85
62.67	401.46	1.66	5.16	4.14	0.85
64.30	401.48	1.68	5.20	4.20	0.85

Tailwater Channel Data - 1456+00 (POST) 162

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 399.80 ft

Roadway Data for Crossing: 1456+00 (POST) 162

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 406.00 ft

Roadway Surface: Paved

Roadway Top Width: 25.00 ft

CULVERT 163

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 163**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.33	0.2961
Grass	0.25	0.32	0.0797
Woods	0.15	0.00	0.0000
	Σ	**0.65**	0.3758

$C_{ave} = \frac{0.3758}{0.65} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.38	0.3420
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.38**	0.3420

$C_{ave} = \frac{0.3420}{0.38} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	0.65	x	1	=	**2.34**	cfs
Q_{10} =	0.58	x	6.98	x	0.65	x	1	=	**2.62**	cfs
Q_{25} =	0.58	x	8.08	x	0.65	x	1.1	=	**3.34**	cfs
Q_{50} =	0.58	x	8.93	x	0.65	x	1.2	=	**4.03**	cfs
Q_{100} =	0.58	x	9.81	x	0.65	x	1.25	=	**4.61**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.38	x	1	=	**2.13**	cfs
Q_{10} =	0.90	x	6.98	x	0.38	x	1	=	**2.39**	cfs
Q_{25} =	0.90	x	8.08	x	0.38	x	1.1	=	**3.04**	cfs
Q_{50} =	0.90	x	8.93	x	0.38	x	1.2	=	**3.66**	cfs
Q_{100} =	0.90	x	9.81	x	0.38	x	1.25	=	**4.19**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.34 cfs

Design Flow: 4.03 cfs

Maximum Flow: 4.61 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1456+00 (PRE) 163

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
404.62	3.34	3.34	0.00	1
404.64	3.47	3.47	0.00	1
404.67	3.59	3.59	0.00	1
404.70	3.72	3.72	0.00	1
404.73	3.85	3.85	0.00	1
404.75	3.98	3.98	0.00	1
404.77	4.03	4.03	0.00	1
404.81	4.23	4.23	0.00	1
404.84	4.36	4.36	0.00	1
404.87	4.48	4.48	0.00	1
404.90	4.61	4.61	0.00	1
406.87	9.81	9.81	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.34	3.34	404.62	1.076	0.0*	1-S2n	0.347	0.731	0.347	0.510	11.620	2.169
3.47	3.47	404.64	1.103	0.0*	1-S2n	0.354	0.749	0.354	0.520	11.751	2.193
3.59	3.59	404.67	1.131	0.0*	1-S2n	0.360	0.763	0.360	0.530	11.892	2.215
3.72	3.72	404.70	1.158	0.0*	1-S2n	0.367	0.776	0.367	0.540	12.027	2.238
3.85	3.85	404.73	1.186	0.0*	1-S2n	0.373	0.789	0.373	0.550	12.082	2.259
3.98	3.98	404.75	1.214	0.0*	1-S2n	0.380	0.802	0.380	0.559	12.197	2.280
4.03	4.03	404.77	1.227	0.0*	1-S2n	0.383	0.808	0.383	0.563	12.245	2.289
4.23	4.23	404.81	1.272	0.0*	5-S2n	0.392	0.827	0.392	0.578	12.433	2.320
4.36	4.36	404.84	1.301	0.0*	5-S2n	0.398	0.843	0.425	0.587	11.459	2.339
4.48	4.48	404.87	1.331	0.0*	5-S2n	0.404	0.856	0.414	0.596	12.211	2.358
4.61	4.61	404.90	1.361	0.0*	5-S2n	0.410	0.868	0.410	0.604	12.705	2.377

* Full Flow Headwater elevation is below inlet invert.

****

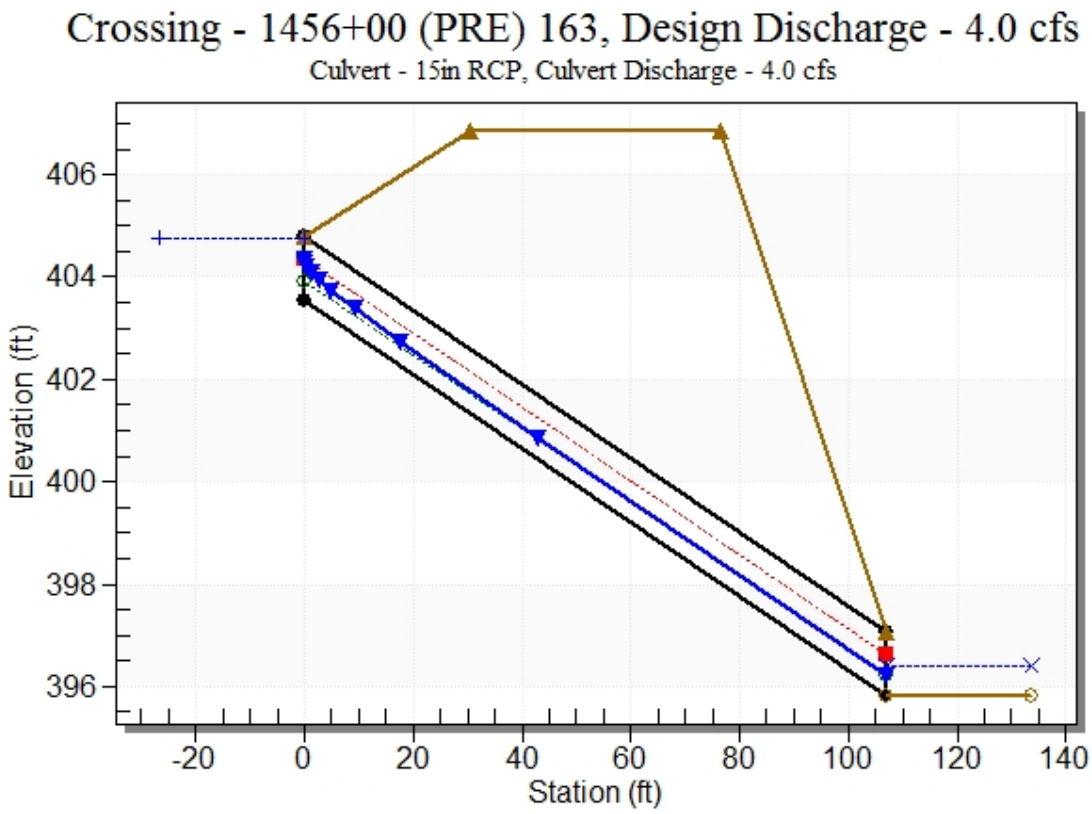
Straight Culvert

Inlet Elevation (invert): 403.54 ft, Outlet Elevation (invert): 395.83 ft

Culvert Length: 107.28 ft, Culvert Slope: 0.0721

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 403.54 ft

Outlet Station: 107.00 ft

Outlet Elevation: 395.83 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1456+00 (PRE) 163)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.34	396.34	0.51	2.17	0.95	0.62
3.47	396.35	0.52	2.19	0.97	0.62
3.59	396.36	0.53	2.22	0.99	0.62
3.72	396.37	0.54	2.24	1.01	0.62
3.85	396.38	0.55	2.26	1.03	0.62
3.98	396.39	0.56	2.28	1.05	0.63
4.03	396.39	0.56	2.29	1.05	0.63
4.23	396.41	0.58	2.32	1.08	0.63
4.36	396.42	0.59	2.34	1.10	0.63
4.48	396.43	0.60	2.36	1.12	0.63
4.61	396.43	0.60	2.38	1.13	0.63

Tailwater Channel Data - 1456+00 (PRE) 163

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 395.83 ft

Roadway Data for Crossing: 1456+00 (PRE) 163

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 406.87 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.04 cfs

Design Flow: 3.66 cfs

Maximum Flow: 4.19 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1456+00 (POST) 163

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
404.55	3.04	3.04	0.00	1
404.58	3.16	3.16	0.00	1
404.60	3.27	3.27	0.00	1
404.63	3.39	3.39	0.00	1
404.65	3.50	3.50	0.00	1
404.68	3.62	3.62	0.00	1
404.69	3.66	3.66	0.00	1
404.73	3.85	3.85	0.00	1
404.75	3.96	3.96	0.00	1
404.78	4.08	4.08	0.00	1
404.80	4.19	4.19	0.00	1
406.87	9.81	9.81	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.04	3.04	404.55	1.011	0.0*	1-S2n	0.331	0.698	0.331	0.485	11.367	2.112
3.16	3.16	404.58	1.036	0.0*	1-S2n	0.337	0.711	0.337	0.495	11.508	2.134
3.27	3.27	404.60	1.061	0.0*	1-S2n	0.343	0.724	0.343	0.504	11.547	2.157
3.39	3.39	404.63	1.085	0.0*	1-S2n	0.350	0.736	0.350	0.513	11.665	2.178
3.50	3.50	404.65	1.110	0.0*	1-S2n	0.356	0.752	0.372	0.523	11.025	2.199
3.62	3.62	404.68	1.135	0.0*	1-S2n	0.362	0.765	0.362	0.532	11.915	2.219
3.66	3.66	404.69	1.145	0.0*	1-S2n	0.364	0.770	0.364	0.535	11.963	2.227
3.85	3.85	404.73	1.186	0.0*	1-S2n	0.373	0.789	0.373	0.549	12.079	2.258
3.96	3.96	404.75	1.211	0.0*	1-S2n	0.379	0.801	0.379	0.558	12.184	2.277
4.08	4.08	404.78	1.237	0.0*	1-S2n	0.385	0.812	0.385	0.567	12.285	2.296
4.19	4.19	404.80	1.263	0.0*	5-S2n	0.390	0.823	0.390	0.575	12.396	2.314

* Full Flow Headwater elevation is below inlet invert.

****

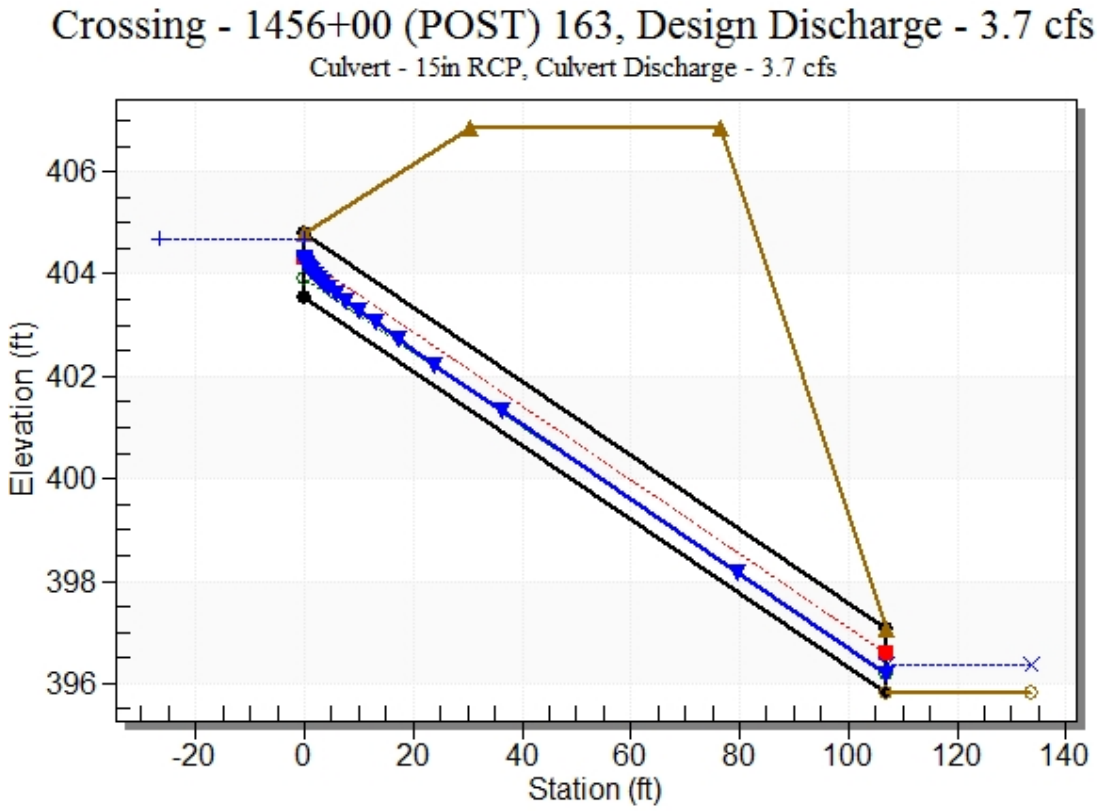
Straight Culvert

Inlet Elevation (invert): 403.54 ft, Outlet Elevation (invert): 395.83 ft

Culvert Length: 107.28 ft, Culvert Slope: 0.0721

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 403.54 ft

Outlet Station: 107.00 ft

Outlet Elevation: 395.83 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1456+00 (POST) 163)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.04	396.31	0.48	2.11	0.91	0.62
3.16	396.32	0.49	2.13	0.93	0.62
3.27	396.33	0.50	2.16	0.94	0.62
3.39	396.34	0.51	2.18	0.96	0.62
3.50	396.35	0.52	2.20	0.98	0.62
3.62	396.36	0.53	2.22	1.00	0.62
3.66	396.37	0.54	2.23	1.00	0.62
3.85	396.38	0.55	2.26	1.03	0.62
3.96	396.39	0.56	2.28	1.04	0.63
4.08	396.40	0.57	2.30	1.06	0.63
4.19	396.40	0.57	2.31	1.08	0.63

Tailwater Channel Data - 1456+00 (POST) 163

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0600

Channel Invert Elevation: 395.83 ft

Roadway Data for Crossing: 1456+00 (POST) 163

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 406.87 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 164

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 164**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.41	0.3734
Grass	0.25	0.29	0.0713
Woods	0.15	0.00	0.0000
	Σ	**0.70**	0.4447

$C_{ave} = \frac{0.4447}{0.70} = 0.64$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.48	0.4320
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.48**	0.4320

$C_{ave} = \frac{0.4320}{0.48} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.64	x	6.23	x	0.70	x	1	=	**2.77**	cfs
Q_{10} =	0.64	x	6.98	x	0.70	x	1	=	**3.10**	cfs
Q_{25} =	0.64	x	8.08	x	0.70	x	1.1	=	**3.95**	cfs
Q_{50} =	0.64	x	8.93	x	0.70	x	1.2	=	**4.76**	cfs
Q_{100} =	0.64	x	9.81	x	0.70	x	1.25	=	**5.45**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.48	x	1	=	**2.69**	cfs
Q_{10} =	0.90	x	6.98	x	0.48	x	1	=	**3.01**	cfs
Q_{25} =	0.90	x	8.08	x	0.48	x	1.1	=	**3.84**	cfs
Q_{50} =	0.90	x	8.93	x	0.48	x	1.2	=	**4.63**	cfs
Q_{100} =	0.90	x	9.81	x	0.48	x	1.25	=	**5.30**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.95 cfs

Design Flow: 4.76 cfs

Maximum Flow: 5.45 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1461+25 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
409.91	3.95	3.95	0.00	1
409.94	4.10	4.10	0.00	1
409.97	4.25	4.25	0.00	1
410.01	4.40	4.40	0.00	1
410.04	4.55	4.55	0.00	1
410.08	4.70	4.70	0.00	1
410.09	4.76	4.76	0.00	1
410.16	5.00	5.00	0.00	1
410.19	5.15	5.15	0.00	1
410.23	5.30	5.30	0.00	1
410.28	5.45	5.45	0.00	1
412.20	10.14	10.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.95	3.95	409.91	1.215	0.0*	1-S2n	0.395	0.800	0.395	0.620	11.524	1.967
4.10	4.10	409.94	1.249	0.0*	1-S2n	0.402	0.815	0.402	0.632	11.659	1.987
4.25	4.25	409.97	1.283	0.0*	5-S2n	0.410	0.829	0.410	0.644	11.729	2.008
4.40	4.40	410.01	1.318	0.0*	5-S2n	0.418	0.848	0.418	0.656	11.846	2.027
4.55	4.55	410.04	1.354	0.0*	5-S2n	0.425	0.862	0.425	0.667	11.971	2.046
4.70	4.70	410.08	1.390	0.0*	5-S2n	0.432	0.876	0.467	0.678	10.862	2.064
4.76	4.76	410.09	1.405	0.0*	5-S2n	0.435	0.882	0.465	0.683	11.094	2.071
5.00	5.00	410.16	1.465	0.0*	5-S2n	0.447	0.904	0.455	0.700	11.988	2.099
5.15	5.15	410.19	1.504	0.0*	5-S2n	0.454	0.917	0.454	0.711	12.372	2.116
5.30	5.30	410.23	1.544	0.0*	5-S2n	0.461	0.930	0.461	0.722	12.478	2.133
5.45	5.45	410.28	1.585	0.0*	5-S2n	0.468	0.943	0.468	0.732	12.548	2.150

* Full Flow Headwater elevation is below inlet invert.

****

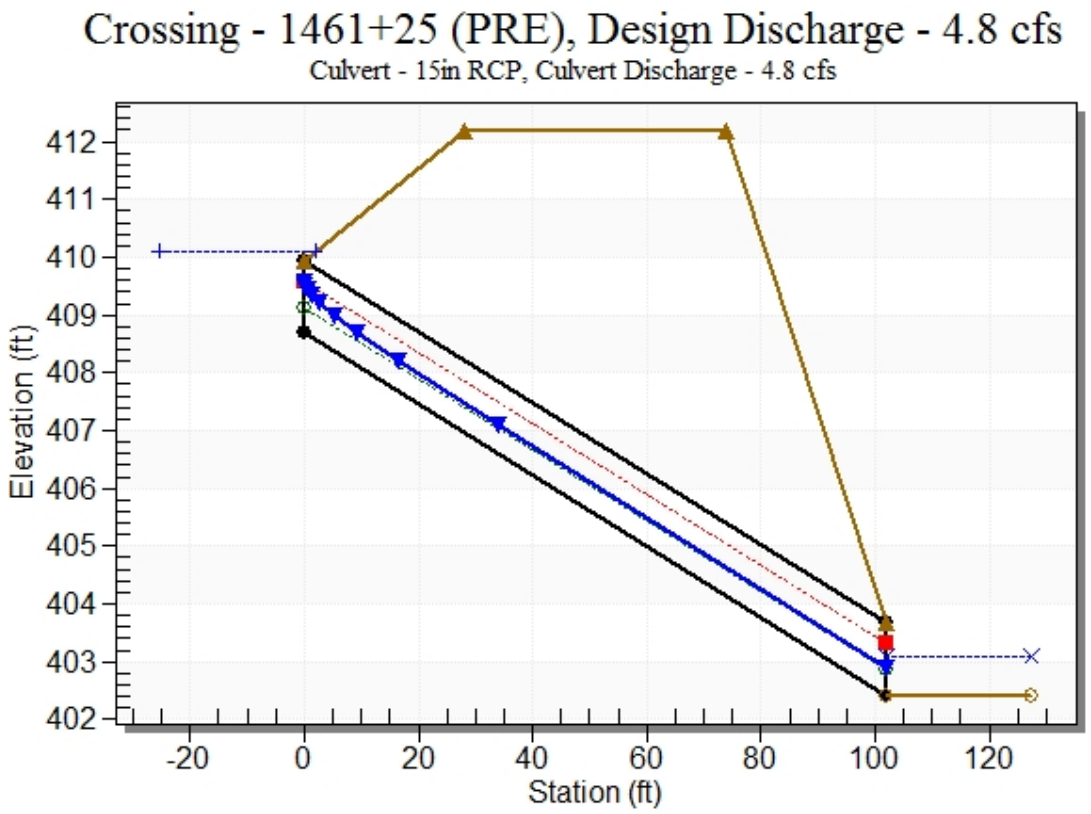
Straight Culvert

Inlet Elevation (invert): 408.69 ft, Outlet Elevation (invert): 402.42 ft

Culvert Length: 102.19 ft, Culvert Slope: 0.0615

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 408.69 ft

Outlet Station: 102.00 ft

Outlet Elevation: 402.42 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1461+25 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.95	403.04	0.62	1.97	0.77	0.52
4.10	403.05	0.63	1.99	0.79	0.52
4.25	403.06	0.64	2.01	0.80	0.52
4.40	403.08	0.66	2.03	0.82	0.52
4.55	403.09	0.67	2.05	0.83	0.52
4.70	403.10	0.68	2.06	0.85	0.52
4.76	403.10	0.68	2.07	0.85	0.52
5.00	403.12	0.70	2.10	0.87	0.53
5.15	403.13	0.71	2.12	0.89	0.53
5.30	403.14	0.72	2.13	0.90	0.53
5.45	403.15	0.73	2.15	0.91	0.53

Tailwater Channel Data - 1461+25 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 402.42 ft

Roadway Data for Crossing: 1461+25 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 412.20 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.84 cfs

Design Flow: 4.63 cfs

Maximum Flow: 5.3 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1461+25 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
409.88	3.84	3.84	0.00	1
409.91	3.99	3.99	0.00	1
409.95	4.13	4.13	0.00	1
409.98	4.28	4.28	0.00	1
410.01	4.42	4.42	0.00	1
410.05	4.57	4.57	0.00	1
410.06	4.63	4.63	0.00	1
410.12	4.86	4.86	0.00	1
410.16	5.01	5.01	0.00	1
410.20	5.15	5.15	0.00	1
410.23	5.30	5.30	0.00	1
412.20	10.14	10.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.84	3.84	409.88	1.191	0.0*	1-S2n	0.389	0.788	0.409	0.611	10.636	1.951
3.99	3.99	409.91	1.223	0.0*	1-S2n	0.396	0.803	0.396	0.623	11.557	1.972
4.13	4.13	409.95	1.256	0.0*	5-S2n	0.404	0.818	0.404	0.635	11.634	1.992
4.28	4.28	409.98	1.290	0.0*	5-S2n	0.411	0.836	0.411	0.646	11.751	2.011
4.42	4.42	410.01	1.324	0.0*	5-S2n	0.419	0.850	0.419	0.657	11.867	2.030
4.57	4.57	410.05	1.358	0.0*	5-S2n	0.426	0.864	0.426	0.669	11.987	2.048
4.63	4.63	410.06	1.373	0.0*	5-S2n	0.429	0.870	0.469	0.673	10.635	2.055
4.86	4.86	410.12	1.430	0.0*	5-S2n	0.440	0.891	0.461	0.690	11.460	2.083
5.01	5.01	410.16	1.467	0.0*	5-S2n	0.447	0.904	0.454	0.701	12.020	2.100
5.15	5.15	410.20	1.505	0.0*	5-S2n	0.454	0.917	0.454	0.711	12.374	2.117
5.30	5.30	410.23	1.544	0.0*	5-S2n	0.461	0.930	0.461	0.722	12.478	2.133

* Full Flow Headwater elevation is below inlet invert.

****

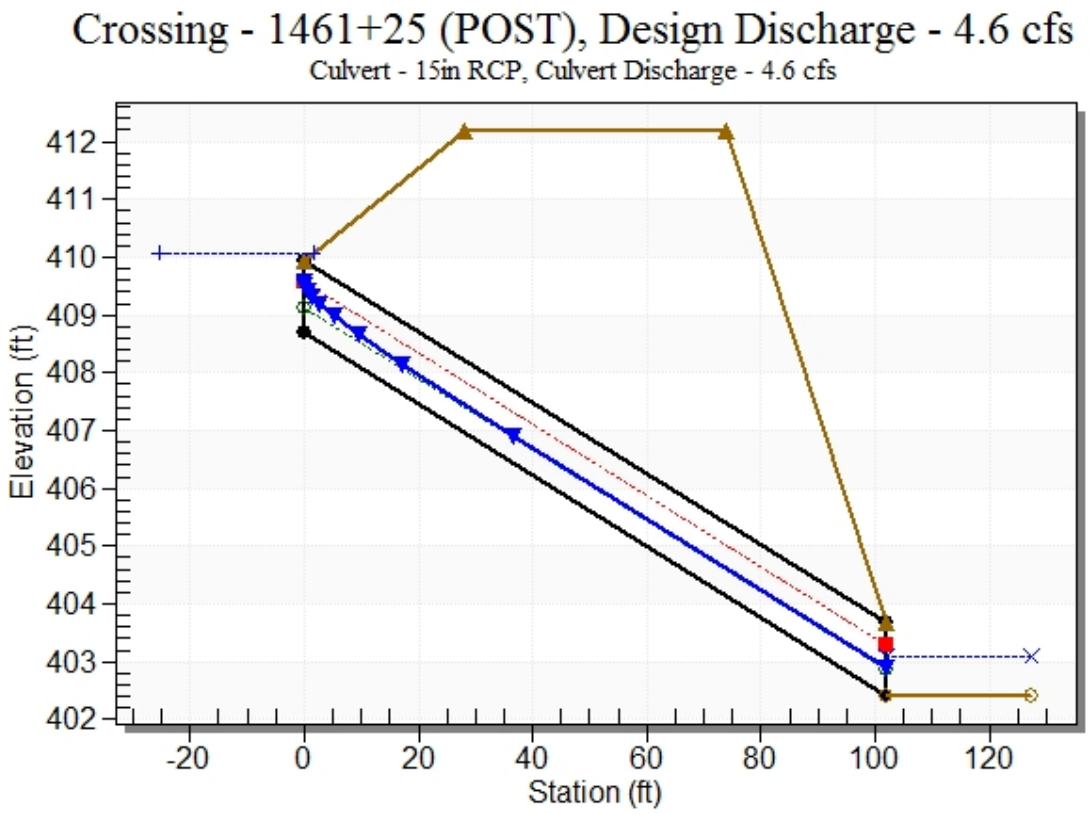
Straight Culvert

Inlet Elevation (invert): 408.69 ft, Outlet Elevation (invert): 402.42 ft

Culvert Length: 102.19 ft, Culvert Slope: 0.0615

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 408.69 ft

Outlet Station: 102.00 ft

Outlet Elevation: 402.42 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1461+25 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.84	403.03	0.61	1.95	0.76	0.52
3.99	403.04	0.62	1.97	0.78	0.52
4.13	403.05	0.63	1.99	0.79	0.52
4.28	403.07	0.65	2.01	0.81	0.52
4.42	403.08	0.66	2.03	0.82	0.52
4.57	403.09	0.67	2.05	0.83	0.52
4.63	403.09	0.67	2.06	0.84	0.52
4.86	403.11	0.69	2.08	0.86	0.52
5.01	403.12	0.70	2.10	0.87	0.53
5.15	403.13	0.71	2.12	0.89	0.53
5.30	403.14	0.72	2.13	0.90	0.53

Tailwater Channel Data - 1461+25 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 402.42 ft

Roadway Data for Crossing: 1461+25 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 412.20 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 165

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 165a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.86	4.3734
Grass	0.25	11.09	2.7736
Woods	0.15	2.23	0.3347
	Σ	**18.18**	7.4816

$C_{ave} = \frac{7.4816}{18.18} = 0.41$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.86	4.3734
Grass	0.25	11.09	2.7736
Woods	0.15	2.23	0.3347
	Σ	**18.18**	7.4816

$C_{ave} = \frac{7.4816}{18.18} = 0.41$

T_c =	102.10	min.								
I_{05} =	1.71	in / hr								
I_{10} =	1.89	in / hr								
I_{25} =	2.13	in / hr								
I_{50} =	2.32	in / hr								
I_{100} =	2.50	in / hr								

Pre Construction Runoff:

Q_{05} =	0.41	**x**	1.71	**x**	18.18	**x**	1	=	**12.82**	cfs
Q_{10} =	0.41	**x**	1.89	**x**	18.18	**x**	1	=	**14.11**	cfs
Q_{25} =	0.41	**x**	2.13	**x**	18.18	**x**	1.1	=	**17.56**	cfs
Q_{50} =	0.41	**x**	2.32	**x**	18.18	**x**	1.2	=	**20.80**	cfs
Q_{100} =	0.41	**x**	2.50	**x**	18.18	**x**	1.25	=	**23.40**	cfs

Post Construction Runoff:

Q_{05} =	0.41	**x**	1.71	**x**	18.18	**x**	1	=	**12.82**	cfs
Q_{10} =	0.41	**x**	1.89	**x**	18.18	**x**	1	=	**14.11**	cfs
Q_{25} =	0.41	**x**	2.13	**x**	18.18	**x**	1.1	=	**17.56**	cfs
Q_{50} =	0.41	**x**	2.32	**x**	18.18	**x**	1.2	=	**20.80**	cfs
Q_{100} =	0.41	**x**	2.50	**x**	18.18	**x**	1.25	=	**23.40**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 165b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.33	0.2951
Grass	0.25	0.28	0.0707
Woods	0.15	0.00	0.0000
	Σ	**0.61**	0.3658

$C_{ave} = \frac{0.3658}{0.61} = 0.60$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.45	0.4031
Grass	0.25	0.28	0.0707
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.4738

$C_{ave} = \frac{0.4738}{0.73} = 0.65$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.60	x	6.23	x	0.61	x	1	=	**2.28**	cfs
Q_{10} =	0.60	x	6.98	x	0.61	x	1	=	**2.55**	cfs
Q_{25} =	0.60	x	8.08	x	0.61	x	1.1	=	**3.25**	cfs
Q_{50} =	0.60	x	8.93	x	0.61	x	1.2	=	**3.92**	cfs
Q_{100} =	0.60	x	9.81	x	0.61	x	1.25	=	**4.48**	cfs

Post Construction Runoff:

Q_{05} =	0.65	x	6.23	x	0.73	x	1	=	**2.95**	cfs
Q_{10} =	0.65	x	6.98	x	0.73	x	1	=	**3.31**	cfs
Q_{25} =	0.65	x	8.08	x	0.73	x	1.1	=	**4.21**	cfs
Q_{50} =	0.65	x	8.93	x	0.73	x	1.2	=	**5.07**	cfs
Q_{100} =	0.65	x	9.81	x	0.73	x	1.25	=	**5.81**	cfs

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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 165c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.42	0.3762
Grass	0.25	0.24	0.0589
Woods	0.15	0.00	0.0000
	Σ	**0.65**	0.4351

$C_{ave} = \frac{0.4351}{0.65} = 0.67$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.54	0.4842
Grass	0.25	0.24	0.0589
Woods	0.15	0.00	0.0000
	Σ	**0.77**	0.5431

$C_{ave} = \frac{0.5431}{0.77} = 0.70$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.67	x	6.23	x	0.65	x	1	=	**2.71**	cfs
Q_{10} =	0.67	x	6.98	x	0.65	x	1	=	**3.04**	cfs
Q_{25} =	0.67	x	8.08	x	0.65	x	1.1	=	**3.87**	cfs
Q_{50} =	0.67	x	8.93	x	0.65	x	1.2	=	**4.66**	cfs
Q_{100} =	0.67	x	9.81	x	0.65	x	1.25	=	**5.33**	cfs

Post Construction Runoff:

Q_{05} =	0.70	x	6.23	x	0.77	x	1	=	**3.38**	cfs
Q_{10} =	0.70	x	6.98	x	0.77	x	1	=	**3.79**	cfs
Q_{25} =	0.70	x	8.08	x	0.77	x	1.1	=	**4.83**	cfs
Q_{50} =	0.70	x	8.93	x	0.77	x	1.2	=	**5.82**	cfs
Q_{100} =	0.70	x	9.81	x	0.77	x	1.25	=	**6.66**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 165a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved		unpaved		
8	Flow length, L		ft	**800**		**600**		
9	Watercourse slope, s		ft/ft	**0.0300**		**0.0001**		
10	Average velocity, V (figure 3-1)		ft/s	**2.79**		**0.16**		
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.080**	+	**1.033**	=	**1.113**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)			**3**				
	Back Slope, (_ : 1)			**3**				
	Bottom Width		ft	**2**				
	Flow Depth		ft	**0**				
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**2.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**0.00**		**#DIV/0!**		
15	Channel Slope, s		ft/ft	**0.0000**				
16	Manning's roughness coeff., n			**0.15**				
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**0.00**		**#DIV/0!**		
18	Flow length, L		ft	**0**				
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**1.702**
							min	**102.10**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-165		Outlet	OP	412.82	412.82	0.00	0.48	0.00	102.41	0.00	19.44	0.43	0.00
CB-165c		Other	C.B. TYPE 112	422.00	422.00	3.93	0.04	102.30	102.30	23.19	19.44	0.43	2.34
CB-165b		Other	C.B. TYPE 112	422.00	422.00	3.23	0.01	102.22	102.22	22.01	18.79	0.42	2.34
DN-165a		Other	DUMMY JOINT	421.31	421.31	0.00	0.00	102.10	102.10	21.00	18.18	0.41	2.34

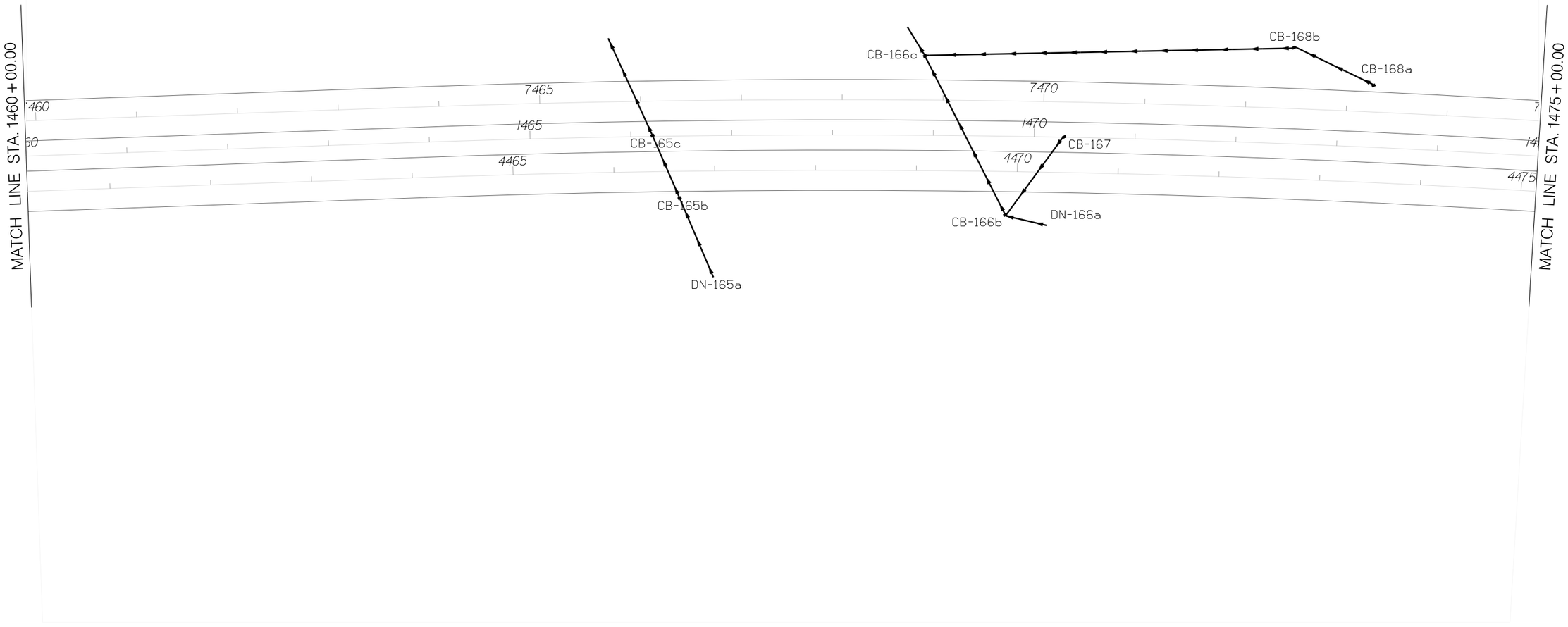
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-48	CB-165c	OF-165	Circular	Concrete	1	1.50	105	4.99	23.19	27.36	1.12	16.32	419.57	419.64	414.32	413.98	418.07	412.82	13.13	15.79	1.50	1.16
NP-47	CB-165b	CB-165c	Circular	Concrete	1	1.50	65	0.50	22.01	8.69	1.50	12.78	420.27	422.47	419.94	419.92	418.77	418.44	12.45	12.49	1.50	1.48
NP-46	DN-165a	CB-165b	Circular	Concrete	1	1.50	84	2.79	21.00	20.46	1.50	12.19	422.81	428.08	420.46	422.47	421.31	418.96	11.88	11.88	1.50	1.50

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-165c	5.00	4.65	9.03	0.66	0.65	0.66	0.65	0.00	0.00
CB-165b	5.00	3.98	9.03	0.60	0.61	0.60	0.61	0.00	0.00
DN-165a	102.10	21.00	2.34	0.41	18.18	0.41	18.18	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	65



REVISIONS NO.	DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

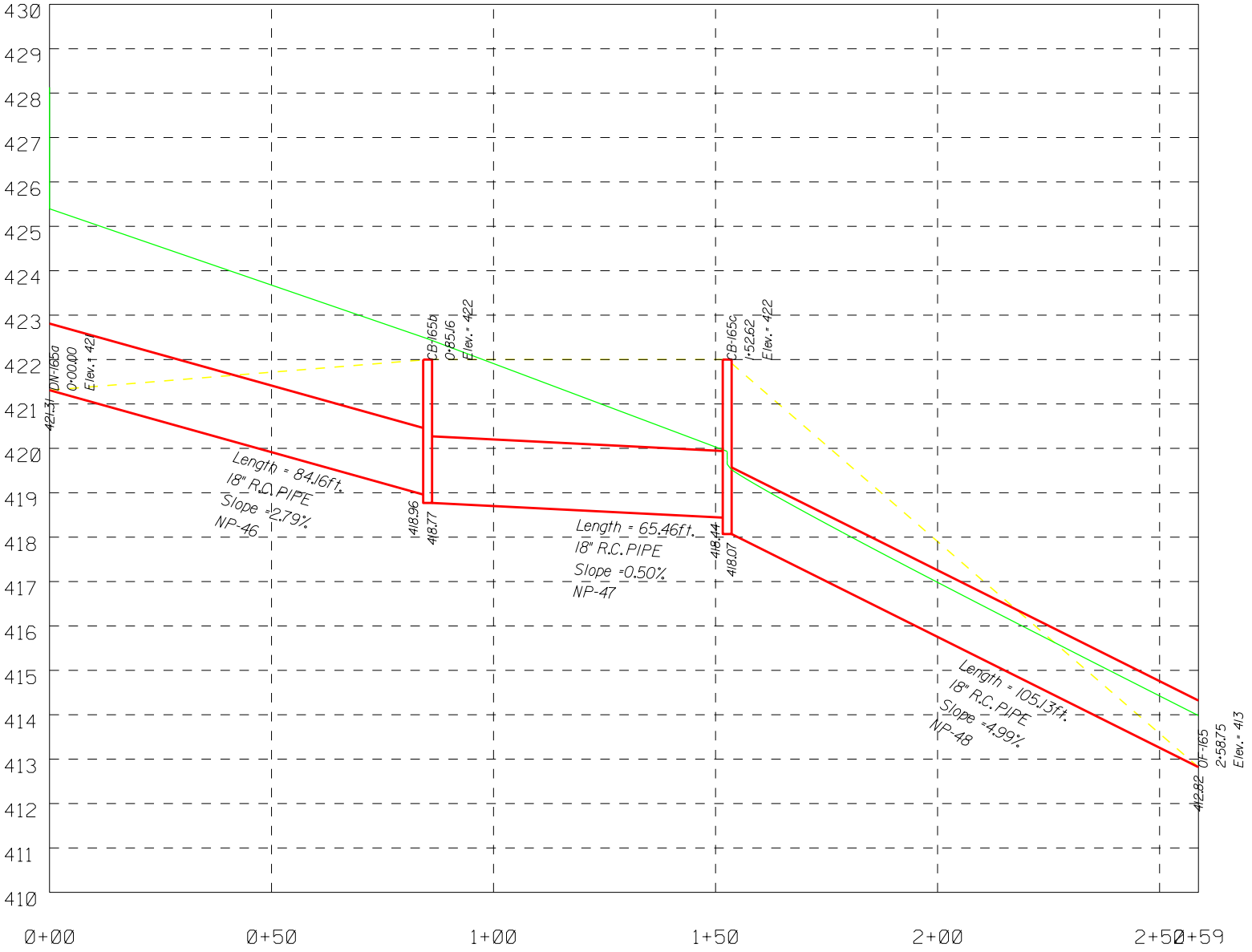
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1460+00.00 TO STA. 1475+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$

OF-165 (50 YR PRE)



SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-165	Outlet	OP	412.82	412.82	0.00	0.48	0.00	102.41	0.00	19.68	0.43	0.00
CB-165c	Other	C.B. TYPE 112	422.00	422.00	3.93	0.04	102.30	102.30	23.80	19.68	0.43	2.34
CB-165b	Other	C.B. TYPE 112	422.00	422.00	3.23	0.01	102.22	102.22	22.31	18.91	0.42	2.34
DN-165a	Other	DUMMY JOINT	421.31	421.31	0.00	0.00	102.10	102.10	21.00	18.18	0.41	2.34

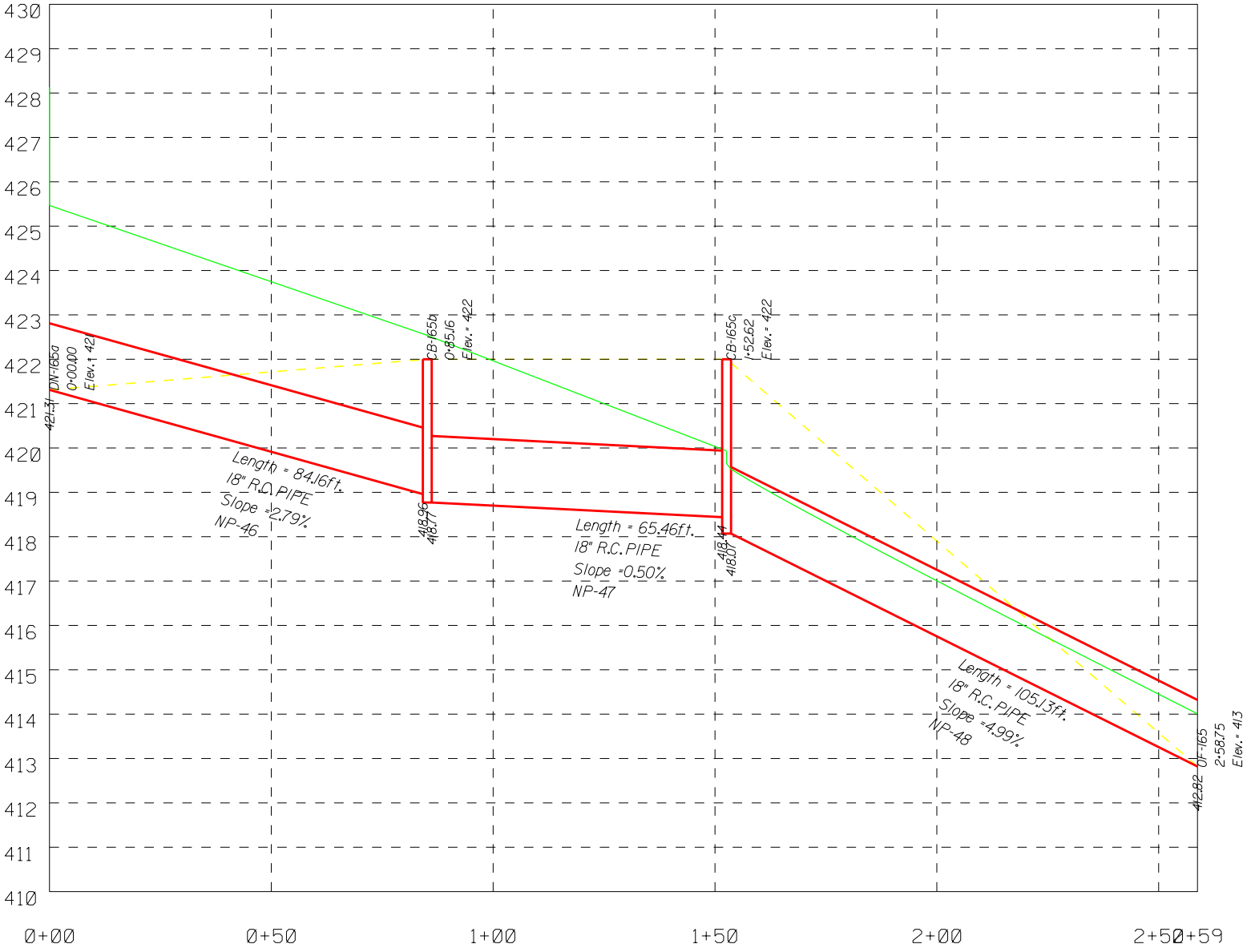
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-48	CB-165c	OF-165	Circular	Concrete	1	1.50	105	4.99	23.80	27.36	1.15	16.36	419.57	419.64	414.32	414.01	418.07	412.82	13.47	15.85	1.50	1.19
NP-47	CB-165b	CB-165c	Circular	Concrete	1	1.50	65	0.50	22.31	8.69	1.50	12.95	420.27	422.54	419.94	419.92	418.77	418.44	12.62	12.66	1.50	1.48
NP-46	DN-165a	CB-165b	Circular	Concrete	1	1.50	84	2.79	21.00	20.46	1.50	12.19	422.81	428.08	420.46	422.54	421.31	418.96	11.88	11.88	1.50	1.50

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-165c	5.00	5.82	9.03	0.70	0.77	0.70	0.77	0.00	0.00
CB-165b	5.00	5.15	9.03	0.65	0.73	0.65	0.73	0.00	0.00
DN-165a	102.10	21.00	2.34	0.41	18.18	0.41	18.18	0.00	0.00

OF-165 (50 YR POST)



CULVERT 166/167/168

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 166aa**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.41	3.9672
Grass	0.25	18.52	4.6297
Woods	0.15	2.08	0.3115
	Σ	**25.00**	8.9083

$C_{ave} = \frac{8.9083}{25.00} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.41	3.9672
Grass	0.25	18.52	4.6297
Woods	0.15	2.08	0.3115
	Σ	**25.00**	8.9083

$C_{ave} = \frac{8.9083}{25.00} = 0.36$

T_c =	48.35	min.								
I_{05} =	2.87	in / hr								
I_{10} =	3.17	in / hr								
I_{25} =	3.60	in / hr								
I_{50} =	3.92	in / hr								
I_{100} =	4.24	in / hr								

Pre Construction Runoff:

Q_{05} =	0.36	**x**	2.87	**x**	25.00	**x**	1	=	**25.59**	cfs
Q_{10} =	0.36	**x**	3.17	**x**	25.00	**x**	1	=	**28.25**	cfs
Q_{25} =	0.36	**x**	3.60	**x**	25.00	**x**	1.1	=	**35.28**	cfs
Q_{50} =	0.36	**x**	3.92	**x**	25.00	**x**	1.2	=	**41.89**	cfs
Q_{100} =	0.36	**x**	4.24	**x**	25.00	**x**	1.25	=	**47.24**	cfs

Post Construction Runoff:

Q_{05} =	0.36	**x**	2.87	**x**	25.00	**x**	1	=	**25.59**	cfs
Q_{10} =	0.36	**x**	3.17	**x**	25.00	**x**	1	=	**28.25**	cfs
Q_{25} =	0.36	**x**	3.60	**x**	25.00	**x**	1.1	=	**35.28**	cfs
Q_{50} =	0.36	**x**	3.92	**x**	25.00	**x**	1.2	=	**41.89**	cfs
Q_{100} =	0.36	**x**	4.24	**x**	25.00	**x**	1.25	=	**47.24**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 166a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.50	4.0485
Grass	0.25	18.93	4.7323
Woods	0.15	2.08	0.3115
	Σ	**25.50**	9.0922

$C_{ave} = \frac{9.0922}{25.50} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	4.50	4.0485
Grass	0.25	18.93	4.7323
Woods	0.15	2.08	0.3115
	Σ	**25.50**	9.0922

$C_{ave} = \frac{9.0922}{25.50} = 0.36$

T_c =	48.35	min.
I_{05} =	2.87	in / hr
I_{10} =	3.17	in / hr
I_{25} =	3.60	in / hr
I_{50} =	3.92	in / hr
I_{100} =	4.24	in / hr

Pre Construction Runoff:

Q_{05} =	0.36	x	2.87	x	25.50	x	1	=	**26.12**	cfs
Q_{10} =	0.36	x	3.17	x	25.50	x	1	=	**28.83**	cfs
Q_{25} =	0.36	x	3.60	x	25.50	x	1.1	=	**36.01**	cfs
Q_{50} =	0.36	x	3.92	x	25.50	x	1.2	=	**42.75**	cfs
Q_{100} =	0.36	x	4.24	x	25.50	x	1.25	=	**48.22**	cfs

Post Construction Runoff:

Q_{05} =	0.36	x	2.87	x	25.50	x	1	=	**26.12**	cfs
Q_{10} =	0.36	x	3.17	x	25.50	x	1	=	**28.83**	cfs
Q_{25} =	0.36	x	3.60	x	25.50	x	1.1	=	**36.01**	cfs
Q_{50} =	0.36	x	3.92	x	25.50	x	1.2	=	**42.75**	cfs
Q_{100} =	0.36	x	4.24	x	25.50	x	1.25	=	**48.22**	cfs

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(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 166b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.60	0.5441
Grass	0.25	0.37	0.0924
Woods	0.15	0.00	0.0000
	Σ	**0.97**	0.6364

$C_{ave} = \frac{0.6364}{0.97} = 0.65$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.78	0.7061
Grass	0.25	0.37	0.0924
Woods	0.15	0.00	0.0000
	Σ	**1.15**	0.7984

$C_{ave} = \frac{0.7984}{1.15} = 0.69$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.65	x	6.23	x	0.97	x	1	=	**3.97**	cfs
Q_{10} =	0.65	x	6.98	x	0.97	x	1	=	**4.44**	cfs
Q_{25} =	0.65	x	8.08	x	0.97	x	1.1	=	**5.66**	cfs
Q_{50} =	0.65	x	8.93	x	0.97	x	1.2	=	**6.82**	cfs
Q_{100} =	0.65	x	9.81	x	0.97	x	1.25	=	**7.80**	cfs

Post Construction Runoff:

Q_{05} =	0.69	x	6.23	x	1.15	x	1	=	**4.97**	cfs
Q_{10} =	0.69	x	6.98	x	1.15	x	1	=	**5.57**	cfs
Q_{25} =	0.69	x	8.08	x	1.15	x	1.1	=	**7.10**	cfs
Q_{50} =	0.69	x	8.93	x	1.15	x	1.2	=	**8.55**	cfs
Q_{100} =	0.69	x	9.81	x	1.15	x	1.25	=	**9.79**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 166c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.06	0.0584
Grass	0.25	1.05	0.2624
Woods	0.15	3.60	0.5393
	Σ	**4.71**	0.8601

$C_{ave} = \frac{0.8601}{4.71} = 0.18$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.06	0.0584
Grass	0.25	1.05	0.2624
Woods	0.15	3.60	0.5393
	Σ	**4.71**	0.8601

$C_{ave} = \frac{0.8601}{4.71} = 0.18$

T_c =	28.89	min.
I_{05} =	3.79	in / hr
I_{10} =	4.20	in / hr
I_{25} =	4.79	in / hr
I_{50} =	5.23	in / hr
I_{100} =	5.68	in / hr

Pre Construction Runoff:

Q_{05} =	0.18	x	3.79	x	4.71	x	1	=	**3.26**	cfs
Q_{10} =	0.18	x	4.20	x	4.71	x	1	=	**3.61**	cfs
Q_{25} =	0.18	x	4.79	x	4.71	x	1.1	=	**4.53**	cfs
Q_{50} =	0.18	x	5.23	x	4.71	x	1.2	=	**5.40**	cfs
Q_{100} =	0.18	x	5.68	x	4.71	x	1.25	=	**6.11**	cfs

Post Construction Runoff:

Q_{05} =	0.18	x	3.79	x	4.71	x	1	=	**3.26**	cfs
Q_{10} =	0.18	x	4.20	x	4.71	x	1	=	**3.61**	cfs
Q_{25} =	0.18	x	4.79	x	4.71	x	1.1	=	**4.53**	cfs
Q_{50} =	0.18	x	5.23	x	4.71	x	1.2	=	**5.40**	cfs
Q_{100} =	0.18	x	5.68	x	4.71	x	1.25	=	**6.11**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 167**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.60	0.5369
Grass	0.25	0.35	0.0881
Woods	0.15	0.00	0.0000
	Σ	**0.95**	0.6250

$C_{ave} = \frac{0.6250}{0.95} = 0.66$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.77	0.6899
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.77**	0.6899

$C_{ave} = \frac{0.6899}{0.77} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.66	x	6.23	x	0.95	x	1	=	**3.89**	cfs
Q_{10} =	0.66	x	6.98	x	0.95	x	1	=	**4.36**	cfs
Q_{25} =	0.66	x	8.08	x	0.95	x	1.1	=	**5.56**	cfs
Q_{50} =	0.66	x	8.93	x	0.95	x	1.2	=	**6.69**	cfs
Q_{100} =	0.66	x	9.81	x	0.95	x	1.25	=	**7.66**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.77	x	1	=	**4.30**	cfs
Q_{10} =	0.90	x	6.98	x	0.77	x	1	=	**4.81**	cfs
Q_{25} =	0.90	x	8.08	x	0.77	x	1.1	=	**6.13**	cfs
Q_{50} =	0.90	x	8.93	x	0.77	x	1.2	=	**7.39**	cfs
Q_{100} =	0.90	x	9.81	x	0.77	x	1.25	=	**8.46**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 168a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2237
Grass	0.25	0.32	0.0803
Woods	0.15	0.00	0.0000
	Σ	**0.57**	0.3040

$C_{ave} = \frac{0.3040}{0.57} = 0.53$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2237
Grass	0.25	0.32	0.0803
Woods	0.15	0.00	0.0000
	Σ	**0.57**	0.3040

$C_{ave} = \frac{0.3040}{0.57} = 0.53$

T_c =	5.00 min.
I_{05} =	6.23 in / hr
I_{10} =	6.98 in / hr
I_{25} =	8.08 in / hr
I_{50} =	8.93 in / hr
I_{100} =	9.81 in / hr

Pre Construction Runoff:

Q_{05} =	0.53	x	6.23	x	0.57	x	1	=	**1.89**	cfs
Q_{10} =	0.53	x	6.98	x	0.57	x	1	=	**2.12**	cfs
Q_{25} =	0.53	x	8.08	x	0.57	x	1.1	=	**2.70**	cfs
Q_{50} =	0.53	x	8.93	x	0.57	x	1.2	=	**3.26**	cfs
Q_{100} =	0.53	x	9.81	x	0.57	x	1.25	=	**3.73**	cfs

Post Construction Runoff:

Q_{05} =	0.53	x	6.23	x	0.57	x	1	=	**1.89**	cfs
Q_{10} =	0.53	x	6.98	x	0.57	x	1	=	**2.12**	cfs
Q_{25} =	0.53	x	8.08	x	0.57	x	1.1	=	**2.70**	cfs
Q_{50} =	0.53	x	8.93	x	0.57	x	1.2	=	**3.26**	cfs
Q_{100} =	0.53	x	9.81	x	0.57	x	1.25	=	**3.73**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 168b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.11	0.0985
Grass	0.25	0.08	0.0197
Woods	0.15	0.79	0.1180
	Σ	**0.98**	0.2362

$C_{ave} = \frac{0.2362}{0.98} = 0.24$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.11	0.0985
Grass	0.25	0.08	0.0197
Woods	0.15	0.79	0.1180
	Σ	**0.98**	0.2362

$C_{ave} = \frac{0.2362}{0.98} = 0.24$

T_c =	22.84	min.								
I_{05} =	4.21	in / hr								
I_{10} =	4.67	in / hr								
I_{25} =	5.34	in / hr								
I_{50} =	5.84	in / hr								
I_{100} =	6.36	in / hr								

Pre Construction Runoff:

Q_{05} =	0.24	**x**	4.21	**x**	0.98	**x**	1	=	**1.00**	cfs
Q_{10} =	0.24	**x**	4.67	**x**	0.98	**x**	1	=	**1.10**	cfs
Q_{25} =	0.24	**x**	5.34	**x**	0.98	**x**	1.1	=	**1.39**	cfs
Q_{50} =	0.24	**x**	5.84	**x**	0.98	**x**	1.2	=	**1.66**	cfs
Q_{100} =	0.24	**x**	6.36	**x**	0.98	**x**	1.25	=	**1.88**	cfs

Post Construction Runoff:

Q_{05} =	0.24	**x**	4.21	**x**	0.98	**x**	1	=	**1.00**	cfs
Q_{10} =	0.24	**x**	4.67	**x**	0.98	**x**	1	=	**1.10**	cfs
Q_{25} =	0.24	**x**	5.34	**x**	0.98	**x**	1.1	=	**1.39**	cfs
Q_{50} =	0.24	**x**	5.84	**x**	0.98	**x**	1.2	=	**1.66**	cfs
Q_{100} =	0.24	**x**	6.36	**x**	0.98	**x**	1.25	=	**1.88**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 166aa	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Grass				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.240**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.225**	+		=	**0.225**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved		unpaved		
8	Flow length, L	----------	ft	**900**		**300**		
9	Watercourse slope, s	----------	ft/ft	**0.0578**		**0.0001**		
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.88**		**0.16**		
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.064**	+	**0.516**	=	**0.581**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)			----------			hr	**0.806**
							min	**48.35**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 166c Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Wooded				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft	**100**					
4 Two-yr 24-hr rainfall, P_2		in	**3.58**					
5 Land slope, s		ft/ft	**0.0500**					
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.408**	+		=	**0.408**	
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)				unpaved				
8 Flow length, L		ft	**1040**					
9 Watercourse slope, s		ft/ft	**0.0600**					
10 Average velocity, V (figure 3-1)		ft/s	**3.95**					
11 $T_t = L / (3600\ V)$	Compute T_t	hr	**0.073**	+		=	**0.073**	
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2	**0.00**	**0.00**				
13 Wetted perimeter, p_w		ft	**0.00**	**0.00**				
14 Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**	**#DIV/0!**				
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**	**#DIV/0!**				
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.481**
							min	**28.89**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 168b	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Wooded				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0700**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.357**	+		=	**0.357**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**390**				
9	Watercourse slope, s		ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)		ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.024**	+		=	**0.024**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.000**	+	**0.000**	=	**0.000**
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.381**
							min	**22.84**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-166/167/168		Outlet	OP	422.62	422.62	0.00	0.48	0.00	48.63	0.00	33.68	0.35	0.00
CB-166c		Other	C.B. TYPE 112	428.40	428.40	5.34	0.45	48.59	48.59	55.62	33.68	0.35	3.94
CB-168b		Other	C.B. TYPE 112	443.57	443.57	2.88	0.07	22.84	22.84	3.84	1.55	0.35	5.90
CB-166b		Other	C.B. TYPE 112	431.16	431.16	4.16	0.70	48.39	48.39	49.12	27.42	0.38	3.95
CB-168a		Other	C.B. TYPE 112	447.27	447.27	3.93	0.00	5.00	5.00	3.30	0.57	0.54	9.03
DN-166a		Other	DUMMY JOINT	428.62	428.62	0.00	0.00	48.35	48.35	43.17	25.50	0.36	3.96
CB-167		Other	C.B. TYPE 112	434.58	434.58	3.58	0.00	5.00	5.00	6.80	0.95	0.66	9.03

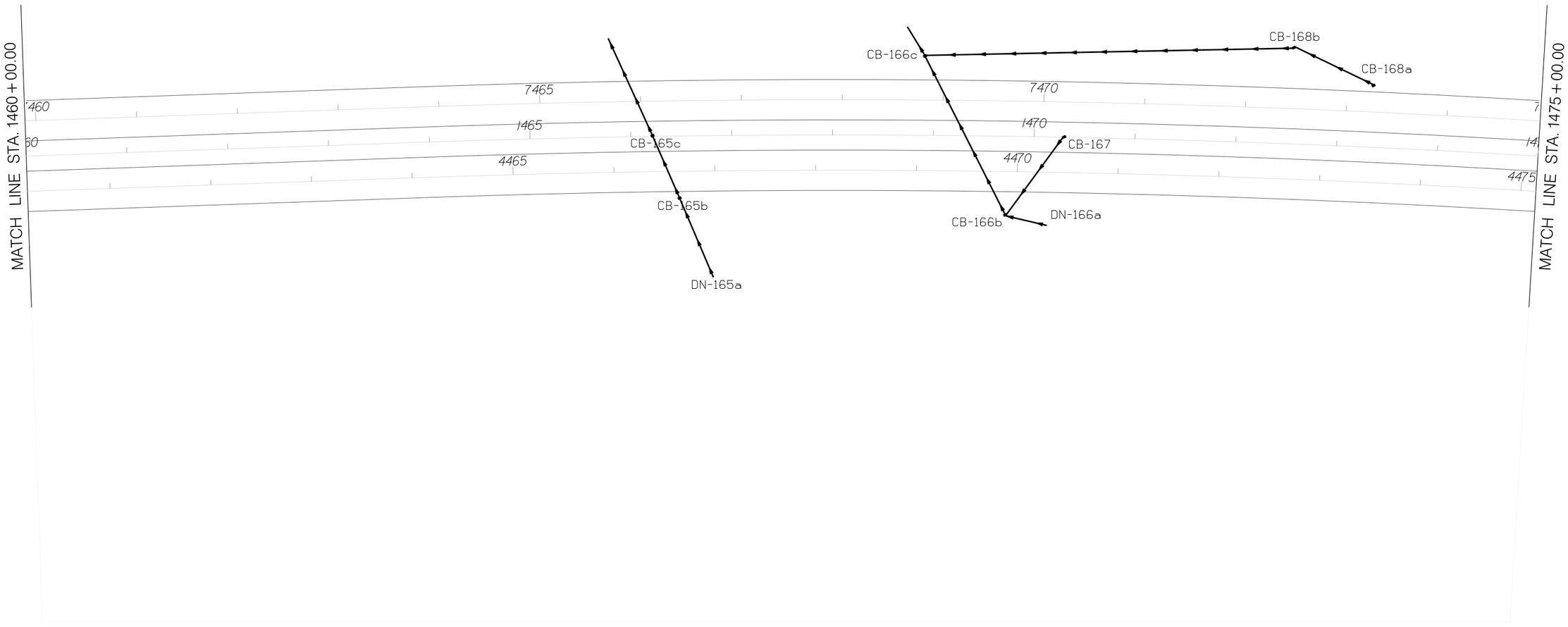
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-45	CB-166c	OF-166/167/168	Circular	Concrete	1	3.00	33	1.34	55.62	90.08	1.79	12.67	426.06	425.94	425.62	424.65	423.06	422.62	7.98	10.93	2.88	2.03
NP-41	CB-168b	CB-166c	Circular	Concrete	1	1.50	363	4.68	3.84	26.48	0.40	10.13	442.19	441.65	425.20	424.10	440.69	423.70	3.23	10.13	0.96	0.40
NP-44	CB-166b	CB-166c	Circular	Concrete	1	3.00	175	2.26	49.12	116.77	1.42	14.96	430.00	430.02	426.06	424.52	427.00	423.06	6.95	14.32	3.00	1.46
NP-40	CB-168a	CB-168b	Circular	Concrete	1	1.50	86	2.37	3.30	18.84	0.44	7.61	444.84	444.35	442.81	441.75	443.34	441.31	2.61	7.56	1.01	0.44
NP-42	DN-166a	CB-166b	Circular	Concrete	1	3.00	42	3.89	43.17	153.25	1.13	17.66	431.62	432.13	430.00	428.39	428.62	427.00	6.11	13.53	3.00	1.39
NP-43	CB-167	CB-166b	Circular	Concrete	1	1.25	94	4.24	6.80	15.50	0.60	11.58	432.25	433.05	428.25	427.61	431.00	427.00	5.54	11.38	1.25	0.61

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-166c	28.89	5.43	5.29	0.18	4.71	0.18	4.71	0.00	0.00
CB-168b	22.84	1.68	5.90	0.24	0.98	0.24	0.98	0.00	0.00
CB-166b	5.00	6.85	9.03	0.65	0.97	0.65	0.97	0.00	0.00
CB-168a	5.00	3.30	9.03	0.54	0.57	0.54	0.57	0.00	0.00
DN-166a	48.35	43.17	3.96	0.36	25.50	0.36	25.50	0.00	0.00
CB-167	5.00	6.80	9.03	0.66	0.95	0.66	0.95	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	65



REVISIONS NO.	DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

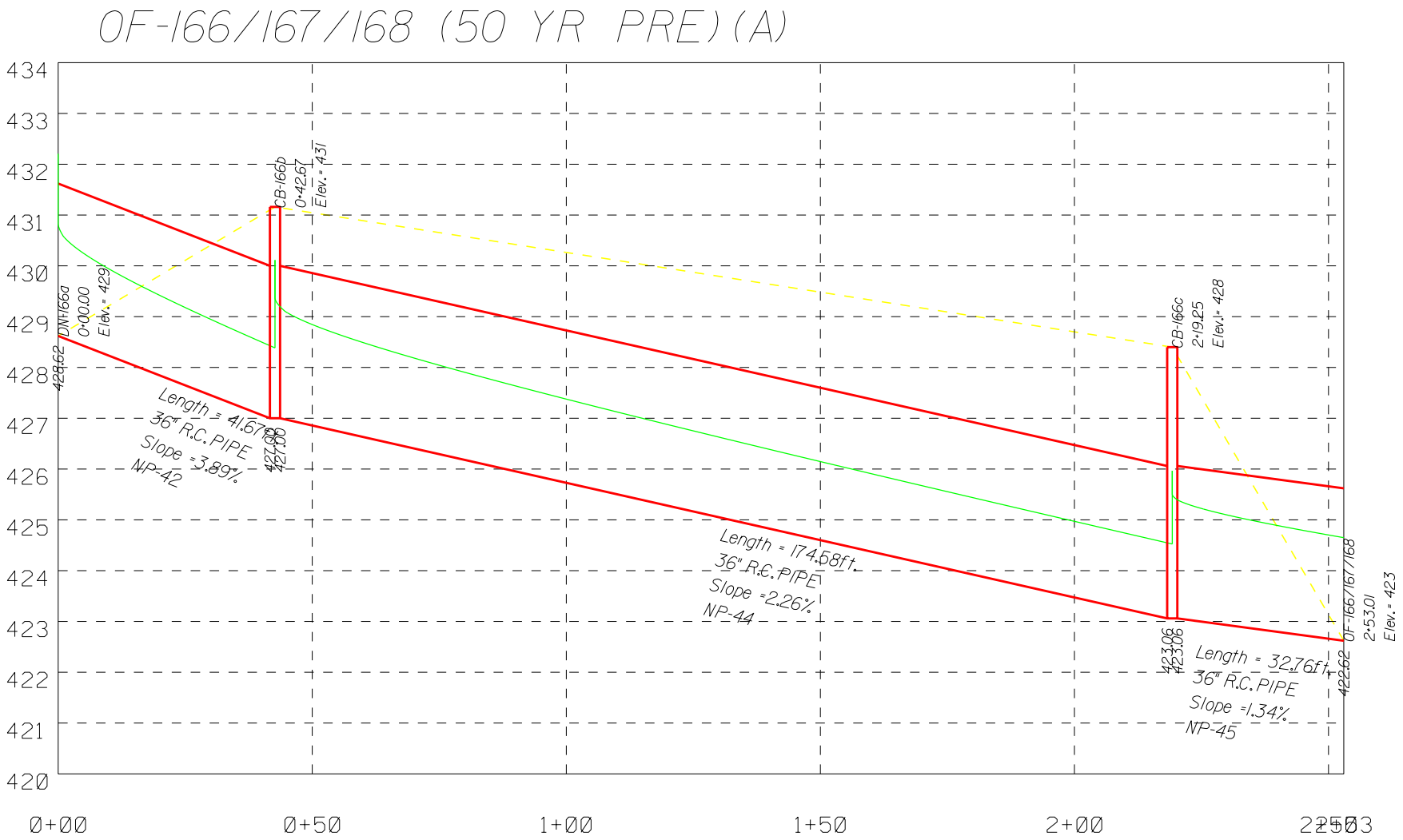
SCALE: 1" = 50' HORIZ

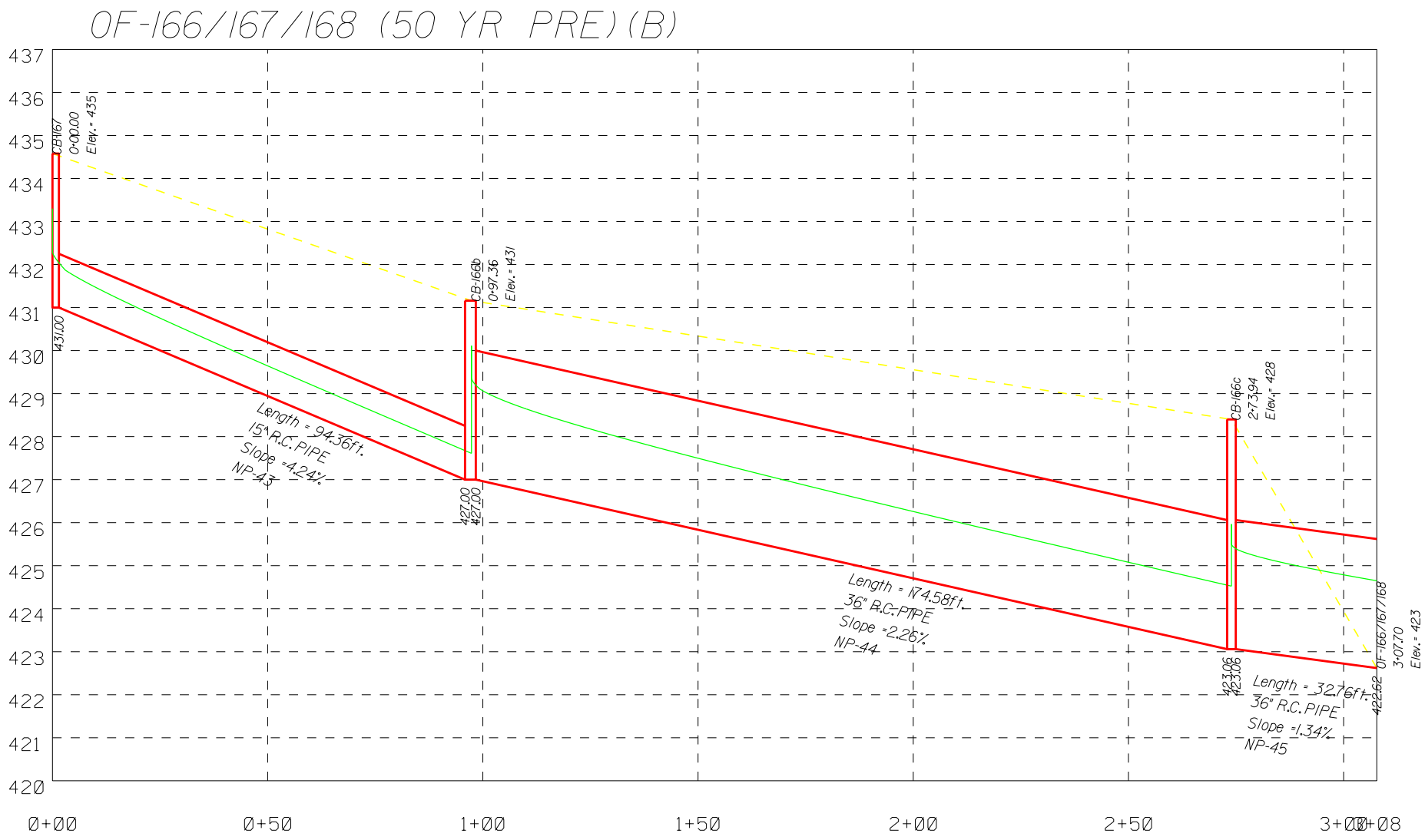
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1460+00.00 TO STA. 1475+00.00

$$$$$$path$$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-166/167/168 (50 YR PRE)(A)
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
2+53.01
DM-166a
0+00.00
Elev.= 429
428.62
CB-166b
0+42.67
Elev.= 431
427.00
427.00
Length = 41.67ft.
36" R.C. PIPE
Slope =3.89%
NP-42
Length = 174.58ft.
36" R.C. PIPE
Slope =2.26%
NP-44
CB-166c
2+19.25
Elev.= 428
423.06
423.06
Length = 32.76ft.
36" R.C. PIPE
Slope =1.34%
NP-45
422.62
OF-166/167/168
2+53.01
Elev.= 423


OF-166/167/168 (50 YR PRE)(B)
437
436
435
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+08
CB1167
0+00.00
Elev.= 435
431.00
Length = 94.36ft.
15" R.C. PIPE
Slope =4.24%
NP-43
CB-166b
0+97.36
Elev.= 431
427.00
427.00
Length = 174.58ft.
36" R.C. PIPE
Slope =2.26%
NP-44
CB-166c
2+73.94
Elev.= 428
423.06
423.06
Length = 32.76ft.
36" R.C. PIPE
Slope =1.34%
NP-45
OF-166/167/168
3+07.70
Elev.= 423
422.62


OF-166/167/168 (50 YR PRE)(C)
CB-166a
0+00.00
Elev.= 447
443.54
Length = 85.71ft.
18" R.C. PIPE
Slope =2.37%
NP-40
CB-168b
0+88.21
Elev.= 444
441.31
440.89
Length = 363.11ft.
18" R.C. PIPE
Slope =4.68%
NP-41
CB-166c
4+54.33
Elev.= 428
433.70
423.06
Length = 32.76ft.
36" R.C. PIPE
Slope =1.34%
NP=45
422.62
OF-166/167/168
4+88.09
Elev.= 423
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
435
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+88

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

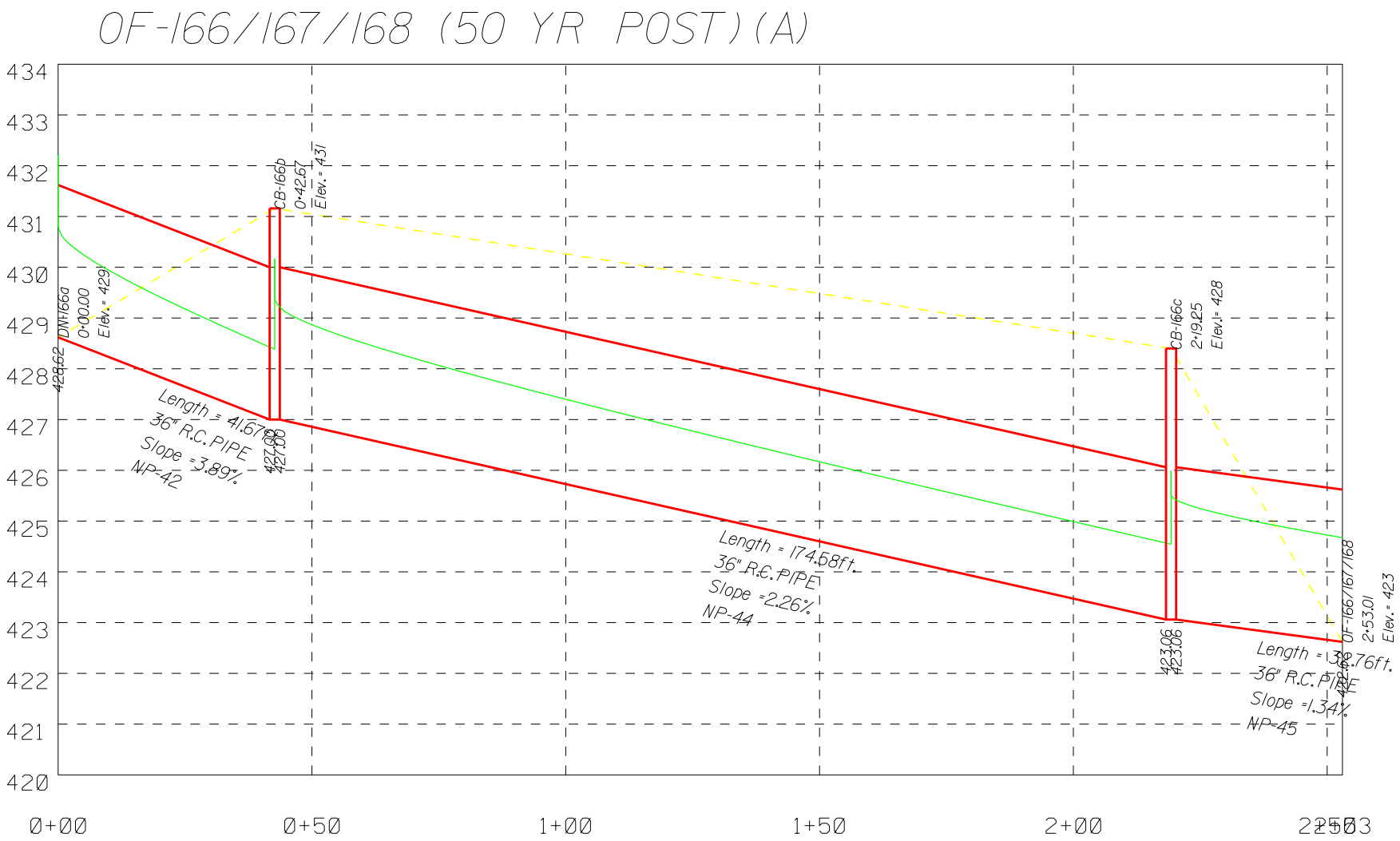
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-166/167/168	Outlet	OP	422.62	422.62	0.00	0.48	0.00	48.63	0.00	33.68	0.36	0.00
CB-166c	Other	C.B. TYPE 112	428.40	428.40	5.34	0.45	48.59	48.59	56.70	33.68	0.36	3.94
CB-168b	Other	C.B. TYPE 112	443.57	443.57	2.88	0.07	22.84	22.84	3.84	1.55	0.35	5.90
CB-166b	Other	C.B. TYPE 112	431.16	431.16	4.16	0.73	48.39	48.39	50.20	27.42	0.39	3.95
CB-168a	Other	C.B. TYPE 112	447.27	447.27	3.93	0.00	5.00	5.00	3.30	0.57	0.54	9.03
DN-166a	Other	DUMMY JOINT	428.62	428.62	0.00	0.00	48.35	48.35	43.17	25.50	0.36	3.96
CB-167	Other	C.B. TYPE 112	434.58	434.58	3.58	0.00	5.00	5.00	7.51	0.77	0.90	9.03

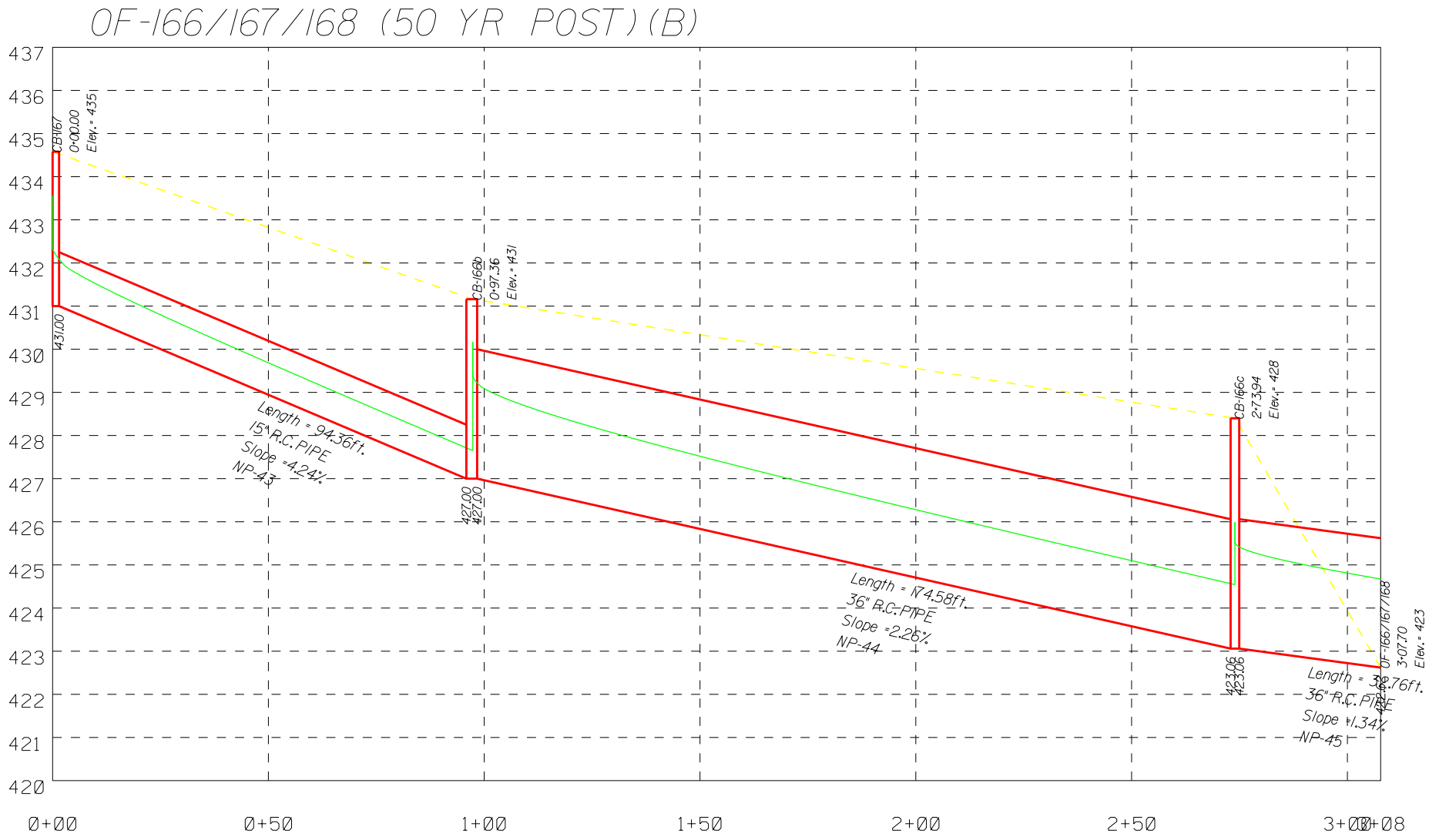
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-45	CB-166c	DF-166/167/168	Circular	Concrete	1	3.00	33	1.34	56.70	90.08	1.81	12.72	426.06	425.96	425.62	424.67	423.06	422.62	8.10	11.00	2.90	2.05
NP-41	CB-168b	CB-166c	Circular	Concrete	1	1.50	363	4.68	3.84	26.48	0.40	10.13	442.19	441.65	425.20	424.10	440.69	423.70	3.23	10.13	0.96	0.40
NP-44	CB-166b	CB-166c	Circular	Concrete	1	3.00	175	2.26	50.20	116.77	1.43	15.06	430.00	430.08	426.06	424.54	427.00	423.06	7.10	14.40	3.00	1.48
NP-40	CB-168a	CB-168b	Circular	Concrete	1	1.50	86	2.37	3.30	18.84	0.44	7.61	444.84	444.35	442.81	441.75	443.34	441.31	2.61	7.56	1.01	0.44
NP-42	DN-166a	CB-166b	Circular	Concrete	1	3.00	42	3.89	43.17	153.25	1.13	17.66	431.62	432.13	430.00	428.39	428.62	427.00	6.11	13.53	3.00	1.39
NP-43	CB-167	CB-166b	Circular	Concrete	1	1.25	94	4.24	7.51	15.50	0.64	11.86	432.25	433.31	428.25	427.65	431.00	427.00	6.12	11.65	1.25	0.65

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-166c	28.89	5.43	5.29	0.18	4.71	0.18	4.71	0.00	0.00
CB-168b	22.84	1.68	5.90	0.24	0.98	0.24	0.98	0.00	0.00
CB-166b	5.00	8.61	9.03	0.69	1.15	0.69	1.15	0.00	0.00
CB-168a	5.00	3.30	9.03	0.54	0.57	0.54	0.57	0.00	0.00
DN-166a	48.35	43.17	3.96	0.36	25.50	0.36	25.50	0.00	0.00
CB-167	5.00	7.51	9.03	0.90	0.77	0.90	0.77	0.00	0.00


OF-166/167/168 (50 YR POST)(A)
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
2+53
DM-166a
0+00.00
Elev.= 429
428.62
CB-166b
0+42.67
Elev.= 431
427.00
427.00
Length = 41.67ft.
36" R.C. PIPE
Slope =3.89%
NP=42
CB-166c
2+19.25
Elev.= 428
423.06
423.06
Length = 174.58ft.
36" R.C. PIPE
Slope =2.26%
NP=44
OF-166/167/168
2+53.01
Elev.= 423
Length = 36.76ft.
36" R.C. PIPE
Slope =1.34%
NP=45


OF-166/167/168 (50 YR POST)(B)
437
436
435
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+08
CB1167
0+00.00
Elev.= 435
431.00
Length = 94.36ft.
15" R.C. PIPE
Slope =4.24%
NP-43
CB-166b
1+97.36
Elev.= 431
427.00
427.00
Length = 174.58ft.
36" R.C. PIPE
Slope =2.26%
NP-44
CB-166c
2+73.94
Elev.= 428
423.06
423.06
Length = 36.76ft.
36" R.C. PIPE
Slope =1.34%
NP-45
OF-166/167/168
3+07.70
Elev.= 423


OF-166/167/168 (50 YR POST)(C)
CB-166a
0+00.00
Elev.= 447
443.54
Length = 85.71ft.
18" R.C. PIPE
Slope =2.37%
NP-40
CB-168b
0+88.21
Elev.= 444
441.31
440.89
Length = 363.11ft.
18" R.C. PIPE
Slope =4.68%
NP-41
CB-166c
4+54.33
Elev.= 428
423.29
423.06
Length = 38.76ft.
36" R.C. PIPE
Slope =1.34%
NP-45
OF-166/167/168
4+88.09
Elev.= 423
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
435
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+88

CULVERT 169/170

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 169a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7857
Grass	0.25	0.75	0.1880
Woods	0.15	0.22	0.0326
	Σ	**1.84**	1.0063

$C_{ave} = \frac{1.0063}{1.84} = 0.55$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.06	0.9567
Grass	0.25	0.75	0.1880
Woods	0.15	0.22	0.0326
	Σ	**2.03**	1.1773

$C_{ave} = \frac{1.1773}{2.03} = 0.58$

T_c =	25.14	min.
I_{05} =	4.04	in / hr
I_{10} =	4.48	in / hr
I_{25} =	5.12	in / hr
I_{50} =	5.60	in / hr
I_{100} =	6.08	in / hr

Pre Construction Runoff:

Q_{05} =	0.55	x	4.04	x	1.84	x	1	=	**4.07**	cfs
Q_{10} =	0.55	x	4.48	x	1.84	x	1	=	**4.51**	cfs
Q_{25} =	0.55	x	5.12	x	1.84	x	1.1	=	**5.67**	cfs
Q_{50} =	0.55	x	5.60	x	1.84	x	1.2	=	**6.76**	cfs
Q_{100} =	0.55	x	6.08	x	1.84	x	1.25	=	**7.65**	cfs

Post Construction Runoff:

Q_{05} =	0.58	x	4.04	x	2.03	x	1	=	**4.76**	cfs
Q_{10} =	0.58	x	4.48	x	2.03	x	1	=	**5.28**	cfs
Q_{25} =	0.58	x	5.12	x	2.03	x	1.1	=	**6.63**	cfs
Q_{50} =	0.58	x	5.60	x	2.03	x	1.2	=	**7.91**	cfs
Q_{100} =	0.58	x	6.08	x	2.03	x	1.25	=	**8.95**	cfs

MICHAEL BAKER INTERNATIONAL
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Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 169b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.67	0.6059
Grass	0.25	0.55	0.1366
Woods	0.15	0.00	0.0000
	Σ	**1.22**	0.7424

$C_{ave} = \frac{0.7424}{1.22} =$ **0.61**

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.84	0.7560
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.84**	0.7560

$C_{ave} = \frac{0.7560}{0.84} =$ **0.90**

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.61	x	6.23	x	1.22	x	1	=	**4.63**	cfs
Q_{10} =	0.61	x	6.98	x	1.22	x	1	=	**5.18**	cfs
Q_{25} =	0.61	x	8.08	x	1.22	x	1.1	=	**6.60**	cfs
Q_{50} =	0.61	x	8.93	x	1.22	x	1.2	=	**7.95**	cfs
Q_{100} =	0.61	x	9.81	x	1.22	x	1.25	=	**9.10**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.84	x	1	=	**4.71**	cfs
Q_{10} =	0.90	x	6.98	x	0.84	x	1	=	**5.28**	cfs
Q_{25} =	0.90	x	8.08	x	0.84	x	1.1	=	**6.72**	cfs
Q_{50} =	0.90	x	8.93	x	0.84	x	1.2	=	**8.10**	cfs
Q_{100} =	0.90	x	9.81	x	0.84	x	1.25	=	**9.27**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 170a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.47	0.4190
Grass	0.25	0.51	0.1283
Woods	0.15	0.00	0.0000
	Σ	**0.98**	0.5472

$C_{ave} = \frac{0.5472}{0.98} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.66	0.5900
Grass	0.25	0.51	0.1283
Woods	0.15	0.00	0.0000
	Σ	**1.17**	0.7182

$C_{ave} = \frac{0.7182}{1.17} = 0.61$

T_c =	5.00 min.
I_{05} =	6.23 in / hr
I_{10} =	6.98 in / hr
I_{25} =	8.08 in / hr
I_{50} =	8.93 in / hr
I_{100} =	9.81 in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.23	x	0.98	x	1	=	**3.41**	cfs
Q_{10} =	0.56	x	6.98	x	0.98	x	1	=	**3.82**	cfs
Q_{25} =	0.56	x	8.08	x	0.98	x	1.1	=	**4.87**	cfs
Q_{50} =	0.56	x	8.93	x	0.98	x	1.2	=	**5.86**	cfs
Q_{100} =	0.56	x	9.81	x	0.98	x	1.25	=	**6.71**	cfs

Post Construction Runoff:

Q_{05} =	0.61	x	6.23	x	1.17	x	1	=	**4.47**	cfs
Q_{10} =	0.61	x	6.98	x	1.17	x	1	=	**5.01**	cfs
Q_{25} =	0.61	x	8.08	x	1.17	x	1.1	=	**6.39**	cfs
Q_{50} =	0.61	x	8.93	x	1.17	x	1.2	=	**7.69**	cfs
Q_{100} =	0.61	x	9.81	x	1.17	x	1.25	=	**8.81**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 170b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.14	0.1265
Grass	0.25	0.39	0.0983
Woods	0.15	0.00	0.0000
	Σ	**0.53**	0.2248

$C_{ave} = \frac{0.2248}{0.53} = 0.42$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.14	0.1265
Grass	0.25	0.39	0.0983
Woods	0.15	0.00	0.0000
	Σ	**0.53**	0.2248

$C_{ave} = \frac{0.2248}{0.53} = 0.42$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.42	**x**	6.23	**x**	0.53	**x**	1	=	**1.40**	cfs
Q_{10} =	0.42	**x**	6.98	**x**	0.53	**x**	1	=	**1.57**	cfs
Q_{25} =	0.42	**x**	8.08	**x**	0.53	**x**	1.1	=	**2.00**	cfs
Q_{50} =	0.42	**x**	8.93	**x**	0.53	**x**	1.2	=	**2.41**	cfs
Q_{100} =	0.42	**x**	9.81	**x**	0.53	**x**	1.25	=	**2.76**	cfs

Post Construction Runoff:

Q_{05} =	0.42	**x**	6.23	**x**	0.53	**x**	1	=	**1.40**	cfs
Q_{10} =	0.42	**x**	6.98	**x**	0.53	**x**	1	=	**1.57**	cfs
Q_{25} =	0.42	**x**	8.08	**x**	0.53	**x**	1.1	=	**2.00**	cfs
Q_{50} =	0.42	**x**	8.93	**x**	0.53	**x**	1.2	=	**2.41**	cfs
Q_{100} =	0.42	**x**	9.81	**x**	0.53	**x**	1.25	=	**2.76**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 169a Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1 Surface Desciption (table 3-1)				Grass				
2 Manning's roughness coeff., n (table 3-1)				**0.800**				
3 Flow length, L (total L < or = 100)		ft		**80**				
4 Two-yr 24-hr rainfall, P_2		in		**3.58**				
5 Land slope, s		ft/ft		**0.0300**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr		**0.419**	+		=	**0.419**
Shallow Concentrated Flow			Segment ID					
7 Surface Desciption (paved or unpaved)								
8 Flow length, L		ft						
9 Watercourse slope, s		ft/ft						
10 Average velocity, V (figure 3-1)		ft/s						
11 $T_t = L / (3600\ V)$	Compute T_t	hr			+		=	**0.000**
Channel Flow			Segment ID					
Front Slope, (_ : 1)								
Back Slope, (_ : 1)								
Bottom Width		ft						
Flow Depth		ft						
12 Cross sectional flow area, a		ft^2		**0.00**		**0.00**		
13 Wetted perimeter, p_w		ft		**0.00**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r	ft		**#DIV/0!**		**#DIV/0!**		
15 Channel Slope, s		ft/ft						
16 Manning's roughness coeff., n								
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s		**#DIV/0!**		**#DIV/0!**		
18 Flow length, L		ft						
19 $T_t = L / (3600\ V)$	Compute T_t	hr		**#DIV/0!**	+	**#DIV/0!**	=	
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)							hr	**0.419**
							min	**25.14**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-169/170		Outlet	OP	448.29	448.29	0.00	0.48	0.00	25.52	0.00	4.04	0.57	0.00
DN-170b		Other	DUMMY JOINT	456.00	456.00	3.77	0.09	25.42	25.46	15.49	4.04	0.57	5.62
CB-170a		Other	C.B. TYPE 112	455.23	455.23	2.50	0.06	25.42	25.42	15.49	4.04	0.57	5.62
CB-169b		Other	C.B. TYPE 112	457.44	457.44	3.83	0.05	25.25	25.25	11.81	3.06	0.57	5.64
CB-169a		Other	C.B. TYPE 112	458.95	458.95	3.54	0.00	25.14	25.14	6.81	1.84	0.55	5.65

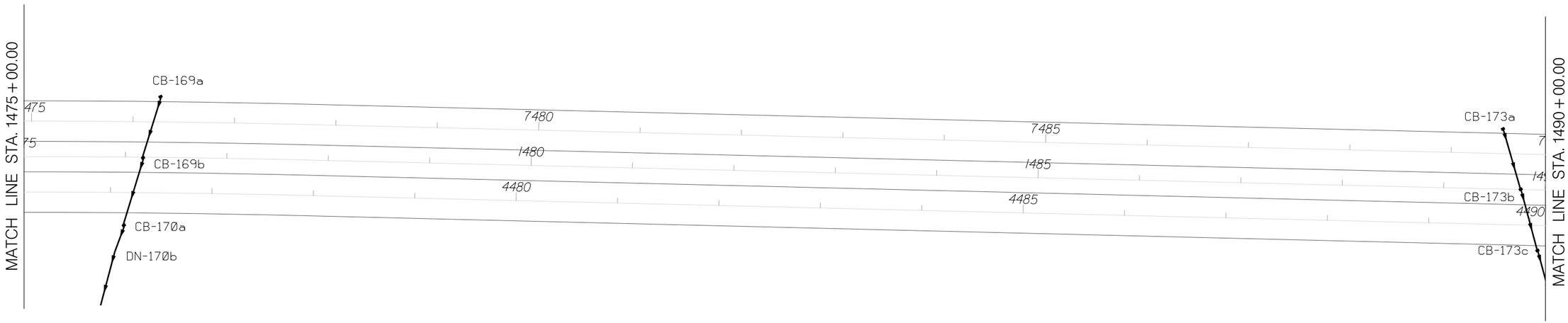
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-39	DN-170b	OF-169/170	Circular	Concrete	1	1.50	54	7.23	15.49	32.92	0.76	17.36	453.73	453.73	449.79	449.12	452.23	448.29	8.76	15.45	1.50	0.83
NP-38	CB-170a	DN-170b	Circular	Concrete	1	1.50	27	1.84	15.49	16.62	1.23	9.97	454.23	454.31	453.73	453.73	452.73	452.23	8.76	8.76	1.50	1.50
NP-37	CB-169b	CB-170a	Circular	Concrete	1	1.50	68	0.87	11.81	11.42	1.50	6.85	455.11	455.14	454.52	454.33	453.61	453.02	6.68	7.23	1.50	1.31
NP-36	CB-169a	CB-169b	Circular	Concrete	1	1.50	61	2.82	6.81	20.57	0.62	9.90	456.91	457.01	455.18	454.32	455.41	453.68	3.85	9.49	1.50	0.64

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-170a	5.00	5.96	9.03	0.56	0.98	0.56	0.98	0.00	0.00
CB-169b	5.00	8.02	9.03	0.61	1.22	0.61	1.22	0.00	0.00
CB-169a	25.14	6.81	5.65	0.55	1.84	0.55	1.84	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	66



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

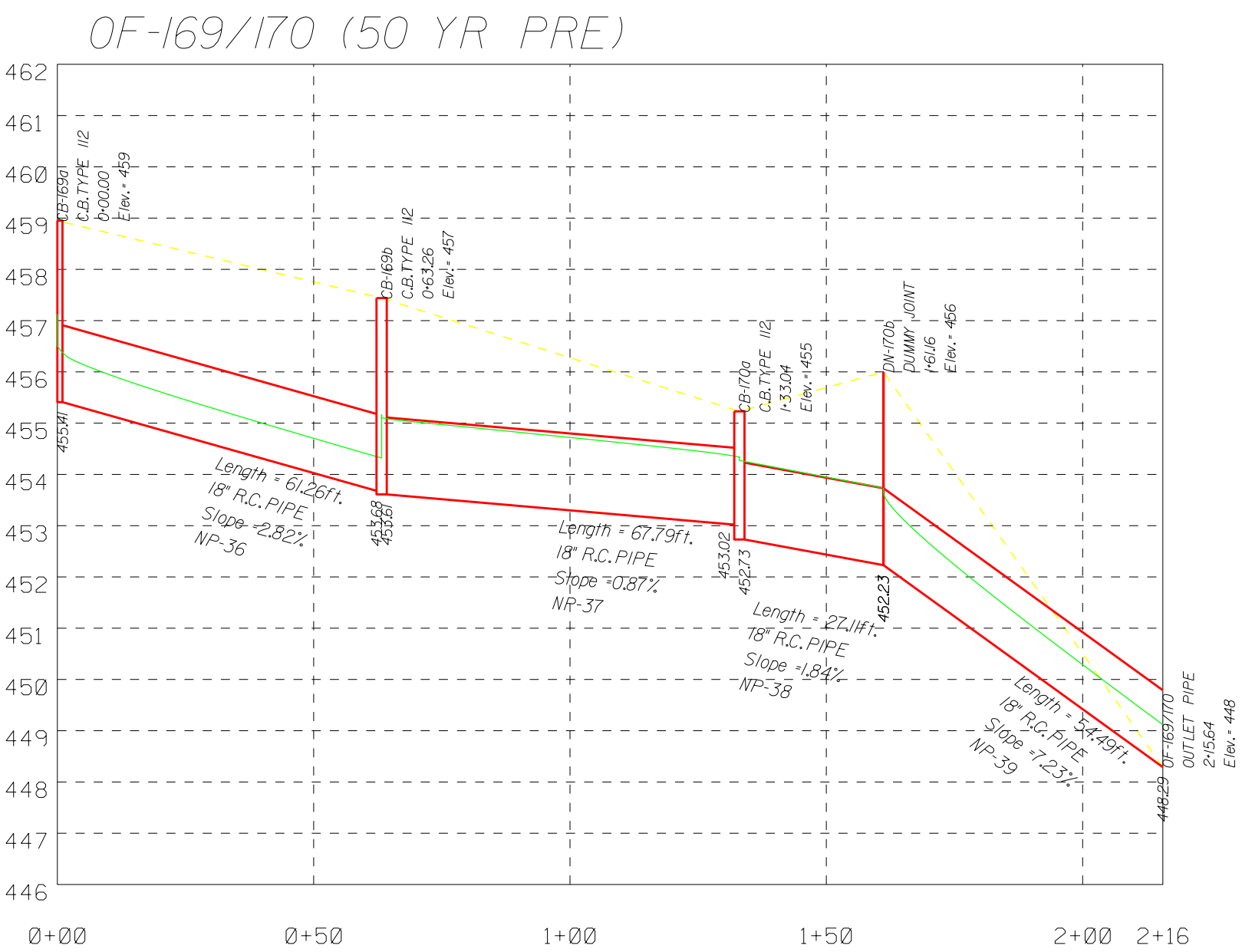
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1475+00.00 TO STA. 1490+00.00

$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$


OF-169/170 (50 YR PRE)
462
461
460
459
458
457
456
455
454
453
452
451
450
449
448
447
446
0+00
0+50
1+00
1+50
2+00
2+16
CB-169a
C.B. TYPE II2
0+00.00
Elev.= 459
455.41
CB-169b
C.B. TYPE II2
0+63.26
Elev.= 457
453.68
453.51
CB-170a
C.B. TYPE II2
1+33.04
Elev.=455
453.02
452.73
DN-170b
DUMMY JOINT
1+61.16
Elev.= 456
452.23
OF-169/170
OUTLET PIPE
2+15.64
Elev.= 448
448.29
Length = 61.26ft.
18" R.C. PIPE
Slope =2.82%
NP-36
Length = 67.79ft.
18" R.C. PIPE
Slope =0.87%
NR-37
Length = 27.14ft.
18" R.C. PIPE
Slope =1.84%
NP-38
Length = 54.49ft.
18" R.C. PIPE
Slope =1.23%
NP-39

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

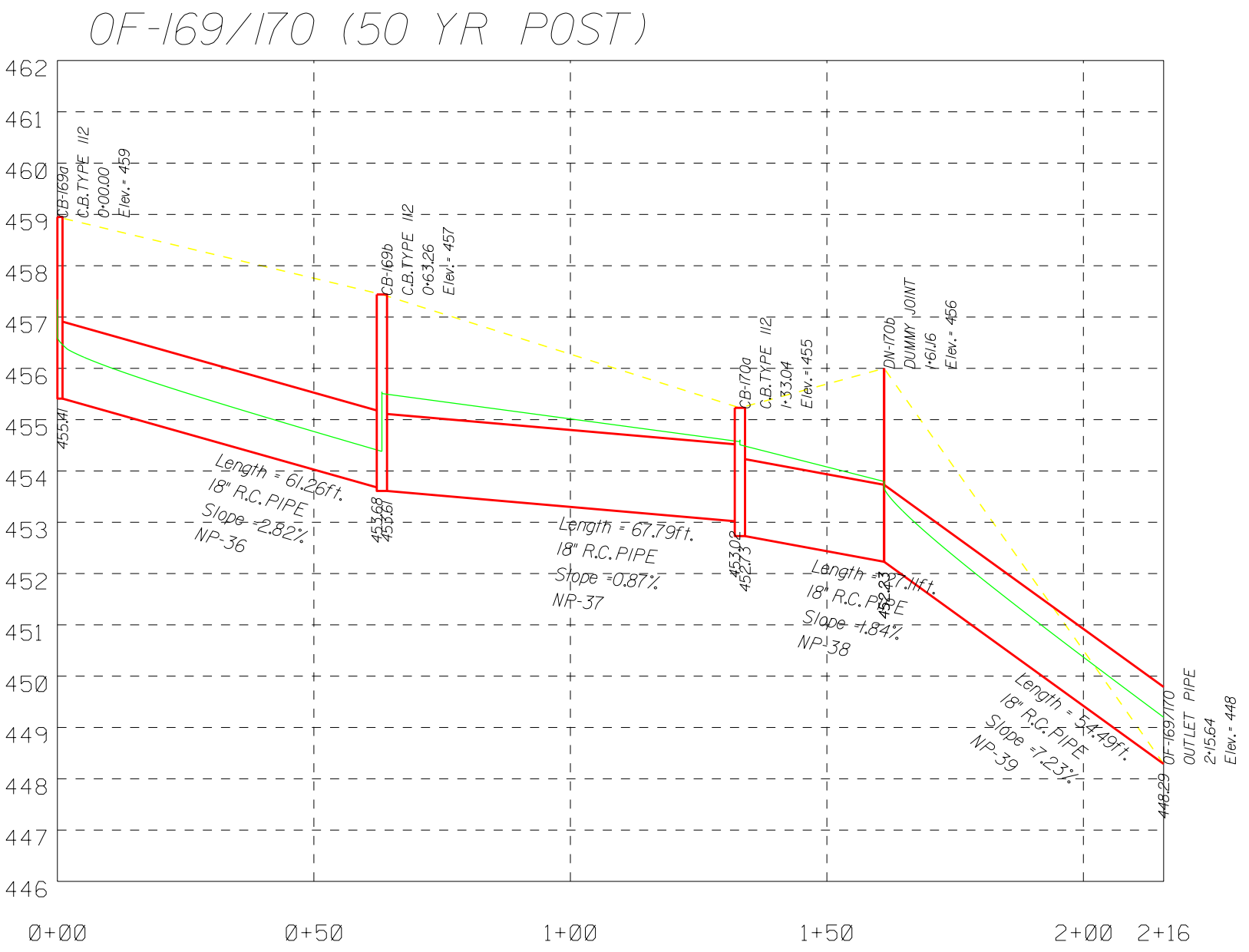
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-169/170	Outlet	OP	448.29	448.29	0.00	0.48	0.00	25.49	0.00	4.04	0.66	0.00
DN-170b	Other	DUMMY JOINT	456.00	456.00	3.77	0.11	25.40	25.44	17.90	4.04	0.66	5.63
CB-170a	Other	C.B. TYPE 112	455.23	455.23	2.50	0.08	25.40	25.40	17.90	4.04	0.66	5.63
CB-169b	Other	C.B. TYPE 112	457.44	457.44	3.83	0.02	25.24	25.24	13.07	2.87	0.67	5.64
CB-169a	Other	C.B. TYPE 112	458.95	458.95	3.54	0.00	25.14	25.14	7.97	2.03	0.58	5.65

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-39	DN-170b	OF-169/170	Circular	Concrete	1	1.50	54	7.23	17.90	32.92	0.82	18.00	453.73	453.79	449.79	449.20	452.23	448.29	10.13	15.96	1.50	0.91
NP-38	CB-170a	DN-170b	Circular	Concrete	1	1.50	27	1.84	17.90	16.62	1.50	10.39	454.23	454.57	453.73	453.79	452.73	452.23	10.13	10.13	1.50	1.50
NP-37	CB-169b	CB-170a	Circular	Concrete	1	1.50	68	0.87	13.07	11.42	1.50	7.59	455.11	455.51	454.52	454.57	453.61	453.02	7.40	7.40	1.50	1.50
NP-36	CB-169a	CB-169b	Circular	Concrete	1	1.50	61	2.82	7.97	20.57	0.68	10.33	456.91	457.23	455.18	454.38	455.41	453.68	4.51	9.82	1.50	0.70

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-170a	5.00	7.82	9.03	0.62	1.17	0.62	1.17	0.00	0.00
CB-169b	5.00	8.19	9.03	0.90	0.84	0.90	0.84	0.00	0.00
CB-169a	25.14	7.97	5.65	0.58	2.03	0.58	2.03	0.00	0.00


OF-169/170 (50 YR POST)
462
461
460
459
458
457
456
455
454
453
452
451
450
449
448
447
446
0+00
0+50
1+00
1+50
2+00
2+16
CB-169a
C.B.TYPE II2
0+00.00
Elev.= 459
455.41
CB-169b
C.B.TYPE II2
0+63.26
Elev.= 457
453.68
453.51
CB-170a
C.B.TYPE II2
1+33.04
Elev.=455
453.08
452.73
DN-170b
DUMMY JOINT
1+61.16
Elev.= 456
452.23
Length = 61.26ft.
18" R.C. PIPE
Slope =2.82%
NP-36
Length = 67.79ft.
18" R.C. PIPE
Slope =0.87%
NR-37
Length = 37.11ft.
18" R.C. PIPE
Slope =1.84%
NP-38
Length = 54.49ft.
18" R.C. PIPE
Slope =1.23%
NP-39
448.29
OF-169/170
OUTLET PIPE
2+15.64
Elev.= 448

CULVERT 171/172

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 171/172**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.41	0.3649
Grass	0.25	1.22	0.3056
Woods	0.15	0.37	0.0551
	Σ	**2.00**	0.7256

$C_{ave} = \frac{0.7256}{2.00} = 0.36$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4369
Grass	0.25	1.22	0.3056
Woods	0.15	0.37	0.0551
	Σ	**2.08**	0.7976

$C_{ave} = \frac{0.7976}{2.08} = 0.38$

T_c =	14.73	min.
I_{05} =	4.94	in / hr
I_{10} =	5.50	in / hr
I_{25} =	6.32	in / hr
I_{50} =	6.93	in / hr
I_{100} =	7.57	in / hr

Pre Construction Runoff:

Q_{05} =	0.36	x	4.94	x	2.00	x	1	=	**3.59**	cfs
Q_{10} =	0.36	x	5.50	x	2.00	x	1	=	**3.99**	cfs
Q_{25} =	0.36	x	6.32	x	2.00	x	1.1	=	**5.04**	cfs
Q_{50} =	0.36	x	6.93	x	2.00	x	1.2	=	**6.03**	cfs
Q_{100} =	0.36	x	7.57	x	2.00	x	1.25	=	**6.86**	cfs

Post Construction Runoff:

Q_{05} =	0.38	x	4.94	x	2.08	x	1	=	**3.94**	cfs
Q_{10} =	0.38	x	5.50	x	2.08	x	1	=	**4.39**	cfs
Q_{25} =	0.38	x	6.32	x	2.08	x	1.1	=	**5.54**	cfs
Q_{50} =	0.38	x	6.93	x	2.08	x	1.2	=	**6.63**	cfs
Q_{100} =	0.38	x	7.57	x	2.08	x	1.25	=	**7.54**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 171/172	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Grass				
2	Manning's roughness coeff., n (table 3-1)			**0.240**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.225**	+		=	**0.225**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**170**				
9	Watercourse slope, s		ft/ft	**0.0200**				
10	Average velocity, V (figure 3-1)		ft/s	**2.28**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.021**	+		=	**0.021**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.246**
							min	**14.73**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.04 cfs

Design Flow: 6.03 cfs

Maximum Flow: 6.86 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1483+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.19	5.04	5.04	0.00	1
476.22	5.22	5.22	0.00	1
476.25	5.40	5.40	0.00	1
476.27	5.59	5.59	0.00	1
476.30	5.77	5.77	0.00	1
476.32	5.95	5.95	0.00	1
476.33	6.03	6.03	0.00	1
476.38	6.31	6.31	0.00	1
476.40	6.50	6.50	0.00	1
476.43	6.68	6.68	0.00	1
476.45	6.86	6.86	0.00	1
480.00	15.17	15.17	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.04	5.04	476.19	1.244	0.0*	1-S2n	0.679	0.859	0.679	0.587	6.272	2.703
5.22	5.22	476.22	1.270	0.0*	1-S2n	0.693	0.878	0.693	0.598	6.330	2.730
5.40	5.40	476.25	1.296	0.0*	1-S2n	0.707	0.893	0.707	0.609	6.384	2.756
5.59	5.59	476.27	1.322	0.0*	1-S2n	0.721	0.908	0.721	0.620	6.438	2.782
5.77	5.77	476.30	1.348	0.0*	1-S2n	0.734	0.923	0.734	0.630	6.490	2.807
5.95	5.95	476.32	1.374	0.0*	1-S2n	0.748	0.938	0.748	0.641	6.539	2.831
6.03	6.03	476.33	1.385	0.0*	1-S2n	0.754	0.944	0.754	0.645	6.560	2.842
6.31	6.31	476.38	1.426	0.0*	1-S2n	0.775	0.966	0.775	0.661	6.634	2.878
6.50	6.50	476.40	1.452	0.0*	1-S2n	0.789	0.984	0.789	0.670	6.679	2.901
6.68	6.68	476.43	1.478	0.0*	1-S2n	0.802	0.997	0.802	0.680	6.723	2.923
6.86	6.86	476.45	1.505	0.0*	5-S2n	0.816	1.011	0.816	0.690	6.765	2.944

* Full Flow Headwater elevation is below inlet invert.

****

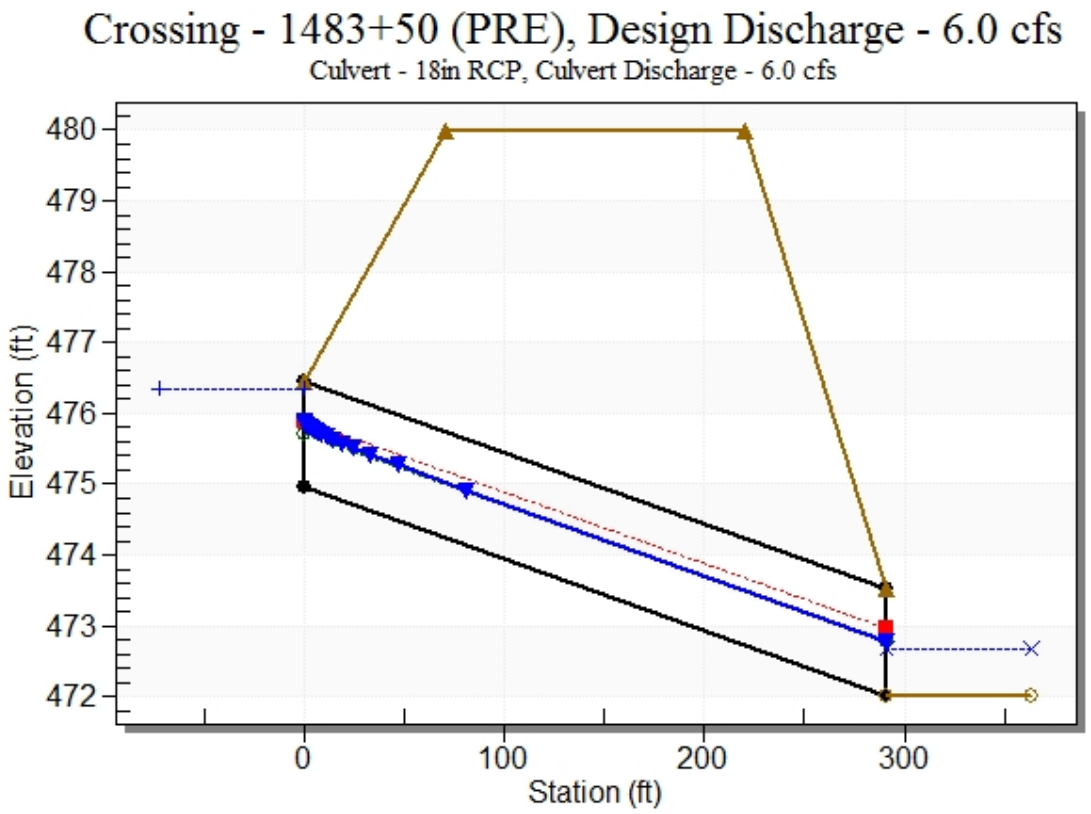
Straight Culvert

Inlet Elevation (invert): 474.95 ft, Outlet Elevation (invert): 472.02 ft

Culvert Length: 291.01 ft, Culvert Slope: 0.0101

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 474.95 ft

Outlet Station: 291.00 ft

Outlet Elevation: 472.02 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1483+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.04	472.61	0.59	2.70	1.47	0.73
5.22	472.62	0.60	2.73	1.49	0.73
5.40	472.63	0.61	2.76	1.52	0.73
5.59	472.64	0.62	2.78	1.55	0.73
5.77	472.65	0.63	2.81	1.57	0.73
5.95	472.66	0.64	2.83	1.60	0.73
6.03	472.67	0.65	2.84	1.61	0.74
6.31	472.68	0.66	2.88	1.65	0.74
6.50	472.69	0.67	2.90	1.67	0.74
6.68	472.70	0.68	2.92	1.70	0.74
6.86	472.71	0.69	2.94	1.72	0.74

Tailwater Channel Data - 1483+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 472.02 ft

Roadway Data for Crossing: 1483+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 480.00 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.54 cfs

Design Flow: 6.63 cfs

Maximum Flow: 7.54 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1483+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
476.27	5.54	5.54	0.00	1
476.29	5.74	5.74	0.00	1
476.32	5.94	5.94	0.00	1
476.35	6.14	6.14	0.00	1
476.38	6.34	6.34	0.00	1
476.41	6.54	6.54	0.00	1
476.42	6.63	6.63	0.00	1
476.47	6.94	6.94	0.00	1
476.50	7.14	7.14	0.00	1
476.53	7.34	7.34	0.00	1
476.56	7.54	7.54	0.00	1
480.00	15.17	15.17	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.54	5.54	476.27	1.315	0.0*	1-S2n	0.717	0.904	0.717	0.617	6.424	2.775
5.74	5.74	476.29	1.344	0.0*	1-S2n	0.732	0.921	0.732	0.629	6.481	2.803
5.94	5.94	476.32	1.372	0.0*	1-S2n	0.747	0.937	0.747	0.640	6.536	2.830
6.14	6.14	476.35	1.401	0.0*	1-S2n	0.762	0.952	0.762	0.651	6.589	2.856
6.34	6.34	476.38	1.429	0.0*	1-S2n	0.777	0.968	0.777	0.662	6.641	2.881
6.54	6.54	476.41	1.458	0.0*	1-S2n	0.792	0.987	0.792	0.673	6.690	2.906
6.63	6.63	476.42	1.471	0.0*	1-S2n	0.799	0.994	0.799	0.677	6.712	2.917
6.94	6.94	476.47	1.517	0.0*	5-S2n	0.822	1.017	0.822	0.694	6.784	2.954
7.14	7.14	476.50	1.547	0.0*	5-S2n	0.836	1.032	0.836	0.704	6.828	2.977
7.34	7.34	476.53	1.577	0.0*	5-S2n	0.851	1.046	0.851	0.714	6.870	3.000
7.54	7.54	476.56	1.608	0.0*	5-S2n	0.866	1.060	0.866	0.724	6.913	3.022

* Full Flow Headwater elevation is below inlet invert.

****

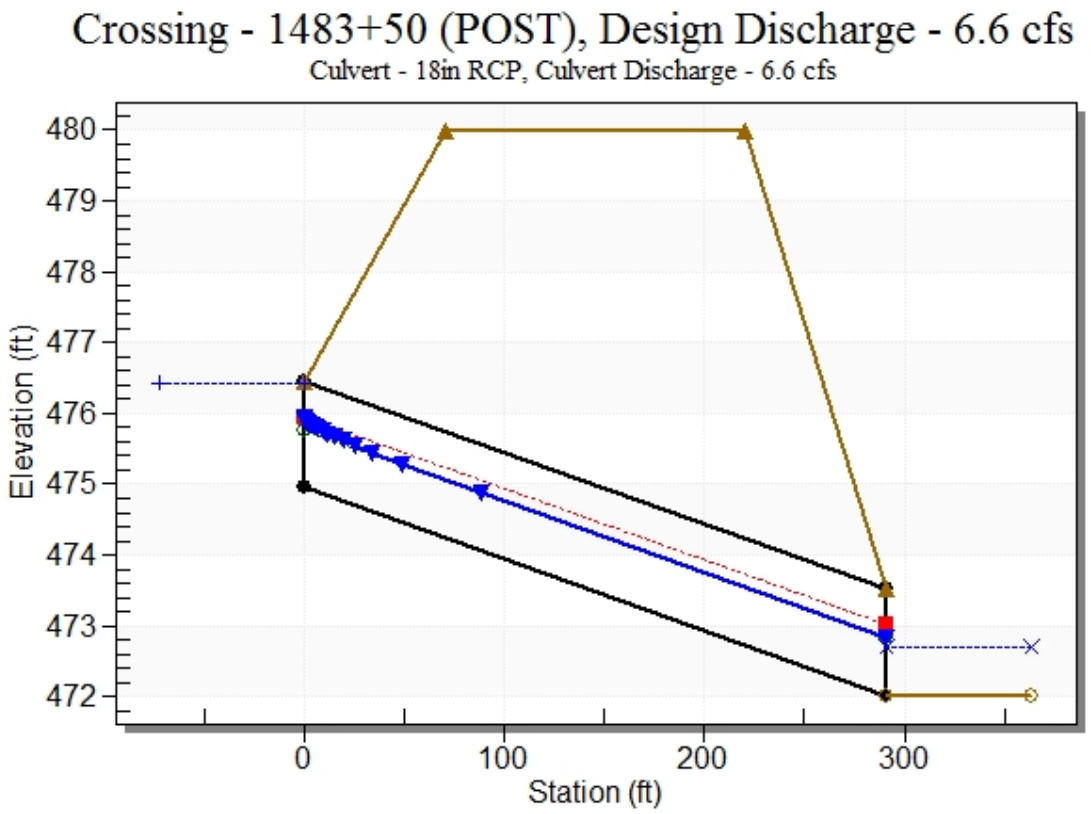
Straight Culvert

Inlet Elevation (invert): 474.95 ft, Outlet Elevation (invert): 472.02 ft

Culvert Length: 291.01 ft, Culvert Slope: 0.0101

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 474.95 ft

Outlet Station: 291.00 ft

Outlet Elevation: 472.02 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1483+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.54	472.64	0.62	2.77	1.54	0.73
5.74	472.65	0.63	2.80	1.57	0.73
5.94	472.66	0.64	2.83	1.60	0.73
6.14	472.67	0.65	2.86	1.63	0.74
6.34	472.68	0.66	2.88	1.65	0.74
6.54	472.69	0.67	2.91	1.68	0.74
6.63	472.70	0.68	2.92	1.69	0.74
6.94	472.71	0.69	2.95	1.73	0.74
7.14	472.72	0.70	2.98	1.76	0.74
7.34	472.73	0.71	3.00	1.78	0.74
7.54	472.74	0.72	3.02	1.81	0.75

Tailwater Channel Data - 1483+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 472.02 ft

Roadway Data for Crossing: 1483+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 480.00 ft

Roadway Surface: Paved

Roadway Top Width: 150.00 ft

CULVERT 173

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 173a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.32	0.2849
Grass	0.25	0.16	0.0389
Woods	0.15	0.21	0.0322
	Σ	**0.69**	0.3559

$C_{ave} = \frac{0.3559}{0.69} = 0.52$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.44	0.3929
Grass	0.25	0.16	0.0389
Woods	0.15	0.21	0.0322
	Σ	**0.81**	0.4639

$C_{ave} = \frac{0.4639}{0.81} = 0.58$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.52	x	6.23	x	0.69	x	1	=	**2.22**	cfs
Q_{10} =	0.52	x	6.98	x	0.69	x	1	=	**2.48**	cfs
Q_{25} =	0.52	x	8.08	x	0.69	x	1.1	=	**3.16**	cfs
Q_{50} =	0.52	x	8.93	x	0.69	x	1.2	=	**3.81**	cfs
Q_{100} =	0.52	x	9.81	x	0.69	x	1.25	=	**4.36**	cfs

Post Construction Runoff:

Q_{05} =	0.58	x	6.23	x	0.81	x	1	=	**2.89**	cfs
Q_{10} =	0.58	x	6.98	x	0.81	x	1	=	**3.24**	cfs
Q_{25} =	0.58	x	8.08	x	0.81	x	1.1	=	**4.12**	cfs
Q_{50} =	0.58	x	8.93	x	0.81	x	1.2	=	**4.97**	cfs
Q_{100} =	0.58	x	9.81	x	0.81	x	1.25	=	**5.69**	cfs

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Job: ***I-26 DB Prep MM 85-101***
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Checked By: _____ Date: _____

Location: **Site 173b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.31	0.2812
Grass	0.25	0.35	0.0872
Woods	0.15	0.00	0.0000
	Σ	**0.66**	0.3683

$C_{ave} = \frac{0.3683}{0.66} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.42	0.3780
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.42**	0.3780

$C_{ave} = \frac{0.3780}{0.42} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.56	**x**	6.23	**x**	0.66	**x**	1	=	**2.29**	cfs
Q_{10} =	0.56	**x**	6.98	**x**	0.66	**x**	1	=	**2.57**	cfs
Q_{25} =	0.56	**x**	8.08	**x**	0.66	**x**	1.1	=	**3.27**	cfs
Q_{50} =	0.56	**x**	8.93	**x**	0.66	**x**	1.2	=	**3.95**	cfs
Q_{100} =	0.56	**x**	9.81	**x**	0.66	**x**	1.25	=	**4.52**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.42	**x**	1	=	**2.36**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.42	**x**	1	=	**2.64**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.42	**x**	1.1	=	**3.36**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.42	**x**	1.2	=	**4.05**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.42	**x**	1.25	=	**4.63**	cfs

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Job ***I-26 DB Prep MM 85-101***
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Calculated By: _____ Date: _____
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Location: **Site 173c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.37	0.3344
Grass	0.25	0.37	0.0913
Woods	0.15	0.00	0.0000
	Σ	**0.74**	0.4257

$C_{ave} = \frac{0.4257}{0.74} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4424
Grass	0.25	0.37	0.0913
Woods	0.15	0.00	0.0000
	Σ	**0.86**	0.5337

$C_{ave} = \frac{0.5337}{0.86} = 0.62$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	0.74	x	1	=	**2.65**	cfs
Q_{10} =	0.58	x	6.98	x	0.74	x	1	=	**2.97**	cfs
Q_{25} =	0.58	x	8.08	x	0.74	x	1.1	=	**3.78**	cfs
Q_{50} =	0.58	x	8.93	x	0.74	x	1.2	=	**4.56**	cfs
Q_{100} =	0.58	x	9.81	x	0.74	x	1.25	=	**5.22**	cfs

Post Construction Runoff:

Q_{05} =	0.62	x	6.23	x	0.86	x	1	=	**3.33**	cfs
Q_{10} =	0.62	x	6.98	x	0.86	x	1	=	**3.72**	cfs
Q_{25} =	0.62	x	8.08	x	0.86	x	1.1	=	**4.74**	cfs
Q_{50} =	0.62	x	8.93	x	0.86	x	1.2	=	**5.72**	cfs
Q_{100} =	0.62	x	9.81	x	0.86	x	1.25	=	**6.54**	cfs

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-173		Outlet	OP	465.76	465.76	0.00	0.48	0.00	5.46	0.00	2.09	0.54	0.00
CB-173c		Other	C.B. TYPE 112	470.87	470.87	3.78	0.05	5.26	5.26	12.04	2.09	0.54	8.96
CB-173b		Other	C.B. TYPE 112	471.51	471.51	3.59	0.04	5.12	5.12	7.50	1.35	0.51	8.99
CB-173a		Other	C.B. TYPE 112	472.02	472.02	2.34	0.00	5.00	5.00	3.55	0.69	0.48	9.03

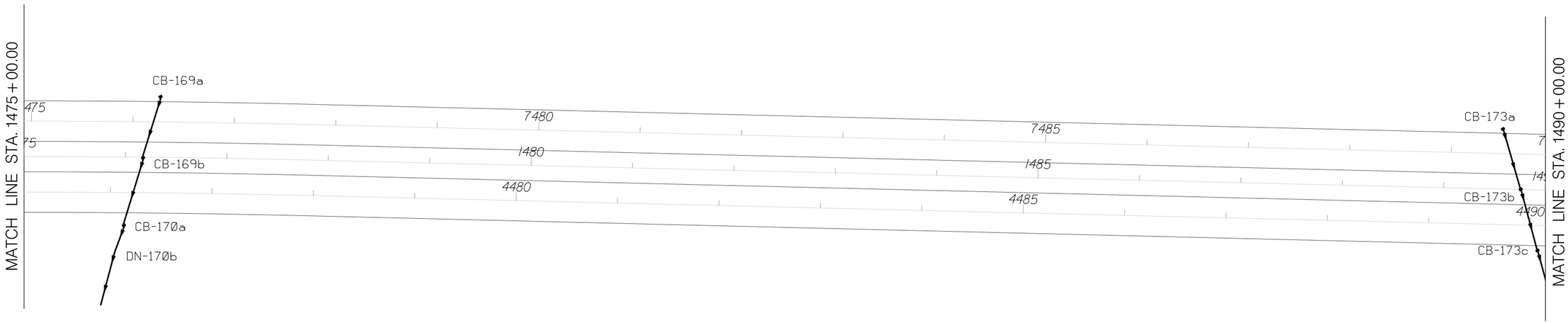
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-35	CB-173c	OF-173	Circular	Concrete	1	1.50	97	1.37	12.04	14.34	1.12	8.53	468.59	468.47	467.26	466.88	467.09	465.76	7.07	8.49	1.38	1.12
NP-34	CB-173b	CB-173c	Circular	Concrete	1	1.50	61	1.20	7.50	13.43	0.84	7.40	469.42	469.05	468.69	468.04	467.92	467.19	5.26	7.25	1.13	0.85
NP-33	CB-173a	CB-173b	Circular	Concrete	1	1.50	60	2.91	3.55	20.88	0.43	8.37	471.18	470.73	469.43	468.37	469.68	467.93	2.68	8.18	1.05	0.44

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-173c	5.00	4.61	9.03	0.57	0.74	0.57	0.74	0.00	0.00
CB-173b	5.00	3.97	9.03	0.56	0.66	0.56	0.66	0.00	0.00
CB-173a	5.00	3.55	9.03	0.48	0.69	0.68	0.48	0.00	0.21

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	66



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1475+00.00 TO STA. 1490+00.00

$$$$$$$path$$$$$$$$$filename$$$$$$$$$
$$$$date$$$$

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	67

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

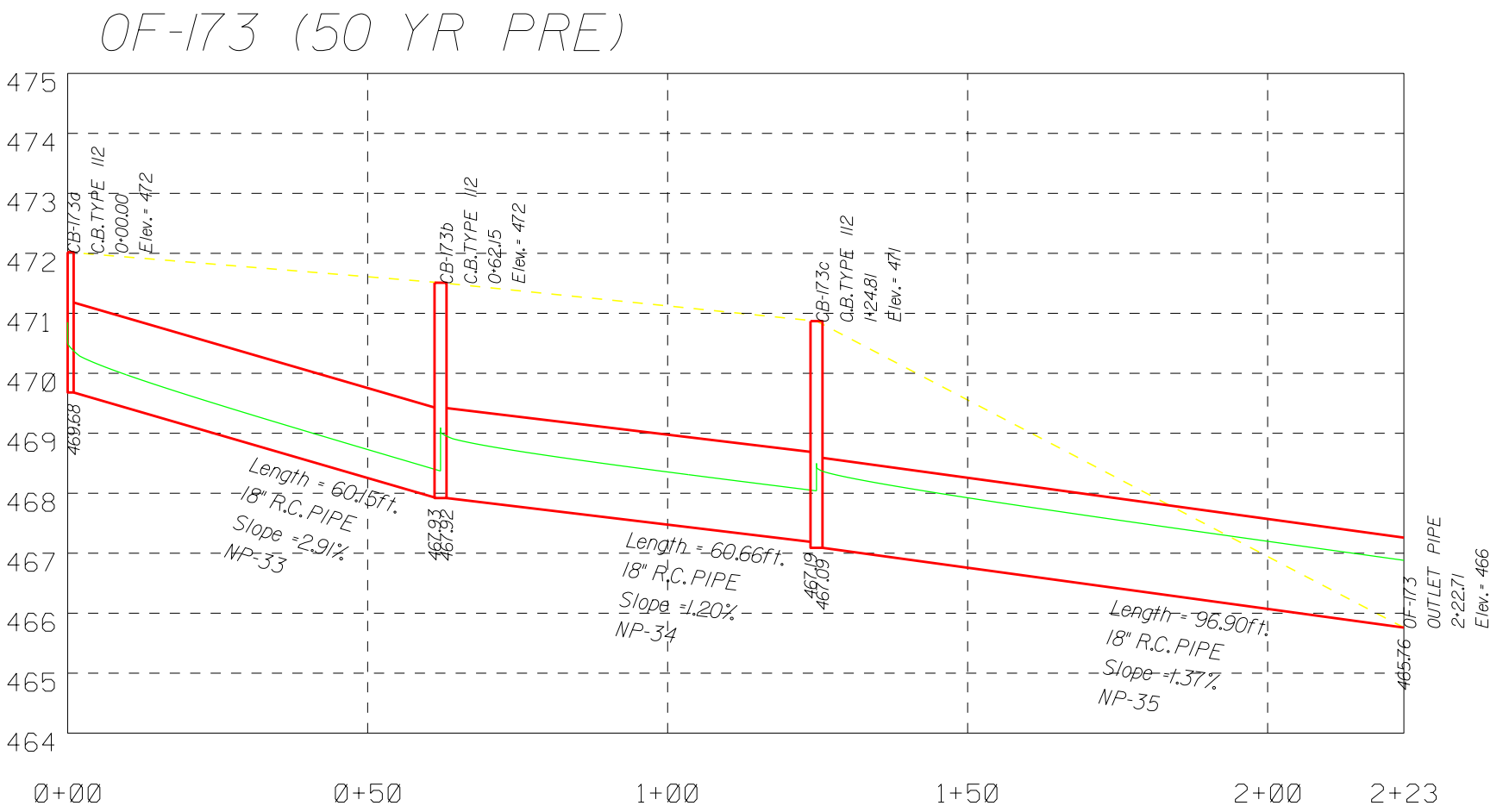
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1490+00.00 TO STA. 1505+00.00

$$$$$$$path$$$$$$$$$$filename$$$$$$$$
$$$$date$$$$


OF-173 (50 YR PRE)
475
474
473
472
471
470
469
468
467
466
465
464
0+00
0+50
1+00
1+50
2+00
2+23
CB-173a
C.B. TYPE II/2
0+00.00
Elev.= 472
469.68
CB-173b
C.B. TYPE II/2
0+62.15
Elev.= 472
467.93
467.92
CB-173c
C.B. TYPE II/2
1+24.81
Elev.= 471
467.19
467.09
OF-173
OUTLET PIPE
2+22.71
Elev.= 466
465.76
Length = 60.15ft.
18" R.C. PIPE
Slope =2.91%
NP-33
Length = 60.66ft.
18" R.C. PIPE
Slope =1.20%
NP-34
Length = 96.90ft.
18" R.C. PIPE
Slope =1.37%
NP-35

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

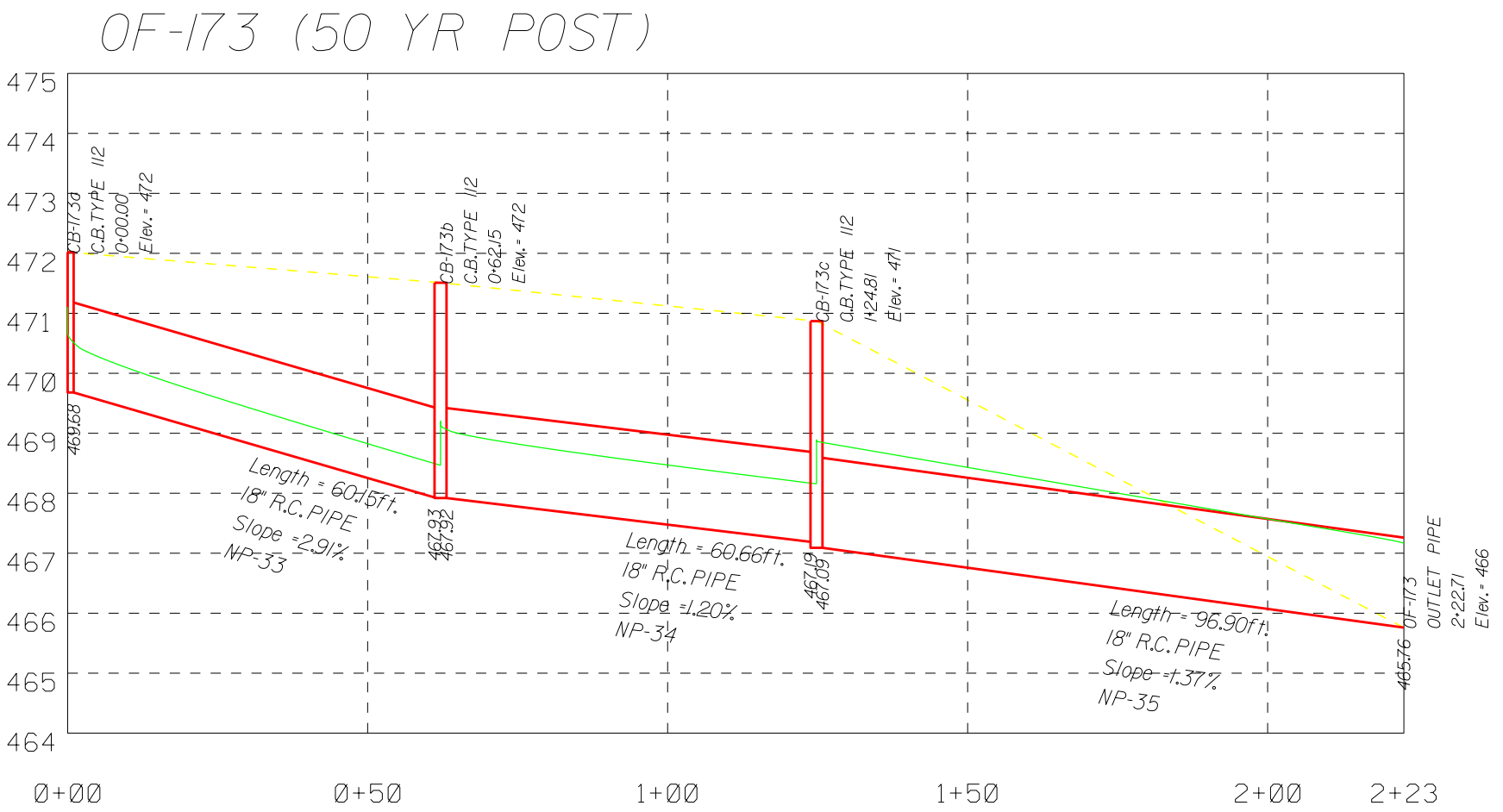
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-173	Outlet	OP	465.76	465.76	0.00	0.48	0.00	5.44	0.00	2.09	0.66	0.00
CB-173c	Other	C.B. TYPE 112	470.87	470.87	3.78	0.02	5.25	5.25	14.83	2.09	0.66	8.96
CB-173b	Other	C.B. TYPE 112	471.51	471.51	3.59	0.05	5.11	5.11	9.13	1.23	0.69	9.00
CB-173a	Other	C.B. TYPE 112	472.02	472.02	2.34	0.00	5.00	5.00	5.06	0.81	0.58	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-35	CB-173c	OF-173	Circular	Concrete	1	1.50	97	1.37	14.83	14.34	1.50	8.61	468.59	468.87	467.26	467.16	467.09	465.76	8.39	8.63	1.50	1.40
NP-34	CB-173b	CB-173c	Circular	Concrete	1	1.50	61	1.20	9.13	13.43	0.95	7.72	469.42	469.16	468.69	468.16	467.92	467.19	5.84	7.58	1.24	0.97
NP-33	CB-173a	CB-173b	Circular	Concrete	1	1.50	60	2.91	5.06	20.88	0.52	9.25	471.18	470.99	469.43	468.47	469.68	467.93	3.09	8.93	1.31	0.54

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-173c	5.00	5.78	9.03	0.62	0.86	0.62	0.86	0.00	0.00
CB-173b	5.00	4.09	9.03	0.90	0.42	0.90	0.42	0.00	0.00
CB-173a	5.00	5.06	9.03	0.58	0.81	0.58	0.81	0.00	0.00


OF-173 (50 YR POST)
475
474
473
472
471
470
469
468
467
466
465
464
0+00
0+50
1+00
1+50
2+00
2+23
CB-173a
C.B.TYPE II/2
0+00.00
Elev.= 472
469.68
CB-173b
C.B.TYPE II/2
0+62.15
Elev.= 472
467.93
467.92
CB-173c
C.B.TYPE II/2
1+24.81
Elev.= 471
467.19
467.09
OF-173
OUTLET PIPE
2+22.71
Elev.= 466
465.76
Length = 60.15ft.
18" R.C. PIPE
Slope =2.91%
NP-33
Length = 60.66ft.
18" R.C. PIPE
Slope =1.20%
NP-34
Length = 96.90ft.
18" R.C. PIPE
Slope =1.37%
NP-35

CULVERT 174

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 174**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.82	0.7423
Grass	0.25	0.91	0.2286
Woods	0.15	1.12	0.1680
	Σ	**2.86**	1.1390

$C_{ave} = \frac{1.1390}{2.86} = 0.40$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.14	1.0299
Grass	0.25	1.23	0.3085
Woods	0.15	1.12	0.1680
	Σ	**3.50**	1.5064

$C_{ave} = \frac{1.5064}{3.50} = 0.43$

T_c =	24.68	min.	
I_{05} =	4.08	in / hr	
I_{10} =	4.52	in / hr	
I_{25} =	5.16	in / hr	
I_{50} =	5.64	in / hr	
I_{100} =	6.14	in / hr	

Pre Construction Runoff:

Q_{05} =	0.40	x	4.08	x	2.86	x	1	=	**4.64**	cfs
Q_{10} =	0.40	x	4.52	x	2.86	x	1	=	**5.15**	cfs
Q_{25} =	0.40	x	5.16	x	2.86	x	1.1	=	**6.47**	cfs
Q_{50} =	0.40	x	5.64	x	2.86	x	1.2	=	**7.71**	cfs
Q_{100} =	0.40	x	6.14	x	2.86	x	1.25	=	**8.74**	cfs

Post Construction Runoff:

Q_{05} =	0.43	x	4.08	x	3.50	x	1	=	**6.14**	cfs
Q_{10} =	0.43	x	4.52	x	3.50	x	1	=	**6.81**	cfs
Q_{25} =	0.43	x	5.16	x	3.50	x	1.1	=	**8.56**	cfs
Q_{50} =	0.43	x	5.64	x	3.50	x	1.2	=	**10.20**	cfs
Q_{100} =	0.43	x	6.14	x	3.50	x	1.25	=	**11.56**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 174	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0500**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.408**	+		=	**0.408**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**67**				
9	Watercourse slope, s	----------	ft/ft	**0.1500**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**6.25**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.003**	+		=	**0.003**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.411**
						min		**24.68**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.47 cfs

Design Flow: 7.71 cfs

Maximum Flow: 8.74 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1495+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
451.71	6.47	6.47	0.00	1
451.75	6.70	6.70	0.00	1
451.79	6.92	6.92	0.00	1
451.83	7.15	7.15	0.00	1
451.88	7.38	7.38	0.00	1
451.92	7.61	7.61	0.00	1
451.94	7.71	7.71	0.00	1
452.01	8.06	8.06	0.00	1
452.05	8.29	8.29	0.00	1
452.10	8.51	8.51	0.00	1
452.15	8.74	8.74	0.00	1
452.99	12.00	12.00	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.47	6.47	451.71	1.533	0.0*	5-S2n	0.682	0.982	0.682	0.669	8.002	2.897
6.70	6.70	451.75	1.572	0.0*	5-S2n	0.696	0.999	0.696	0.681	8.073	2.925
6.92	6.92	451.79	1.613	0.0*	5-S2n	0.709	1.016	0.709	0.693	8.140	2.952
7.15	7.15	451.83	1.653	0.0*	5-S2n	0.723	1.033	0.723	0.704	8.206	2.978
7.38	7.38	451.88	1.695	0.0*	5-S2n	0.736	1.049	0.736	0.716	8.271	3.004
7.61	7.61	451.92	1.738	0.0*	5-S2n	0.750	1.065	0.750	0.727	8.332	3.029
7.71	7.71	451.94	1.758	0.0*	5-S2n	0.756	1.072	0.756	0.732	8.360	3.040
8.06	8.06	452.01	1.826	0.0*	5-S2n	0.776	1.096	0.776	0.749	8.450	3.077
8.29	8.29	452.05	1.872	0.0*	5-S2n	0.790	1.111	0.790	0.759	8.507	3.101
8.51	8.51	452.10	1.919	0.0*	5-S2n	0.803	1.126	0.803	0.770	8.561	3.124
8.74	8.74	452.15	1.967	0.0*	5-S2n	0.816	1.140	0.816	0.780	8.613	3.146

* Full Flow Headwater elevation is below inlet invert.

****

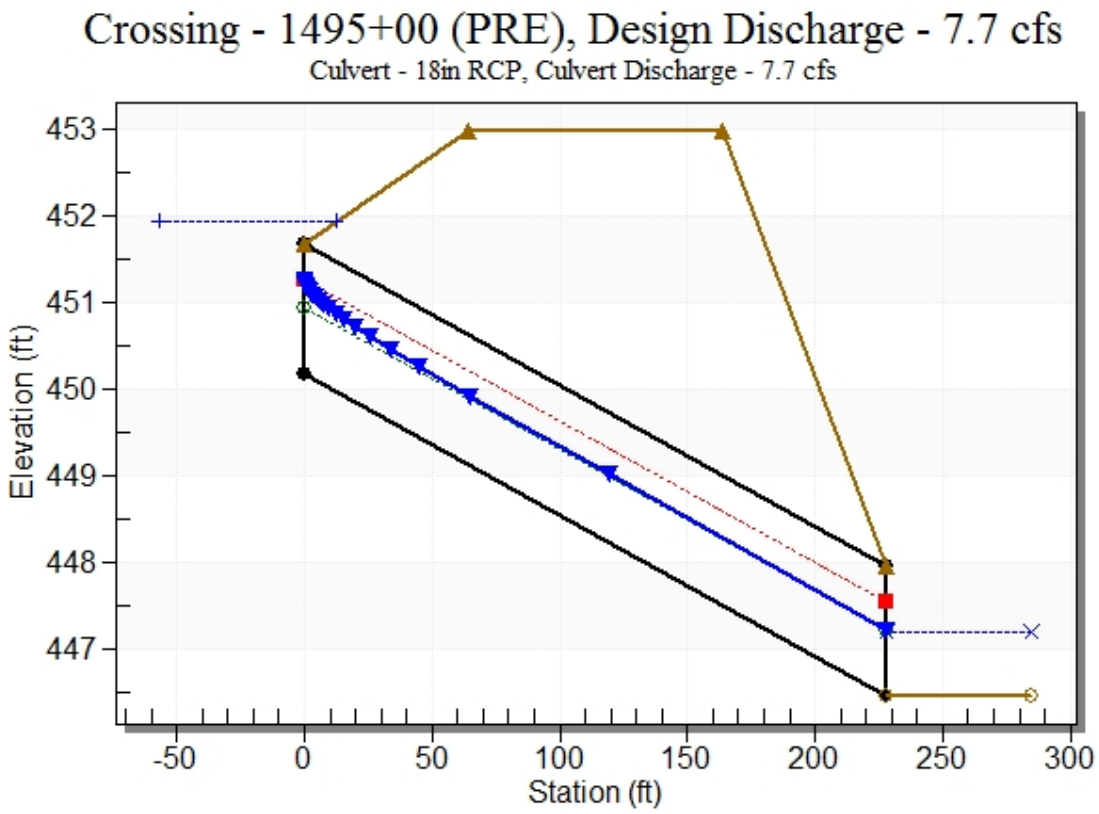
Straight Culvert

Inlet Elevation (invert): 450.18 ft, Outlet Elevation (invert): 446.46 ft

Culvert Length: 228.03 ft, Culvert Slope: 0.0163

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 450.18 ft

Outlet Station: 228.00 ft

Outlet Elevation: 446.46 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1495+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.47	447.13	0.67	2.90	1.67	0.74
6.70	447.14	0.68	2.93	1.70	0.74
6.92	447.15	0.69	2.95	1.73	0.74
7.15	447.16	0.70	2.98	1.76	0.74
7.38	447.18	0.72	3.00	1.79	0.74
7.61	447.19	0.73	3.03	1.81	0.75
7.71	447.19	0.73	3.04	1.83	0.75
8.06	447.21	0.75	3.08	1.87	0.75
8.29	447.22	0.76	3.10	1.90	0.75
8.51	447.23	0.77	3.12	1.92	0.75
8.74	447.24	0.78	3.15	1.95	0.75

Tailwater Channel Data - 1495+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 446.46 ft

Roadway Data for Crossing: 1495+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 452.99 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.56 cfs

Design Flow: 10.2 cfs

Maximum Flow: 11.56 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1495+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
452.11	8.56	8.56	0.00	1
452.17	8.86	8.86	0.00	1
452.24	9.16	9.16	0.00	1
452.31	9.46	9.46	0.00	1
452.38	9.76	9.76	0.00	1
452.45	10.06	10.06	0.00	1
452.49	10.20	10.20	0.00	1
452.61	10.66	10.66	0.00	1
452.69	10.96	10.96	0.00	1
452.77	11.26	11.26	0.00	1
452.86	11.56	11.56	0.00	1
452.99	12.00	12.00	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.56	8.56	452.11	1.929	0.0*	5-S2n	0.806	1.129	0.806	0.772	8.572	3.128
8.86	8.86	452.17	1.993	0.0*	5-S2n	0.823	1.148	0.823	0.786	8.642	3.158
9.16	9.16	452.24	2.059	0.0*	5-S2n	0.840	1.166	0.840	0.799	8.707	3.186
9.46	9.46	452.31	2.128	0.0*	5-S2n	0.858	1.187	0.858	0.812	8.772	3.214
9.76	9.76	452.38	2.200	0.011	5-S2n	0.875	1.204	0.875	0.825	8.831	3.241
10.06	10.06	452.45	2.273	0.167	5-S2n	0.893	1.221	0.893	0.838	8.886	3.268
10.20	10.20	452.49	2.309	0.242	5-S2n	0.901	1.229	0.901	0.843	8.916	3.280
10.66	10.66	452.61	2.428	0.494	5-S2n	0.929	1.253	0.929	0.862	8.994	3.319
10.96	10.96	452.69	2.509	0.663	5-S2n	0.947	1.267	0.947	0.874	9.047	3.343
11.26	11.26	452.77	2.593	0.837	5-S2n	0.965	1.282	0.990	0.886	8.830	3.368
11.56	11.56	452.86	2.680	1.014	5-S2n	0.983	1.295	0.983	0.898	9.139	3.391

* Full Flow Headwater elevation is below inlet invert.

****

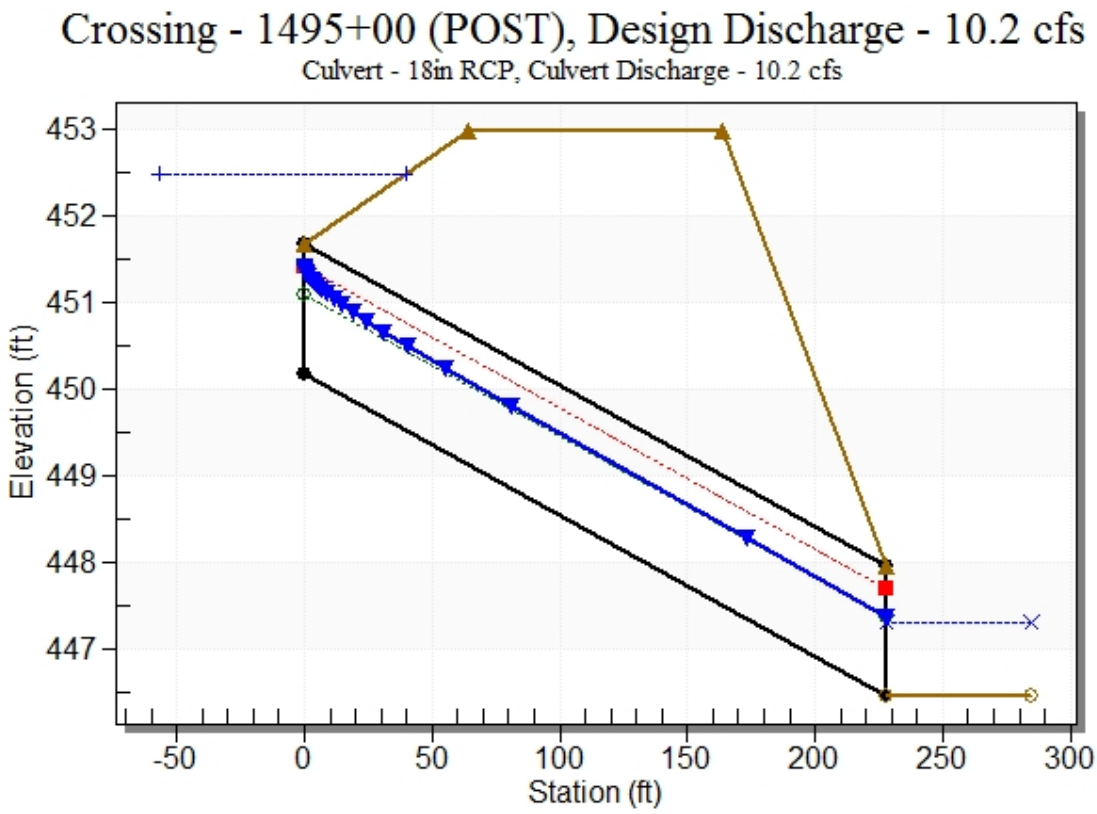
Straight Culvert

Inlet Elevation (invert): 450.18 ft, Outlet Elevation (invert): 446.46 ft

Culvert Length: 228.03 ft, Culvert Slope: 0.0163

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 450.18 ft

Outlet Station: 228.00 ft

Outlet Elevation: 446.46 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1495+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
8.56	447.23	0.77	3.13	1.93	0.75
8.86	447.25	0.79	3.16	1.96	0.75
9.16	447.26	0.80	3.19	1.99	0.75
9.46	447.27	0.81	3.21	2.03	0.76
9.76	447.29	0.83	3.24	2.06	0.76
10.06	447.30	0.84	3.27	2.09	0.76
10.20	447.30	0.84	3.28	2.11	0.76
10.66	447.32	0.86	3.32	2.15	0.76
10.96	447.33	0.87	3.34	2.18	0.76
11.26	447.35	0.89	3.37	2.21	0.76
11.56	447.36	0.90	3.39	2.24	0.77

Tailwater Channel Data - 1495+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 446.46 ft

Roadway Data for Crossing: 1495+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 452.99 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 175

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 175a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.25	0.2224
Grass	0.25	0.20	0.0493
Woods	0.15	0.80	0.1193
	Σ	**1.24**	0.3909

$C_{ave} = \frac{0.3909}{1.24} = 0.32$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.39	0.3484
Grass	0.25	0.20	0.0493
Woods	0.15	0.80	0.1193
	Σ	**1.38**	0.5169

$C_{ave} = \frac{0.5169}{1.38} = 0.37$

T_c =	25.14	min.
I_{05} =	4.04	in / hr
I_{10} =	4.48	in / hr
I_{25} =	5.12	in / hr
I_{50} =	5.60	in / hr
I_{100} =	6.08	in / hr

Pre Construction Runoff:

Q_{05} =	0.32	x	4.04	x	1.24	x	1	=	**1.58**	cfs
Q_{10} =	0.32	x	4.48	x	1.24	x	1	=	**1.75**	cfs
Q_{25} =	0.32	x	5.12	x	1.24	x	1.1	=	**2.20**	cfs
Q_{50} =	0.32	x	5.60	x	1.24	x	1.2	=	**2.63**	cfs
Q_{100} =	0.32	x	6.08	x	1.24	x	1.25	=	**2.97**	cfs

Post Construction Runoff:

Q_{05} =	0.37	x	4.04	x	1.38	x	1	=	**2.09**	cfs
Q_{10} =	0.37	x	4.48	x	1.38	x	1	=	**2.32**	cfs
Q_{25} =	0.37	x	5.12	x	1.38	x	1.1	=	**2.91**	cfs
Q_{50} =	0.37	x	5.60	x	1.38	x	1.2	=	**3.47**	cfs
Q_{100} =	0.37	x	6.08	x	1.38	x	1.25	=	**3.93**	cfs

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Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 175b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.38	0.3461
Grass	0.25	0.35	0.0867
Woods	0.15	0.00	0.0000
	Σ	**0.73**	0.4328

$C_{ave} = \frac{0.4328}{0.73} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.43	0.3870
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.43**	0.3870

$C_{ave} = \frac{0.3870}{0.43} = 0.90$

T_c =	5.00 min.
I_{05} =	6.23 in / hr
I_{10} =	6.98 in / hr
I_{25} =	8.08 in / hr
I_{50} =	8.93 in / hr
I_{100} =	9.81 in / hr

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	0.73	x	1	=	**2.70**	cfs
Q_{10} =	0.59	x	6.98	x	0.73	x	1	=	**3.02**	cfs
Q_{25} =	0.59	x	8.08	x	0.73	x	1.1	=	**3.85**	cfs
Q_{50} =	0.59	x	8.93	x	0.73	x	1.2	=	**4.64**	cfs
Q_{100} =	0.59	x	9.81	x	0.73	x	1.25	=	**5.31**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.43	x	1	=	**2.41**	cfs
Q_{10} =	0.90	x	6.98	x	0.43	x	1	=	**2.70**	cfs
Q_{25} =	0.90	x	8.08	x	0.43	x	1.1	=	**3.44**	cfs
Q_{50} =	0.90	x	8.93	x	0.43	x	1.2	=	**4.15**	cfs
Q_{100} =	0.90	x	9.81	x	0.43	x	1.25	=	**4.74**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 175c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.35	0.3162
Grass	0.25	0.39	0.0974
Woods	0.15	0.00	0.0000
	Σ	**0.74**	0.4136

$C_{ave} = \frac{0.4136}{0.74} = 0.56$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.50	0.4512
Grass	0.25	0.39	0.0974
Woods	0.15	0.00	0.0000
	Σ	**0.89**	0.5486

$C_{ave} = \frac{0.5486}{0.89} = 0.62$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.56	x	6.23	x	0.74	x	1	=	**2.58**	cfs
Q_{10} =	0.56	x	6.98	x	0.74	x	1	=	**2.89**	cfs
Q_{25} =	0.56	x	8.08	x	0.74	x	1.1	=	**3.68**	cfs
Q_{50} =	0.56	x	8.93	x	0.74	x	1.2	=	**4.43**	cfs
Q_{100} =	0.56	x	9.81	x	0.74	x	1.25	=	**5.07**	cfs

Post Construction Runoff:

Q_{05} =	0.62	x	6.23	x	0.89	x	1	=	**3.42**	cfs
Q_{10} =	0.62	x	6.98	x	0.89	x	1	=	**3.83**	cfs
Q_{25} =	0.62	x	8.08	x	0.89	x	1.1	=	**4.88**	cfs
Q_{50} =	0.62	x	8.93	x	0.89	x	1.2	=	**5.88**	cfs
Q_{100} =	0.62	x	9.81	x	0.89	x	1.25	=	**6.73**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 175d**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.83	0.2068
Woods	0.15	0.00	0.0000
	Σ	**0.83**	0.2068

$C_{ave} = \frac{0.2068}{0.83} = 0.25$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.83	0.2068
Woods	0.15	0.00	0.0000
	Σ	**0.83**	0.2068

$C_{ave} = \frac{0.2068}{0.83} = 0.25$

T_c =	14.59	min.								
I_{05} =	4.96	in / hr								
I_{10} =	5.52	in / hr								
I_{25} =	6.34	in / hr								
I_{50} =	6.95	in / hr								
I_{100} =	7.59	in / hr								

Pre Construction Runoff:

Q_{05} =	0.25	**x**	4.96	**x**	0.83	**x**	1	=	**1.02**	cfs
Q_{10} =	0.25	**x**	5.52	**x**	0.83	**x**	1	=	**1.14**	cfs
Q_{25} =	0.25	**x**	6.34	**x**	0.83	**x**	1.1	=	**1.44**	cfs
Q_{50} =	0.25	**x**	6.95	**x**	0.83	**x**	1.2	=	**1.73**	cfs
Q_{100} =	0.25	**x**	7.59	**x**	0.83	**x**	1.25	=	**1.96**	cfs

Post Construction Runoff:

Q_{05} =	0.25	**x**	4.96	**x**	0.83	**x**	1	=	**1.02**	cfs
Q_{10} =	0.25	**x**	5.52	**x**	0.83	**x**	1	=	**1.14**	cfs
Q_{25} =	0.25	**x**	6.34	**x**	0.83	**x**	1.1	=	**1.44**	cfs
Q_{50} =	0.25	**x**	6.95	**x**	0.83	**x**	1.2	=	**1.73**	cfs
Q_{100} =	0.25	**x**	7.59	**x**	0.83	**x**	1.25	=	**1.96**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 175a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**80**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.419**	+		=	**0.419**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------						
8	Flow length, L	----------	ft					
9	Watercourse slope, s	----------	ft/ft					
10	Average velocity, V (figure 3-1)	----------	ft/s					
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	----------	hr					**0.419**
			min					**25.14**

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project ***I-26 DB PREP*** By _____ Date _____
Location Site 175d Checked _____ Date _____

Circle one: Present Developed _____
Circle one: T_c T_t through subarea _____

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)		Segment ID					
1 Surface Desciption (table 3-1)	----------		Grass				
2 Manning's roughness coeff., n (table 3-1)	----------		**0.240**				
3 Flow length, L (total L < or = 100)	----------	ft	**60**				
4 Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5 Land slope, s	----------	ft/ft	**0.0500**				
6 $T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.104**	+		=	**0.104**

Shallow Concentrated Flow		Segment ID					
7 Surface Desciption (paved or unpaved)	----------						
8 Flow length, L	----------	ft					
9 Watercourse slope, s	----------	ft/ft					
10 Average velocity, V (figure 3-1)	----------	ft/s					
11 $T_t = L / (3600\ V)$	Compute T_t ----------	hr		+		=	**0.000**

Channel Flow		Segment ID					
Front Slope, (_ : 1)	----------		**2**				
Back Slope, (_ : 1)	----------		**2**				
Bottom Width	----------	ft					
Flow Depth	----------	ft	**0.5**				
12 Cross sectional flow area, a	----------	ft^2	**0.50**		**0.00**		
13 Wetted perimeter, p_w	----------	ft	**2.24**		**0.00**		
14 Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**0.22**		**#DIV/0!**		
15 Channel Slope, s	----------	ft/ft	**0.0800**				
16 Manning's roughness coeff., n	----------		**0.06**				
17 $V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**2.59**		**#DIV/0!**		
18 Flow length, L	----------	ft	**1300**				
19 $T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.140**	+		=	**0.140**
20 Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.243**
					min		**14.59**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-175		Outlet	OP	425.00	425.00	0.00	0.48	0.00	25.62	0.00	3.54	0.41	0.00
DN-175d		Other	DUMMY JOINT	430.00	430.00	4.46	0.03	25.49	25.49	9.73	3.54	0.41	5.62
CB-175c		Other	C.B. TYPE 112	428.52	428.52	2.52	0.04	25.46	25.46	8.33	2.71	0.46	5.62
CB-175b		Other	C.B. TYPE 112	430.86	430.86	3.39	0.03	25.29	25.29	5.57	1.97	0.42	5.64
CB-175a		Other	C.B. TYPE 112	431.52	431.52	2.19	0.00	25.14	25.14	2.67	1.24	0.32	5.65

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-32	DN-175d	OF-175	Circular	Concrete	1	1.50	57	0.95	9.73	11.95	1.09	7.08	427.04	426.77	426.50	426.09	425.54	425.00	6.27	7.05	1.23	1.09
NP-31	CB-175c	DN-175d	Circular	Concrete	1	1.50	19	2.40	8.33	18.98	0.73	9.83	427.50	427.18	427.04	426.37	426.00	425.54	5.60	8.29	1.18	0.83
NP-30	CB-175b	CB-175c	Circular	Concrete	1	1.50	77	1.91	5.57	16.92	0.62	8.14	428.97	428.45	427.50	426.62	427.47	426.00	4.57	8.00	0.98	0.62
NP-29	CB-175a	CB-175b	Circular	Concrete	1	1.50	64	2.42	2.67	19.04	0.39	7.21	430.83	430.21	429.27	428.17	429.33	427.77	2.46	7.13	0.88	0.40

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
DN-175d	14.59	1.75	7.03	0.25	0.83	0.25	0.83	0.00	0.00
CB-175c	5.00	4.47	9.03	0.56	0.74	0.56	0.74	0.00	0.00
CB-175b	5.00	4.65	9.03	0.59	0.73	0.59	0.73	0.00	0.00
CB-175a	25.14	2.67	5.65	0.32	1.24	0.32	1.24	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	67

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

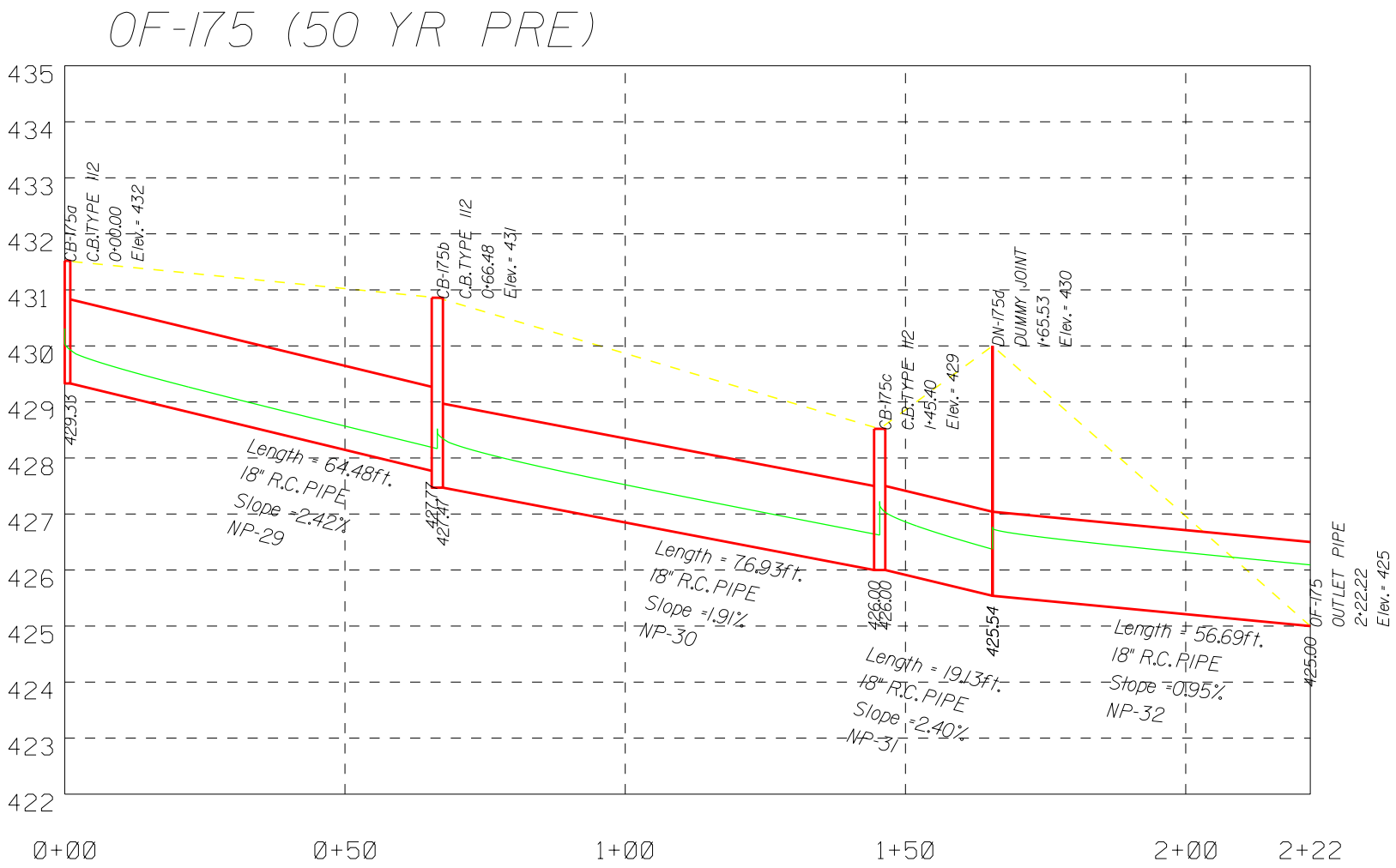
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1490+00.00 TO STA. 1505+00.00

$$$$$$$path$$$$$$$$$$filename$$$$$$$$
$$$$date$$$$


OF-175 (50 YR PRE)
435
434
433
432
431
430
429
428
427
426
425
424
423
422
0+00
0+50
1+00
1+50
2+00
2+22
CB-175a
C.B.TYPE II2
0-00.00
Elev.= 432
429.35
CB-175b
C.B.TYPE II2
0+66.48
Elev.= 431
427.77
427.47
Length = 64.48ft.
18" R.C. PIPE
Slope =2.42%
NP-29
Length = 76.93ft.
18" R.C. PIPE
Slope =1.91%
NP-30
CB-175c
C.B.TYPE II2
1+45.40
Elev.= 429
426.00
426.00
DN-175d
DUMMY JOINT
1+65.53
Elev.= 430
425.54
Length = 19.13ft.
18" R.C. PIPE
Slope =2.40%
NP-31
Length = 56.69ft.
18" R.C. PIPE
Slope =0.95%
NP-32
425.00
OF-175
OUTLET PIPE
2+22.22
Elev.= 425

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

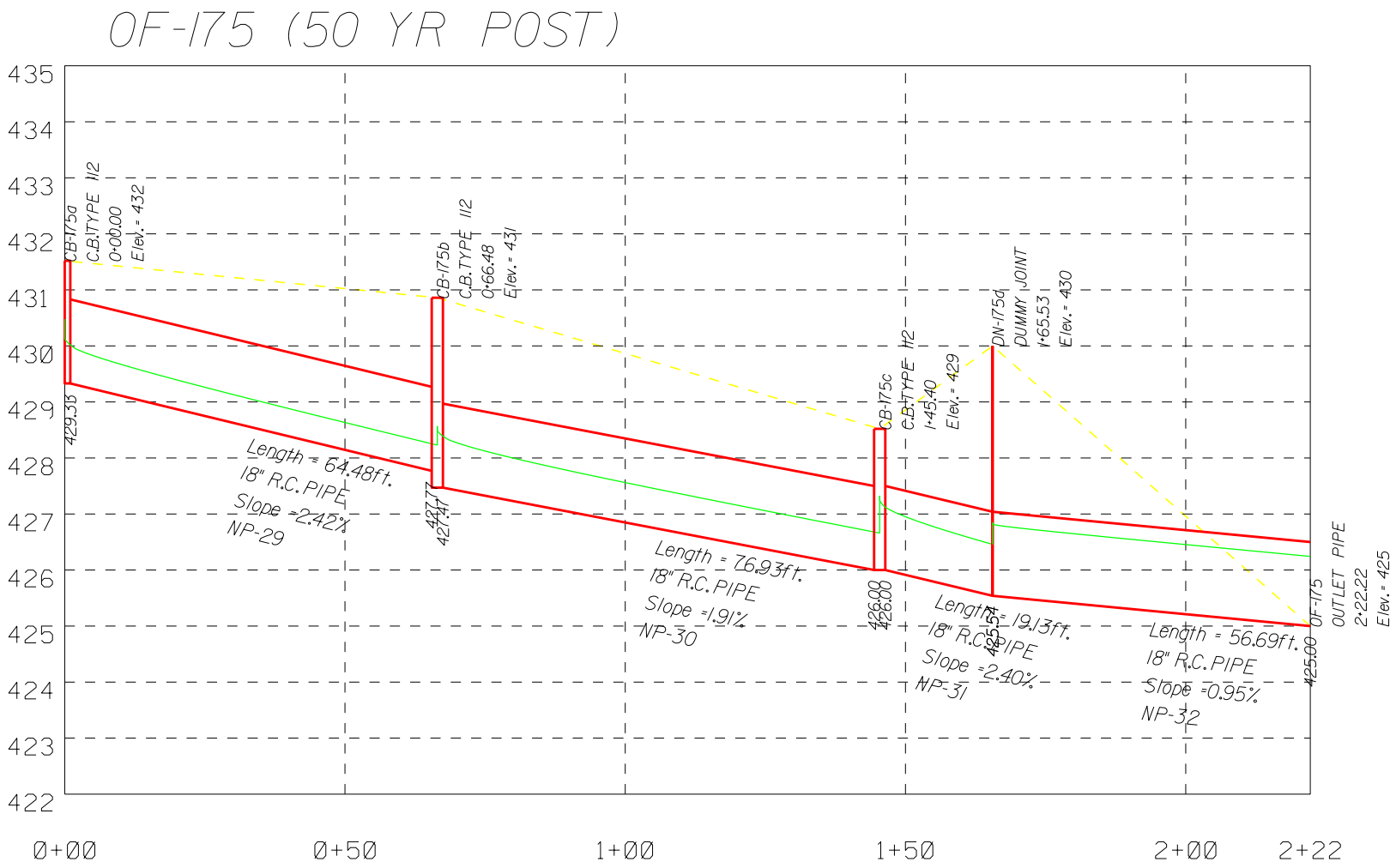
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-175	Outlet	OP	425.00	425.00	0.00	0.48	0.00	25.60	0.00	3.53	0.47	0.00
DN-175d	Other	DUMMY JOINT	430.00	430.00	4.46	0.03	25.47	25.47	11.20	3.53	0.47	5.62
CB-175c	Other	C.B. TYPE 112	428.52	428.52	2.52	0.05	25.44	25.44	9.81	2.70	0.54	5.62
CB-175b	Other	C.B. TYPE 112	430.86	430.86	3.39	0.03	25.28	25.28	6.13	1.81	0.50	5.64
CB-175a	Other	C.B. TYPE 112	431.52	431.52	2.19	0.00	25.14	25.14	3.52	1.38	0.38	5.65

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-32	DN-175d	OF-175	Circular	Concrete	1	1.50	57	0.95	11.20	11.95	1.24	7.15	427.04	426.85	426.50	426.24	425.54	425.00	6.85	7.15	1.31	1.24
NP-31	CB-175c	DN-175d	Circular	Concrete	1	1.50	19	2.40	9.81	18.98	0.80	10.25	427.50	427.28	427.04	426.46	426.00	425.54	6.11	8.65	1.28	0.92
NP-30	CB-175b	CB-175c	Circular	Concrete	1	1.50	77	1.91	6.13	16.92	0.65	8.35	428.97	428.49	427.50	426.66	427.47	426.00	4.78	8.19	1.02	0.66
NP-29	CB-175a	CB-175b	Circular	Concrete	1	1.50	64	2.42	3.52	19.04	0.45	7.81	430.83	430.38	429.27	428.23	429.33	427.77	2.67	7.67	1.05	0.46

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
DN-175d	14.59	1.75	7.03	0.25	0.83	0.25	0.83	0.00	0.00
CB-175c	5.00	5.93	9.03	0.62	0.89	0.62	0.89	0.00	0.00
CB-175b	5.00	4.19	9.03	0.90	0.43	0.90	0.43	0.00	0.00
CB-175a	25.14	3.52	5.65	0.38	1.38	0.38	1.38	0.00	0.00


OF-175 (50 YR POST)
435
434
433
432
431
430
429
428
427
426
425
424
423
422
0+00
0+50
1+00
1+50
2+00
2+22
CB-175a
C.B.TYPE II2
0-00.00
Elev.= 432
429.35
CB-175b
C.B.TYPE II2
0+66.48
Elev.= 431
427.77
427.47
CB-175c
C.B.TYPE II2
1+45.40
Elev.= 429
426.00
426.00
DN-175d
DUMMY JOINT
1+65.53
Elev.= 430
425.51
425.00
OF-175
OUTLET PIPE
2-22.22
Elev.= 425
Length = 64.48ft.
18" R.C. PIPE
Slope =2.42%
NP-29
Length = 76.93ft.
18" R.C. PIPE
Slope =1.91%
NP-30
Length = 19.13ft.
18" R.C. PIPE
Slope =2.40%
NP-31
Length = 56.69ft.
18" R.C. PIPE
Slope =0.95%
NP-32

CULVERT 176/177

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job: ***I-26 DB Prep MM 85-101***
Sheet: _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 176a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.15	0.1352
Grass	0.25	0.14	0.0354
Woods	0.15	4.26	0.6389
	Σ	**4.55**	0.8094

$C_{ave} = \frac{0.8094}{4.55} = 0.18$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.24	0.2162
Grass	0.25	0.14	0.0354
Woods	0.15	4.26	0.6389
	Σ	**4.64**	0.8904

$C_{ave} = \frac{0.8904}{4.64} = 0.19$

T_c =	39.27	min.								
I_{05} =	3.24	in / hr								
I_{10} =	3.58	in / hr								
I_{25} =	4.07	in / hr								
I_{50} =	4.44	in / hr								
I_{100} =	4.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.18	x	3.24	x	4.55	x	1	=	**2.62**	cfs
Q_{10} =	0.18	x	3.58	x	4.55	x	1	=	**2.90**	cfs
Q_{25} =	0.18	x	4.07	x	4.55	x	1.1	=	**3.63**	cfs
Q_{50} =	0.18	x	4.44	x	4.55	x	1.2	=	**4.31**	cfs
Q_{100} =	0.18	x	4.81	x	4.55	x	1.25	=	**4.87**	cfs

Post Construction Runoff:

Q_{05} =	0.19	x	3.24	x	4.64	x	1	=	**2.88**	cfs
Q_{10} =	0.19	x	3.58	x	4.64	x	1	=	**3.19**	cfs
Q_{25} =	0.19	x	4.07	x	4.64	x	1.1	=	**3.99**	cfs
Q_{50} =	0.19	x	4.44	x	4.64	x	1.2	=	**4.74**	cfs
Q_{100} =	0.19	x	4.81	x	4.64	x	1.25	=	**5.35**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 176b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.13	0.1195
Grass	0.25	0.26	0.0645
Woods	0.15	0.00	0.0000
	Σ	**0.39**	0.1840

$C_{ave} = \frac{0.1840}{0.39} = 0.47$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.19	0.1735
Grass	0.25	0.26	0.0645
Woods	0.15	0.00	0.0000
	Σ	**0.45**	0.2380

$C_{ave} = \frac{0.2380}{0.45} = 0.53$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.47	x	6.23	x	0.39	x	1	=	**1.15**	cfs
Q_{10} =	0.47	x	6.98	x	0.39	x	1	=	**1.28**	cfs
Q_{25} =	0.47	x	8.08	x	0.39	x	1.1	=	**1.64**	cfs
Q_{50} =	0.47	x	8.93	x	0.39	x	1.2	=	**1.97**	cfs
Q_{100} =	0.47	x	9.81	x	0.39	x	1.25	=	**2.26**	cfs

Post Construction Runoff:

Q_{05} =	0.53	x	6.23	x	0.45	x	1	=	**1.48**	cfs
Q_{10} =	0.53	x	6.98	x	0.45	x	1	=	**1.66**	cfs
Q_{25} =	0.53	x	8.08	x	0.45	x	1.1	=	**2.12**	cfs
Q_{50} =	0.53	x	8.93	x	0.45	x	1.2	=	**2.55**	cfs
Q_{100} =	0.53	x	9.81	x	0.45	x	1.25	=	**2.92**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 177a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.28	0.2511
Grass	0.25	0.27	0.0680
Woods	0.15	0.00	0.0000
	Σ	**0.55**	0.3191

$C_{ave} = \frac{0.3191}{0.55} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.34	0.3060
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.34**	0.3060

$C_{ave} = \frac{0.3060}{0.34} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.58	**x**	6.23	**x**	0.55	**x**	1	=	**1.99**	cfs
Q_{10} =	0.58	**x**	6.98	**x**	0.55	**x**	1	=	**2.23**	cfs
Q_{25} =	0.58	**x**	8.08	**x**	0.55	**x**	1.1	=	**2.84**	cfs
Q_{50} =	0.58	**x**	8.93	**x**	0.55	**x**	1.2	=	**3.42**	cfs
Q_{100} =	0.58	**x**	9.81	**x**	0.55	**x**	1.25	=	**3.91**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.34	**x**	1	=	**1.91**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.34	**x**	1	=	**2.14**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.34	**x**	1.1	=	**2.72**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.34	**x**	1.2	=	**3.28**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.34	**x**	1.25	=	**3.75**	cfs

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Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 177b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.12	0.1085
Grass	0.25	0.33	0.0831
Woods	0.15	0.00	0.0000
	Σ	**0.45**	0.1916

$C_{ave} = \frac{0.1916}{0.45} = 0.42$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.16	0.1445
Grass	0.25	0.33	0.0831
Woods	0.15	0.00	0.0000
	Σ	**0.49**	0.2276

$C_{ave} = \frac{0.2276}{0.49} = 0.46$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.42	x	6.23	x	0.45	x	1	=	**1.19**	cfs
Q_{10} =	0.42	x	6.98	x	0.45	x	1	=	**1.34**	cfs
Q_{25} =	0.42	x	8.08	x	0.45	x	1.1	=	**1.70**	cfs
Q_{50} =	0.42	x	8.93	x	0.45	x	1.2	=	**2.05**	cfs
Q_{100} =	0.42	x	9.81	x	0.45	x	1.25	=	**2.35**	cfs

Post Construction Runoff:

Q_{05} =	0.46	x	6.23	x	0.49	x	1	=	**1.42**	cfs
Q_{10} =	0.46	x	6.98	x	0.49	x	1	=	**1.59**	cfs
Q_{25} =	0.46	x	8.08	x	0.49	x	1.1	=	**2.02**	cfs
Q_{50} =	0.46	x	8.93	x	0.49	x	1.2	=	**2.44**	cfs
Q_{100} =	0.46	x	9.81	x	0.49	x	1.25	=	**2.79**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 176a	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**1200**				
9	Watercourse slope, s	----------	ft/ft	**0.1000**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**5.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.065**	+		=	**0.065**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.654**
							min	**39.27**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-176/177		Outlet	OP	407.25	407.25	0.00	0.48	0.00	39.77	0.00	5.94	0.25	0.00
CB-176b		Other	C.B. TYPE 112	417.58	417.58	9.75	0.23	39.57	39.57	8.04	5.94	0.25	4.46
CB-177b		Other	C.B. TYPE 112	413.14	413.14	3.17	0.25	5.27	5.27	5.48	1.00	0.51	8.96
CB-176a		Other	DUMMY JOINT	414.93	414.93	0.00	0.00	39.27	39.27	4.35	4.55	0.18	4.48
CB-177a		Other	C.B. TYPE 112	414.71	414.71	3.71	0.00	5.00	5.00	3.46	0.55	0.58	9.03

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-28	CB-176b	OF-176/177	Circular	Concrete	1	2.00	75	0.77	8.04	23.13	0.85	6.35	409.83	409.08	409.25	408.10	407.83	407.25	3.89	6.30	1.25	0.85
NP-26	CB-177b	CB-176b	Circular	Concrete	1	1.50	133	0.68	5.48	10.12	0.83	5.50	411.47	411.14	410.56	409.89	409.97	409.06	3.71	5.50	1.17	0.83
NP-27	CB-176a	CB-176b	Circular	Concrete	1	1.50	171	3.55	4.35	23.07	0.46	9.51	416.43	416.12	410.34	409.30	414.93	408.84	2.89	9.51	1.19	0.46
NP-25	CB-177a	CB-177b	Circular	Concrete	1	1.50	86	0.93	3.46	11.80	0.58	5.52	412.50	412.04	411.70	410.78	411.00	410.20	2.65	5.49	1.04	0.58

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-176b	5.00	1.97	9.03	0.47	0.39	0.47	0.39	0.00	0.00
CB-177b	5.00	2.06	9.03	0.42	0.45	0.42	0.45	0.00	0.00
CB-176a	39.27	4.35	4.48	0.18	4.55	0.18	4.55	0.00	0.00
CB-177a	5.00	3.46	9.03	0.58	0.55	0.58	0.55	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	67

REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

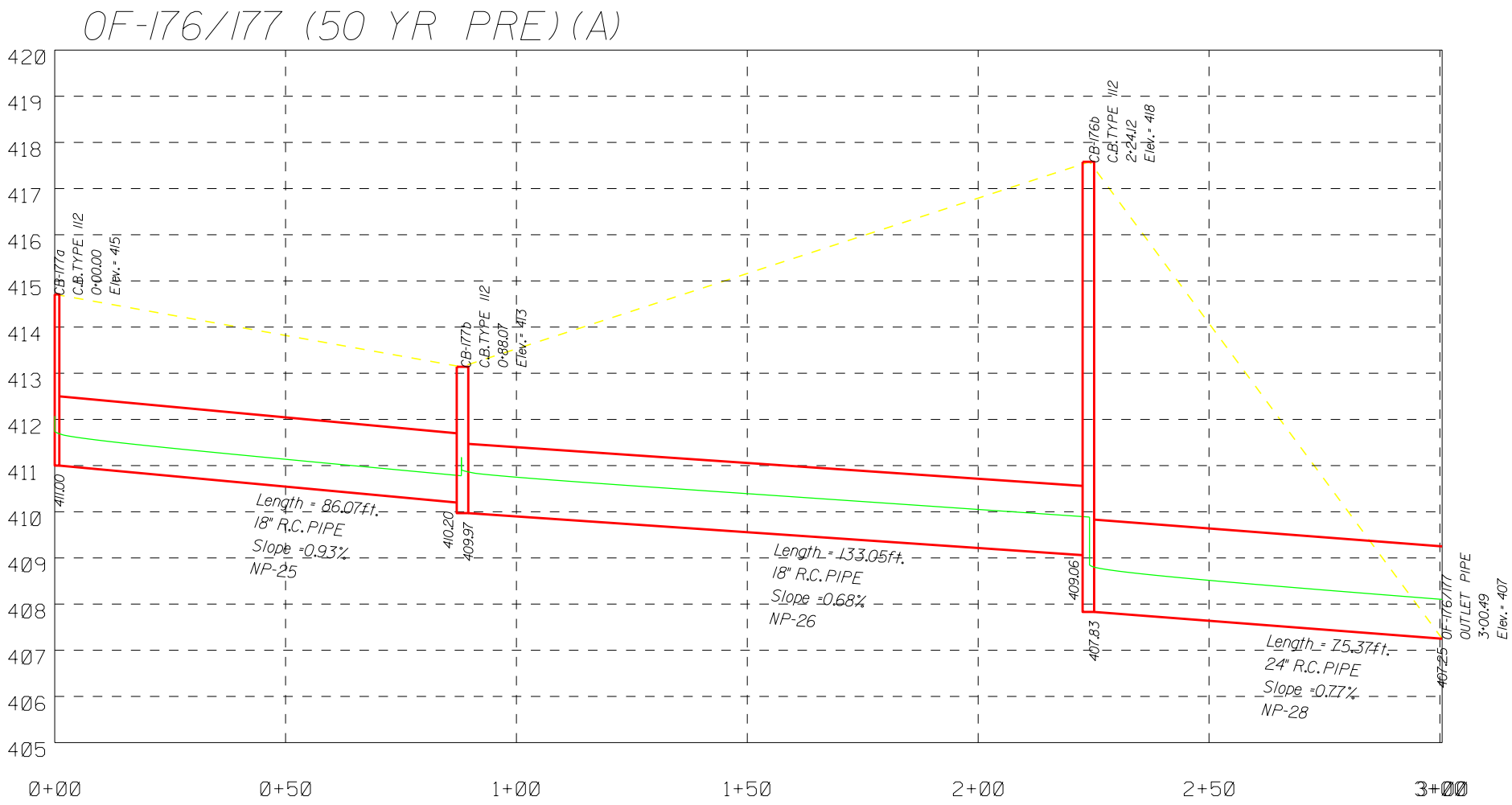
SCALE: 1" = 50' HORIZ

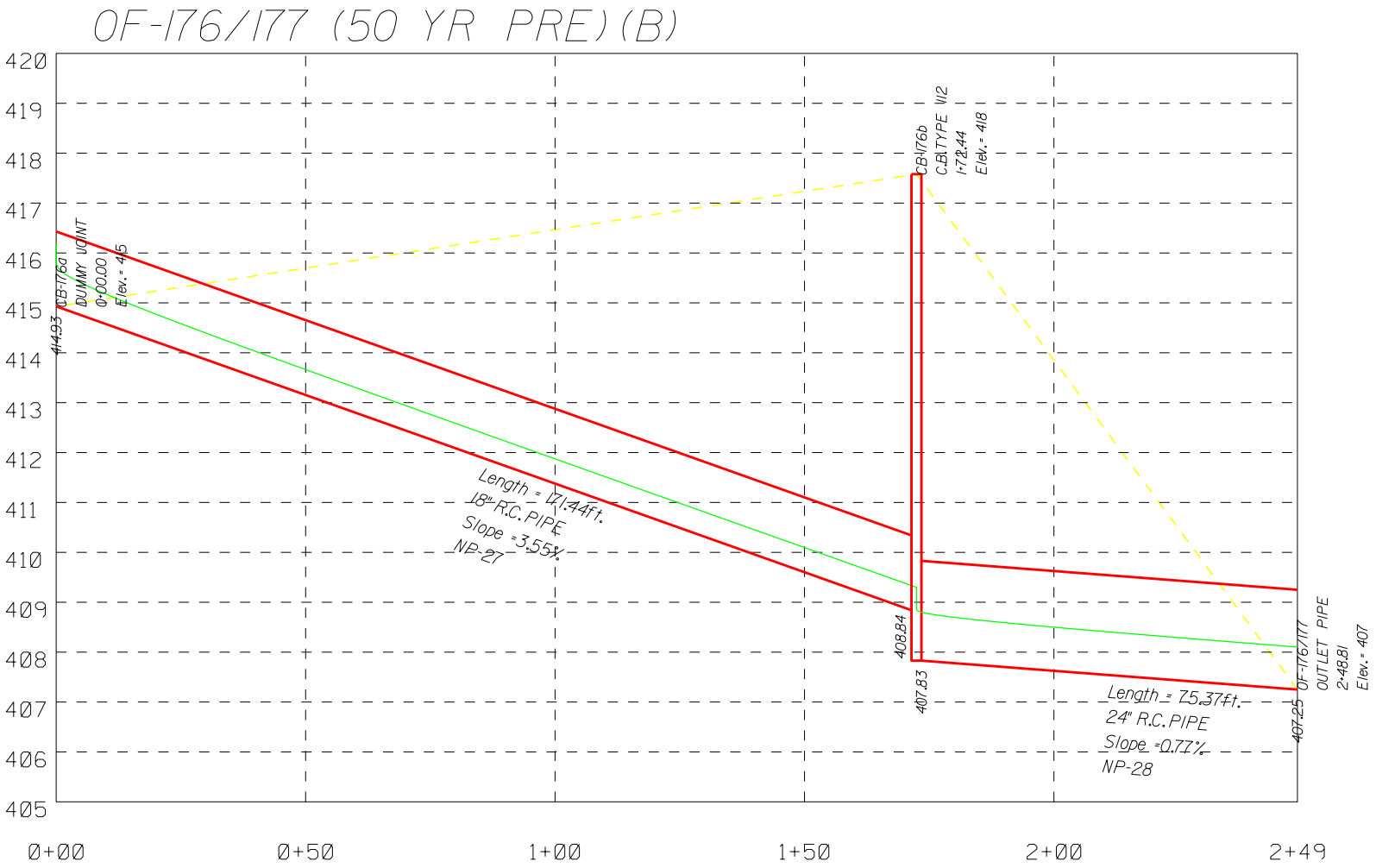
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1490+00.00 TO STA. 1505+00.00

$$$$$$$path$$$$$$$$$$filename$$$$$$$$
$$$$date$$$$


OF-176/177 (50 YR PRE)(A)
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+50
3+00
CB-177a
C.B. TYPE 1/2
0+00.00
Elev. = 415
411.00
CB-177b
C.B. TYPE 1/2
0+88.07
Elev. = 413
410.20
409.97
CB-176b
C.B. TYPE 1/2
2+24.12
Elev. = 418
409.06
407.83
OF-176/177
OUTLET PIPE
3+00.49
Elev. = 407
407.25
Length = 86.07ft.
18" R.C. PIPE
Slope = 0.93%
NP-25
Length = 133.05ft.
18" R.C. PIPE
Slope = 0.68%
NP-26
Length = 75.37ft.
24" R.C. PIPE
Slope = 0.77%
NP-28


OF-176/177 (50 YR PRE)(B)
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+49
CB-176a
DUMMY JOINT
0+00.00
Elev. = 415
414.93
Length = 171.44ft.
18" R.C. PIPE
Slope = 3.55%
NP-27
CB-176b
C.B. TYPE W2
1+72.44
Elev. = 418
408.84
407.83
Length = 75.37ft.
24" R.C. PIPE
Slope = 0.77%
NP-28
OF-176/177
OUTLET PIPE
2+48.81
Elev. = 407
407.25

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

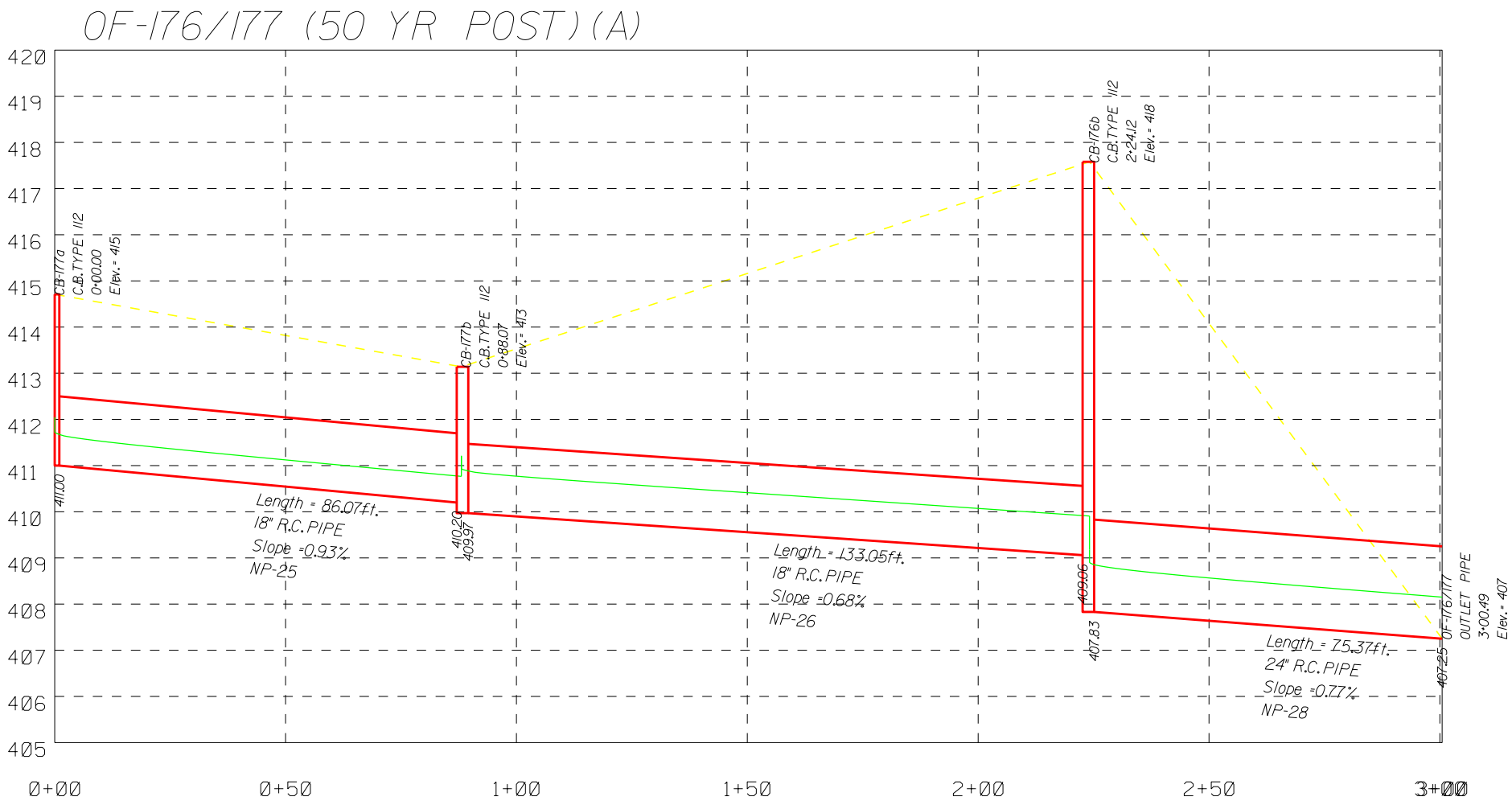
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-176/177	Outlet	OP	407.25	407.25	0.00	0.48	0.00	39.76	0.00	5.92	0.28	0.00
CB-176b	Other	C.B. TYPE 112	417.58	417.58	9.75	0.26	39.56	39.56	8.88	5.92	0.28	4.46
CB-177b	Other	C.B. TYPE 112	413.14	413.14	3.17	0.26	5.27	5.27	5.72	0.83	0.64	8.96
CB-176a	Other	DUMMY JOINT	414.93	414.93	0.00	0.00	39.27	39.27	4.79	4.64	0.19	4.48
CB-177a	Other	C.B. TYPE 112	414.71	414.71	3.71	0.00	5.00	5.00	3.31	0.34	0.90	9.03

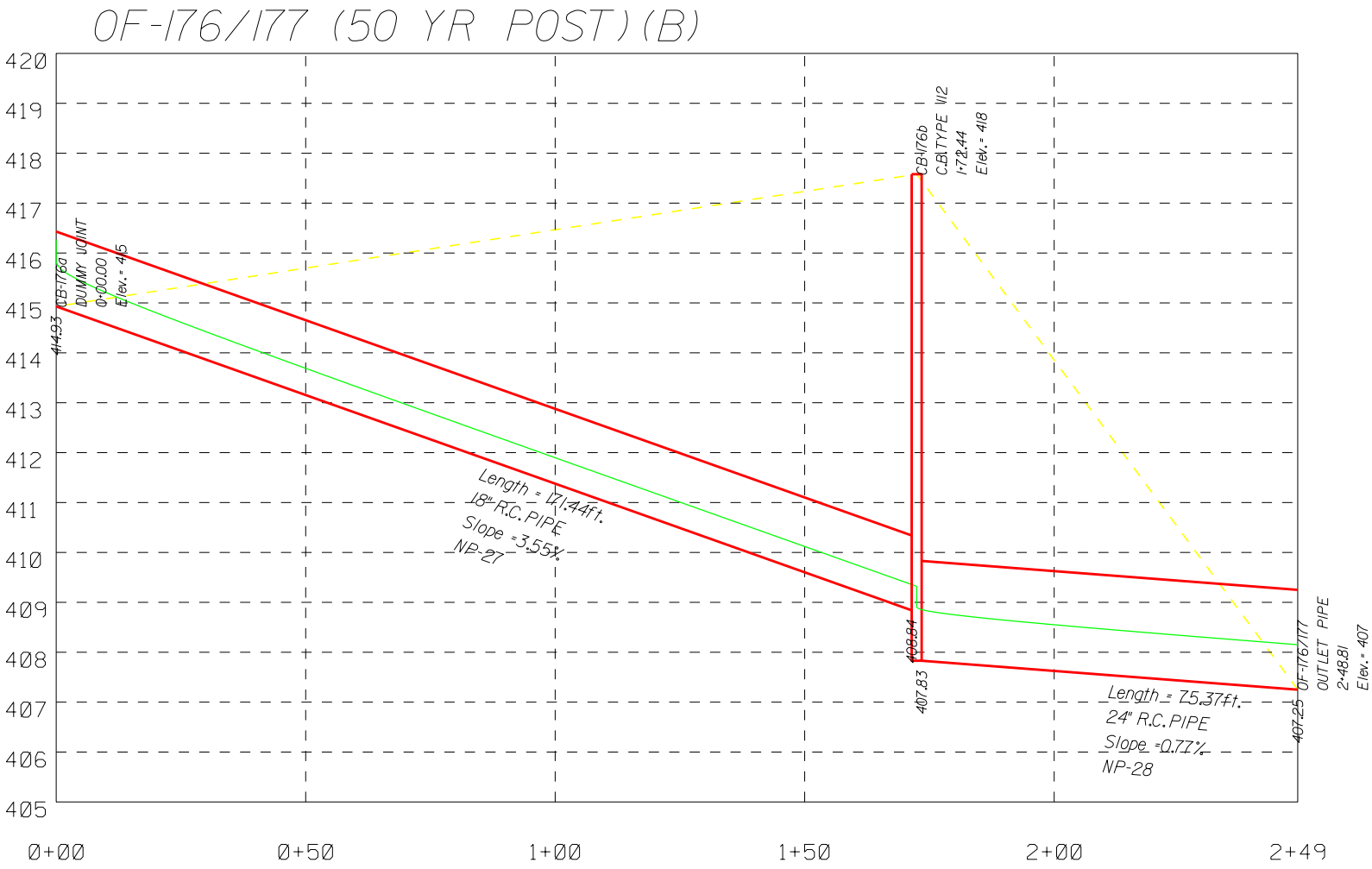
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-28	CB-176b	OF-176/177	Circular	Concrete	1	2.00	75	0.77	8.88	23.13	0.89	6.53	409.83	409.16	409.25	408.15	407.83	407.25	4.00	6.46	1.33	0.90
NP-26	CB-177b	CB-176b	Circular	Concrete	1	1.50	133	0.68	5.72	10.12	0.85	5.56	411.47	411.17	410.56	409.91	409.97	409.06	3.78	5.56	1.20	0.85
NP-27	CB-176a	CB-176b	Circular	Concrete	1	1.50	171	3.55	4.79	23.07	0.48	9.78	416.43	416.20	410.34	409.32	414.93	408.84	3.01	9.76	1.27	0.48
NP-25	CB-177a	CB-177b	Circular	Concrete	1	1.50	86	0.93	3.31	11.80	0.57	5.42	412.50	412.01	411.70	410.77	411.00	410.20	2.62	5.42	1.01	0.57

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-176b	5.00	2.56	9.03	0.52	0.45	0.52	0.45	0.00	0.00
CB-177b	5.00	2.45	9.03	0.46	0.49	0.46	0.49	0.00	0.00
CB-176a	39.27	4.79	4.48	0.19	4.64	0.19	4.64	0.00	0.00
CB-177a	5.00	3.31	9.03	0.90	0.34	0.90	0.34	0.00	0.00


OF-176/177 (50 YR POST)(A)
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+50
3+00
CB-177a
C.B. TYPE 1/2
0+00.00
Elev.= 415
CB-177b
C.B. TYPE 1/2
0+88.07
Elev.= 413
CB-176b
C.B. TYPE 1/2
2+24.12
Elev.= 418
411.00
410.20
409.97
409.96
407.83
407.25
Length = 86.07ft.
18" R.C. PIPE
Slope =0.93%
NP-25
Length = 133.05ft.
18" R.C. PIPE
Slope =0.68%
NP-26
Length = 75.37ft.
24" R.C. PIPE
Slope =0.77%
NP-28
OF-176/177
OUTLET PIPE
3+00.49
Elev.= 407


OF-176/177 (50 YR POST)(B)
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
0+00
0+50
1+00
1+50
2+00
2+49
CB-176a
DUMMY JOINT
0+00.00
Elev. = 415
414.93
Length = 171.44ft.
18" R.C. PIPE
Slope = 3.55%
NP-27
CB-176b
C.B. TYPE M2
1+72.44
Elev. = 418
408.34
407.83
Length = 75.37ft.
24" R.C. PIPE
Slope = 0.77%
NP-28
OF-176/177
OUTLET PIPE
2+48.81
Elev. = 407
407.25

CULVERT 178

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 178a**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.55	0.4930
Grass	0.25	0.46	0.1162
Woods	0.15	0.33	0.0490
	Σ	**1.34**	0.6582

$C_{ave} = \frac{0.6582}{1.34} = 0.49$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.74	0.6640
Grass	0.25	0.46	0.1162
Woods	0.15	0.33	0.0490
	Σ	**1.53**	0.8292

$C_{ave} = \frac{0.8292}{1.53} = 0.54$

T_c =	10.00	min.
I_{05} =	5.50	in / hr
I_{10} =	6.13	in / hr
I_{25} =	7.07	in / hr
I_{50} =	7.77	in / hr
I_{100} =	8.51	in / hr

Pre Construction Runoff:

Q_{05} =	0.49	x	5.50	x	1.34	x	1	=	**3.62**	cfs
Q_{10} =	0.49	x	6.13	x	1.34	x	1	=	**4.04**	cfs
Q_{25} =	0.49	x	7.07	x	1.34	x	1.1	=	**5.12**	cfs
Q_{50} =	0.49	x	7.77	x	1.34	x	1.2	=	**6.14**	cfs
Q_{100} =	0.49	x	8.51	x	1.34	x	1.25	=	**7.00**	cfs

Post Construction Runoff:

Q_{05} =	0.54	x	5.50	x	1.53	x	1	=	**4.56**	cfs
Q_{10} =	0.54	x	6.13	x	1.53	x	1	=	**5.09**	cfs
Q_{25} =	0.54	x	7.07	x	1.53	x	1.1	=	**6.45**	cfs
Q_{50} =	0.54	x	7.77	x	1.53	x	1.2	=	**7.74**	cfs
Q_{100} =	0.54	x	8.51	x	1.53	x	1.25	=	**8.82**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 178b**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.49	0.4366
Grass	0.25	0.43	0.1074
Woods	0.15	0.00	0.0000
	Σ	**0.91**	0.5440

$C_{ave} = \frac{0.5440}{0.91} = 0.59$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.53	0.4770
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.53**	0.4770

$C_{ave} = \frac{0.4770}{0.53} = 0.90$

T_c =	5.00	min.
I_{05} =	6.23	in / hr
I_{10} =	6.98	in / hr
I_{25} =	8.08	in / hr
I_{50} =	8.93	in / hr
I_{100} =	9.81	in / hr

Pre Construction Runoff:

Q_{05} =	0.59	x	6.23	x	0.91	x	1	=	**3.39**	cfs
Q_{10} =	0.59	x	6.98	x	0.91	x	1	=	**3.80**	cfs
Q_{25} =	0.59	x	8.08	x	0.91	x	1.1	=	**4.84**	cfs
Q_{50} =	0.59	x	8.93	x	0.91	x	1.2	=	**5.83**	cfs
Q_{100} =	0.59	x	9.81	x	0.91	x	1.25	=	**6.67**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.53	x	1	=	**2.97**	cfs
Q_{10} =	0.90	x	6.98	x	0.53	x	1	=	**3.33**	cfs
Q_{25} =	0.90	x	8.08	x	0.53	x	1.1	=	**4.24**	cfs
Q_{50} =	0.90	x	8.93	x	0.53	x	1.2	=	**5.11**	cfs
Q_{100} =	0.90	x	9.81	x	0.53	x	1.25	=	**5.85**	cfs

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 178c**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.41	0.3693
Grass	0.25	0.51	0.1274
Woods	0.15	0.60	0.0897
	Σ	**1.52**	0.5864

$C_{ave} = \frac{0.5864}{1.52} = 0.39$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.60	0.5403
Grass	0.25	0.51	0.1274
Woods	0.15	0.60	0.0897
	Σ	**1.71**	0.7574

$C_{ave} = \frac{0.7574}{1.71} = 0.44$

T_c =	26.97	min.
I_{05} =	3.92	in / hr
I_{10} =	4.34	in / hr
I_{25} =	4.95	in / hr
I_{50} =	5.41	in / hr
I_{100} =	5.88	in / hr

Pre Construction Runoff:

Q_{05} =	0.39	x	3.92	x	1.52	x	1	=	**2.30**	cfs
Q_{10} =	0.39	x	4.34	x	1.52	x	1	=	**2.55**	cfs
Q_{25} =	0.39	x	4.95	x	1.52	x	1.1	=	**3.20**	cfs
Q_{50} =	0.39	x	5.41	x	1.52	x	1.2	=	**3.81**	cfs
Q_{100} =	0.39	x	5.88	x	1.52	x	1.25	=	**4.31**	cfs

Post Construction Runoff:

Q_{05} =	0.44	x	3.92	x	1.71	x	1	=	**2.97**	cfs
Q_{10} =	0.44	x	4.34	x	1.71	x	1	=	**3.29**	cfs
Q_{25} =	0.44	x	4.95	x	1.71	x	1.1	=	**4.13**	cfs
Q_{50} =	0.44	x	5.41	x	1.71	x	1.2	=	**4.92**	cfs
Q_{100} =	0.44	x	5.88	x	1.71	x	1.25	=	**5.57**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 178c	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**50**				
9	Watercourse slope, s	----------	ft/ft	**0.0800**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.56**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.003**	+		=	**0.003**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.450**
						min		**26.97**

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Description	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-178		Outlet	OP	382.31	382.31	0.00	0.48	0.00	27.02	0.00	3.77	0.48	0.00
CB-178c		Other	C.B. TYPE 112	386.13	386.13	3.44	0.03	26.97	26.97	11.76	3.77	0.48	5.47
CB-178b		Other	C.B. TYPE 112	387.44	387.44	3.50	0.06	10.12	10.12	11.34	2.25	0.54	7.84
CB-178a		Other	C.B. TYPE 112	388.46	388.46	2.90	0.00	10.00	10.00	6.22	1.34	0.49	7.86

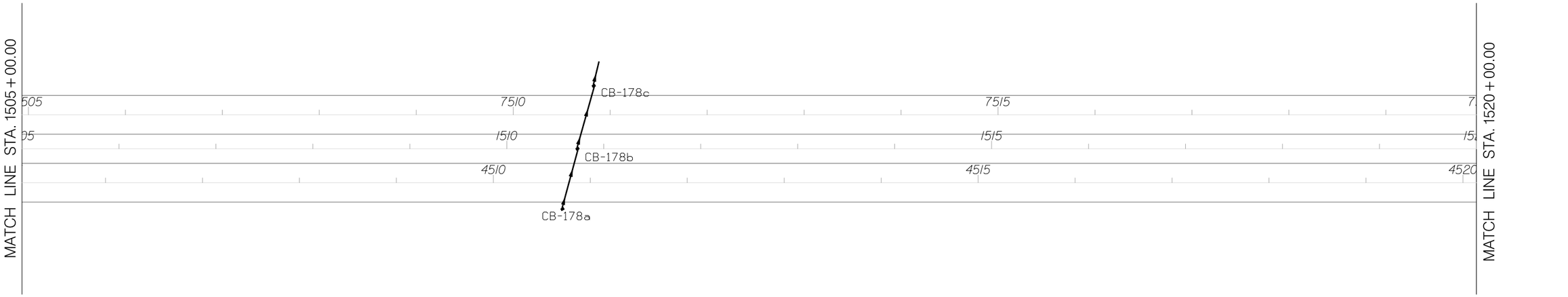
SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-24	CB-178c	OF-178	Circular	Concrete	1	1.50	25	1.52	11.76	15.09	1.05	8.89	384.19	384.04	383.81	383.43	382.69	382.31	7.03	8.33	1.35	1.12
NP-23	CB-178b	CB-178c	Circular	Concrete	1	1.50	65	1.79	11.34	16.37	0.97	9.43	385.44	385.32	384.27	383.76	383.94	382.77	6.67	9.14	1.38	0.99
NP-22	CB-178a	CB-178b	Circular	Concrete	1	1.50	63	2.49	6.22	19.32	0.61	9.24	387.06	387.06	385.50	384.63	385.56	384.00	3.52	8.91	1.50	0.63

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (PRE)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-178c	26.97	3.85	5.47	0.39	1.52	0.39	1.52	0.00	0.00
CB-178b	5.00	5.91	9.03	0.60	0.91	0.60	0.91	0.00	0.00
CB-178a	10.00	6.22	7.86	0.49	1.34	0.49	1.34	0.00	0.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON/ RICHLAND/ NEWBERRY		I-26	68



REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED	REVISIONS NO.	REVISIONS DATE	DESCRIPTION	BY	CHECKED

0 50 100 150 200

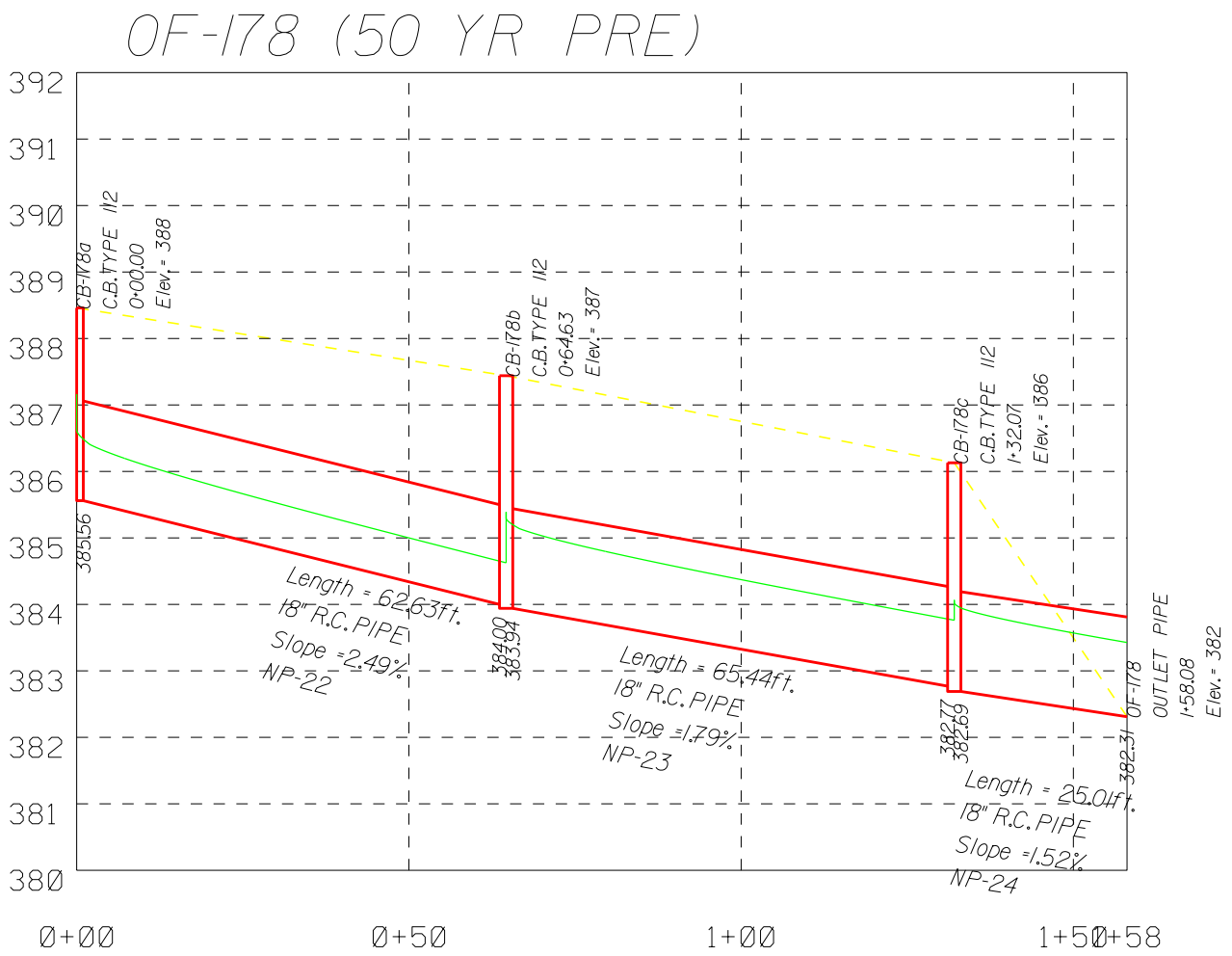
SCALE: 1" = 50' HORIZ

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

INTERSTATE 26 WIDENING

PLAN SHEET
STA. 1505+00.00 TO STA. 1520+00.00

$$$$$$$path$$$$$$$$$$filename$$$$$$$$
$$$$date$$$$


OF-178 (50 YR PRE)
392
391
390
389
388
387
386
385
384
383
382
381
380
0+00
0+50
1+00
1+50
1+58
CB-178a
C.B. TYPE II2
0+00.00
Elev.= 388
385.56
CB-178b
C.B. TYPE II2
0+64.63
Elev.= 387
383.94
CB-178c
C.B. TYPE II2
1+32.07
Elev.= 386
382.77
382.69
OF-178
OUTLET PIPE
1+58.08
Elev.= 382
382.31
Length = 62.63ft.
18" R.C. PIPE
Slope =2.49%
NP-22
Length = 65.44ft.
18" R.C. PIPE
Slope =1.79%
NP-23
Length = 25.0ft.
18" R.C. PIPE
Slope =1.52%
NP-24

SCDOT REPORT - GEOPAK NODE OUTPUT
I-26 DB PREP 50 YR (POST)

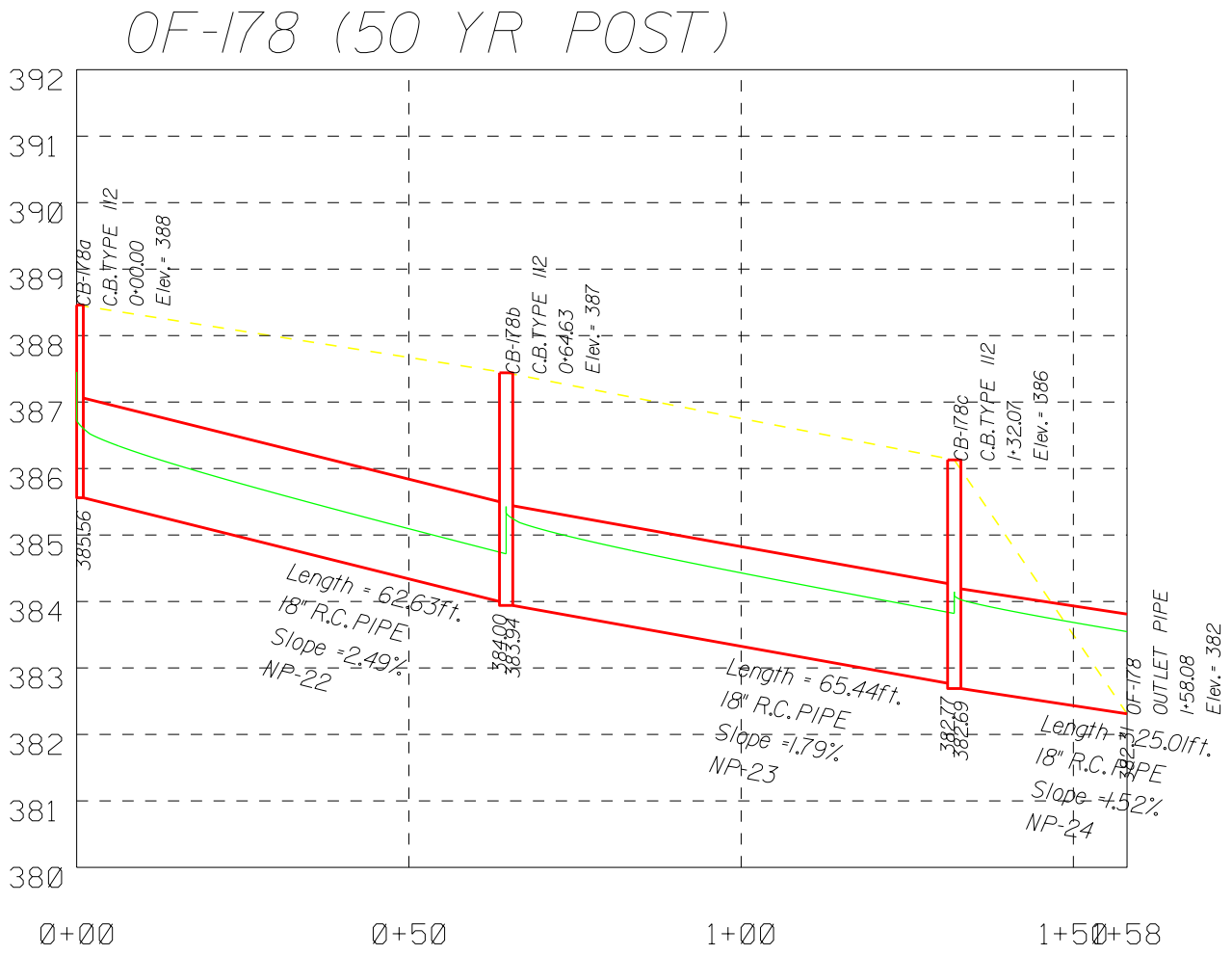
ID	Type	Library Item Name	Ref. Elev.	Elev.	Depth	Junc. Loss	Tc Used	Cum. Tc	Cum. Q	Cum. Area	Cum. C Value	Cum. I
OF-178	Outlet	OP	382.31	382.31	0.00	0.48	0.00	27.02	0.00	3.77	0.55	0.00
CB-178c	Other	C.B. TYPE 112	386.13	386.13	3.44	0.04	26.97	26.97	13.55	3.77	0.55	5.47
CB-178b	Other	C.B. TYPE 112	387.44	387.44	3.50	0.05	10.11	10.11	12.30	2.06	0.63	7.84
CB-178a	Other	C.B. TYPE 112	388.46	388.46	2.90	0.00	10.00	10.00	7.83	1.53	0.54	7.86

SCDOT REPORT - GEOPAK LINK OUTPUT
I-26 DB PREP 50 YR (POST)

ID	US Node	DS Node	Shape	Material	# of Barrels	Rise	Act. L	Slope	Q	Capacity	Uniform Depth	Uniform Vel.	US Soffit	US HGL	DS Soffit	DS HGL	US Invert	DS Invert	Act. Vel. US	Act. Vel. DS	Actual Depth US	Actual Depth DS
NP-24	CB-178c	OF-178	Circular	Concrete	1	1.50	25	1.52	13.55	15.09	1.19	9.03	384.19	384.12	383.81	383.55	382.69	382.31	7.81	8.69	1.43	1.24
NP-23	CB-178b	CB-178c	Circular	Concrete	1	1.50	65	1.79	12.30	16.37	1.02	9.58	385.44	385.36	384.27	383.82	383.94	382.77	7.11	9.30	1.42	1.05
NP-22	CB-178a	CB-178b	Circular	Concrete	1	1.50	63	2.49	7.83	19.32	0.69	9.81	387.06	387.35	385.50	384.72	385.56	384.00	4.43	9.38	1.50	0.72

SCDOT REPORT - GEOPAK AREA OUTPUT
I-26 DB PREP 50 YR (POST)

ID	Tc Used	Discharge	Itensity	Composite C Value	Composite Area	Total Subarea C Value	Total Subarea	Remainder C Value	Remainder Area
CB-178c	26.97	4.97	5.47	0.44	1.71	0.44	1.71	0.00	0.00
CB-178b	5.00	5.17	9.03	0.90	0.53	0.90	0.53	0.00	0.00
CB-178a	10.00	7.83	7.86	0.54	1.53	0.54	1.53	0.00	0.00


OF-178 (50 YR POST)
392
391
390
389
388
387
386
385
384
383
382
381
380
0+00
0+50
1+00
1+50
1+58
CB-178a
C.B. TYPE II2
0+00.00
Elev.= 388
385.56
CB-178b
C.B. TYPE II2
0+64.63
Elev.= 387
384.00
383.94
CB-178c
C.B. TYPE II2
1+32.07
Elev.= 386
382.77
382.69
OF-178
OUTLET PIPE
1+58.08
Elev.= 382
382.31
Length = 62.63ft.
18" R.C. PIPE
Slope =2.49%
NP-22
Length = 65.44ft.
18" R.C. PIPE
Slope =1.79%
NP-23
Length = 25.01ft.
18" R.C. PIPE
Slope =1.52%
NP-24

CULVERT 179

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 179**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.84	0.7582
Grass	0.25	0.60	0.1504
Woods	0.15	0.00	0.0000
	Σ	**1.44**	0.9085

$C_{ave} = \frac{0.9085}{1.44} = 0.63$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.86	0.7740
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.86**	0.7740

$C_{ave} = \frac{0.7740}{0.86} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.63	x	6.23	x	1.44	x	1	=	**5.66**	cfs
Q_{10} =	0.63	x	6.98	x	1.44	x	1	=	**6.34**	cfs
Q_{25} =	0.63	x	8.08	x	1.44	x	1.1	=	**8.08**	cfs
Q_{50} =	0.63	x	8.93	x	1.44	x	1.2	=	**9.73**	cfs
Q_{100} =	0.63	x	9.81	x	1.44	x	1.25	=	**11.14**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.86	x	1	=	**4.82**	cfs
Q_{10} =	0.90	x	6.98	x	0.86	x	1	=	**5.40**	cfs
Q_{25} =	0.90	x	8.08	x	0.86	x	1.1	=	**6.88**	cfs
Q_{50} =	0.90	x	8.93	x	0.86	x	1.2	=	**8.29**	cfs
Q_{100} =	0.90	x	9.81	x	0.86	x	1.25	=	**9.49**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.08 cfs

Design Flow: 9.73 cfs

Maximum Flow: 11.14 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1517+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
372.92	8.08	8.08	0.00	1
373.05	8.39	8.39	0.00	1
373.19	8.69	8.69	0.00	1
373.22	9.00	8.76	0.18	9
373.23	9.30	8.78	0.49	5
373.24	9.61	8.80	0.78	4
373.24	9.73	8.80	0.89	3
373.25	10.22	8.83	1.37	4
373.26	10.53	8.84	1.64	3
373.27	10.83	8.85	1.94	3
373.27	11.14	8.86	2.24	3
373.21	8.73	8.73	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.08	8.08	372.92	2.488	0.0*	5-S2n	0.513	1.118	0.550	0.750	15.022	3.079
8.39	8.39	373.05	2.622	0.0*	5-S2n	0.523	1.132	0.560	0.764	15.231	3.111
8.69	8.69	373.19	2.761	0.0*	5-S2n	0.534	1.145	0.571	0.778	15.376	3.141
9.00	8.76	373.22	2.791	0.0*	5-S2n	0.536	1.147	0.574	0.792	15.403	3.171
9.30	8.78	373.23	2.802	0.0*	5-S2n	0.537	1.148	0.575	0.805	15.412	3.200
9.61	8.80	373.24	2.810	0.0*	5-S2n	0.538	1.148	0.576	0.819	15.419	3.227
9.73	8.80	373.24	2.813	0.0*	5-S2n	0.538	1.149	0.576	0.824	15.421	3.239
10.22	8.83	373.25	2.824	0.0*	5-S2n	0.539	1.149	0.577	0.844	15.430	3.281
10.53	8.84	373.26	2.830	0.0*	5-S2n	0.539	1.150	0.577	0.857	15.435	3.307
10.83	8.85	373.27	2.836	0.0*	5-S2n	0.539	1.150	0.578	0.869	15.439	3.334
11.14	8.86	373.27	2.841	0.0*	5-S2n	0.540	1.151	0.578	0.881	15.444	3.358

* Full Flow Headwater elevation is below inlet invert.

****

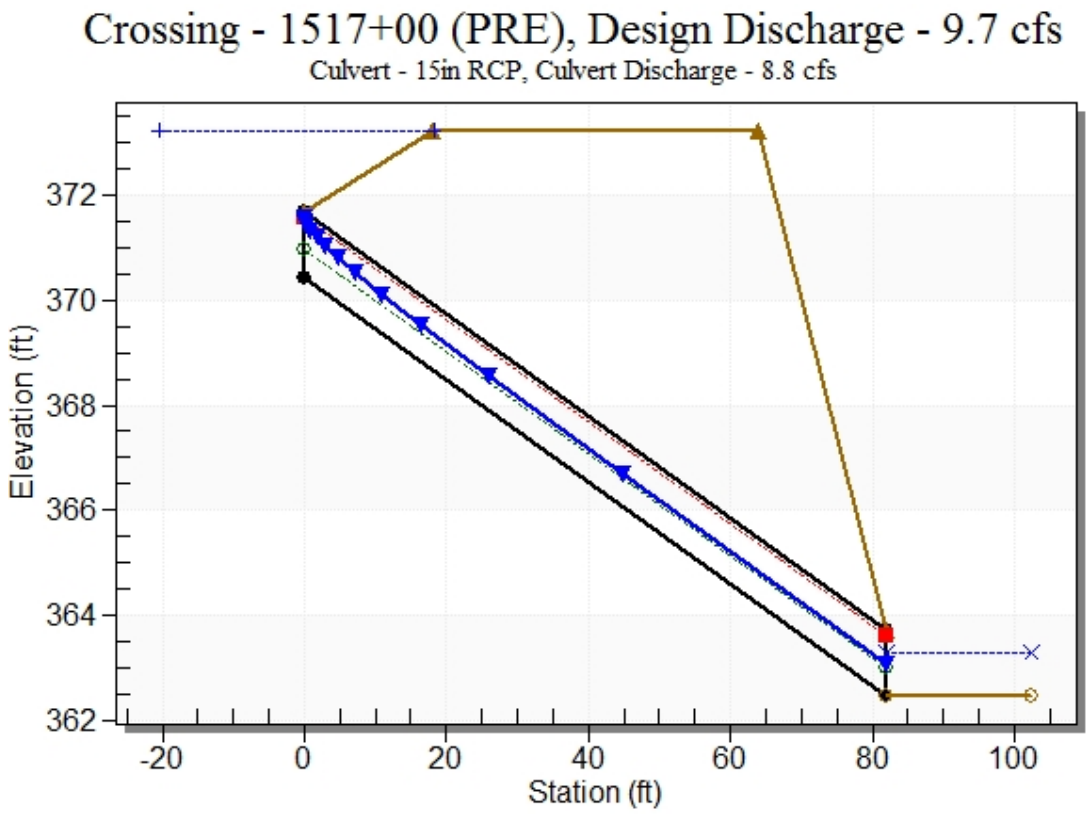
Straight Culvert

Inlet Elevation (invert): 370.43 ft, Outlet Elevation (invert): 362.47 ft

Culvert Length: 82.39 ft, Culvert Slope: 0.0971

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 370.43 ft

Outlet Station: 82.00 ft

Outlet Elevation: 362.47 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1517+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
8.08	363.22	0.75	3.08	1.87	0.75
8.39	363.23	0.76	3.11	1.91	0.75
8.69	363.25	0.78	3.14	1.94	0.75
9.00	363.26	0.79	3.17	1.98	0.75
9.30	363.28	0.81	3.20	2.01	0.76
9.61	363.29	0.82	3.23	2.04	0.76
9.73	363.29	0.82	3.24	2.06	0.76
10.22	363.31	0.84	3.28	2.11	0.76
10.53	363.33	0.86	3.31	2.14	0.76
10.83	363.34	0.87	3.33	2.17	0.76
11.14	363.35	0.88	3.36	2.20	0.76

Tailwater Channel Data - 1517+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 362.47 ft

Roadway Data for Crossing: 1517+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 373.21 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.88 cfs

Design Flow: 8.29 cfs

Maximum Flow: 9.49 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1517+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
372.45	6.88	6.88	0.00	1
372.54	7.14	7.14	0.00	1
372.64	7.40	7.40	0.00	1
372.74	7.66	7.66	0.00	1
372.85	7.92	7.92	0.00	1
372.96	8.19	8.19	0.00	1
373.01	8.29	8.29	0.00	1
373.20	8.71	8.71	0.00	1
373.22	8.97	8.76	0.16	8
373.23	9.23	8.77	0.40	4
373.24	9.49	8.79	0.66	4
373.21	8.73	8.73	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.88	6.88	372.45	2.016	0.0*	5-S2n	0.469	1.050	0.469	0.691	15.788	2.947
7.14	7.14	372.54	2.112	0.0*	5-S2n	0.479	1.066	0.479	0.704	15.950	2.977
7.40	7.40	372.64	2.211	0.0*	5-S2n	0.489	1.082	0.530	0.717	14.478	3.006
7.66	7.66	372.74	2.315	0.0*	5-S2n	0.498	1.097	0.538	0.730	14.680	3.035
7.92	7.92	372.85	2.422	0.0*	5-S2n	0.507	1.111	0.545	0.742	14.900	3.063
8.19	8.19	372.96	2.534	0.0*	5-S2n	0.516	1.123	0.554	0.755	15.099	3.090
8.29	8.29	373.01	2.579	0.0*	5-S2n	0.520	1.128	0.557	0.760	15.170	3.101
8.71	8.71	373.20	2.768	0.0*	5-S2n	0.535	1.145	0.572	0.779	15.382	3.143
8.97	8.76	373.22	2.791	0.0*	5-S2n	0.536	1.147	0.574	0.791	15.402	3.168
9.23	8.77	373.23	2.799	0.0*	5-S2n	0.537	1.147	0.575	0.802	15.410	3.192
9.49	8.79	373.24	2.807	0.0*	5-S2n	0.537	1.148	0.575	0.813	15.417	3.217

* Full Flow Headwater elevation is below inlet invert.

****

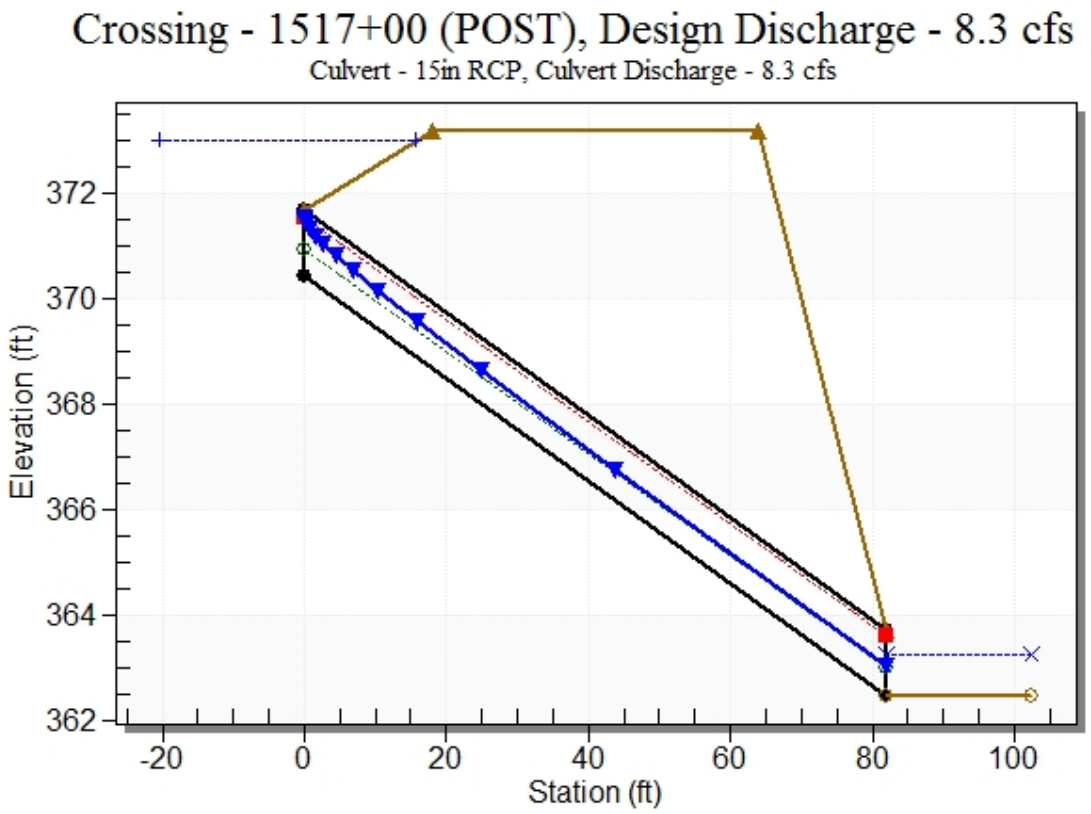
Straight Culvert

Inlet Elevation (invert): 370.43 ft, Outlet Elevation (invert): 362.47 ft

Culvert Length: 82.39 ft, Culvert Slope: 0.0971

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 370.43 ft

Outlet Station: 82.00 ft

Outlet Elevation: 362.47 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1517+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.88	363.16	0.69	2.95	1.72	0.74
7.14	363.17	0.70	2.98	1.76	0.74
7.40	363.19	0.72	3.01	1.79	0.74
7.66	363.20	0.73	3.03	1.82	0.75
7.92	363.21	0.74	3.06	1.85	0.75
8.19	363.22	0.75	3.09	1.88	0.75
8.29	363.23	0.76	3.10	1.90	0.75
8.71	363.25	0.78	3.14	1.94	0.75
8.97	363.26	0.79	3.17	1.97	0.75
9.23	363.27	0.80	3.19	2.00	0.76
9.49	363.28	0.81	3.22	2.03	0.76

Tailwater Channel Data - 1517+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 362.47 ft

Roadway Data for Crossing: 1517+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 373.21 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 180

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\NSS_v6_2017-04-03 (1).mdb
Updated by tkoenig 4/3/2017 3:40:28 PM add VT 2006-5217 pzero equation

Site: Site 160, South_Carolina
User:
Date: Sunday, December 17, 2017 09:57 AM

Equations for South_Carolina developed using English units

Rural Estimate: Site 160
   Basin Drainage Area: 2.03 square miles
   1 Region

   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 2.03 square miles
      Percent_Area_in_Region_1 = 100 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 0 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2

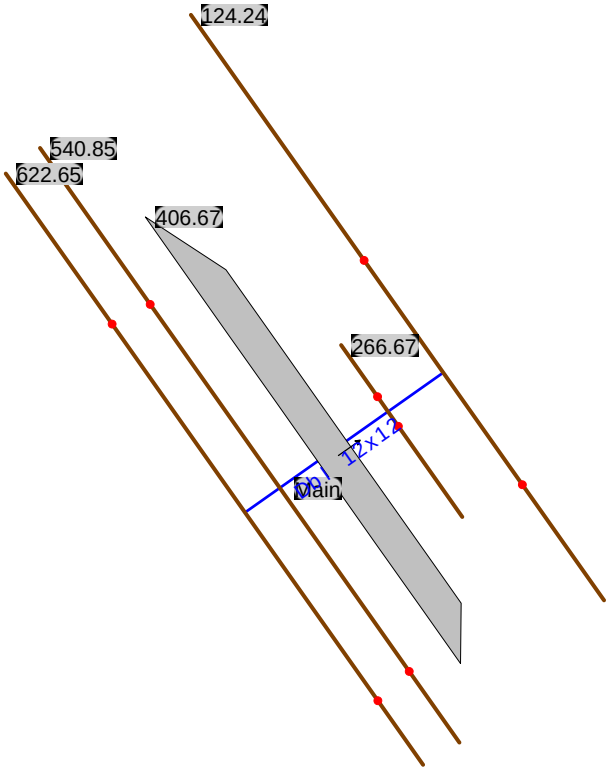
Results for: Site 160

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

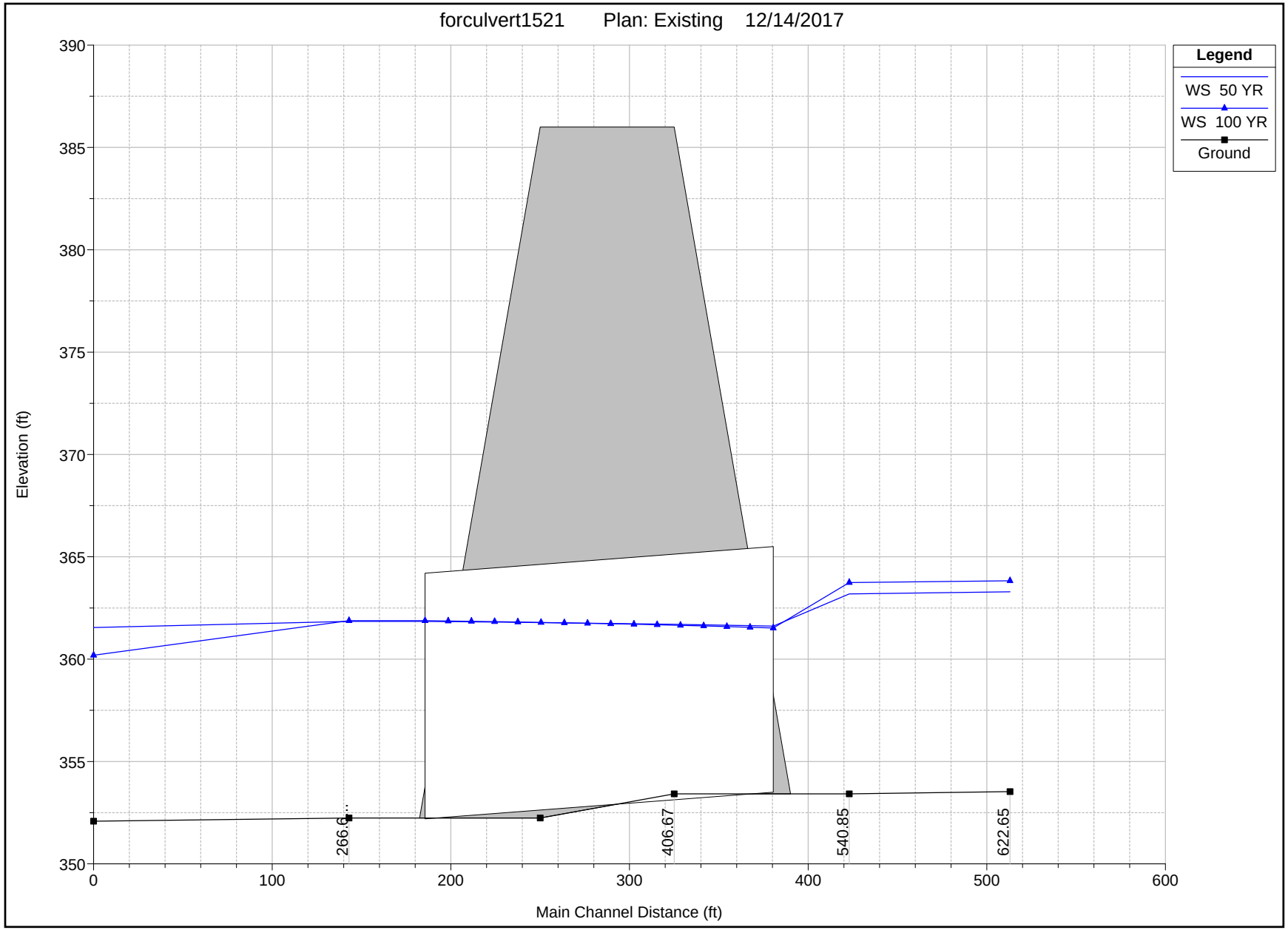
00149*PCTREG3)

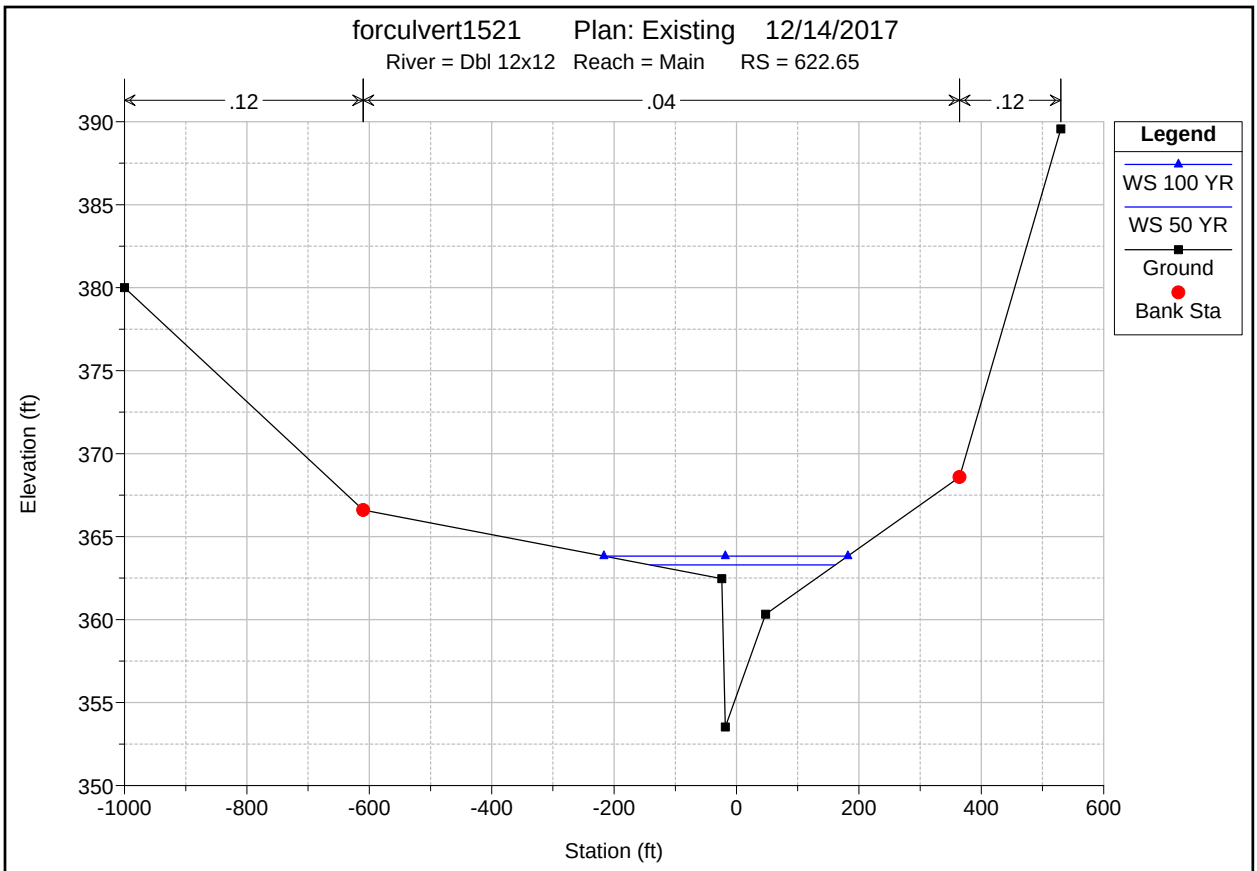
Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	251	144	437	35
PK5	460	266	795	34
PK10	616	351	1080	35
PK25	825	453	1500	38
PK50	1010	538	1900	40
PK100	1180	608	2300	42
PK200	1350	672	2720	44
PK500	1620	766	3420	48

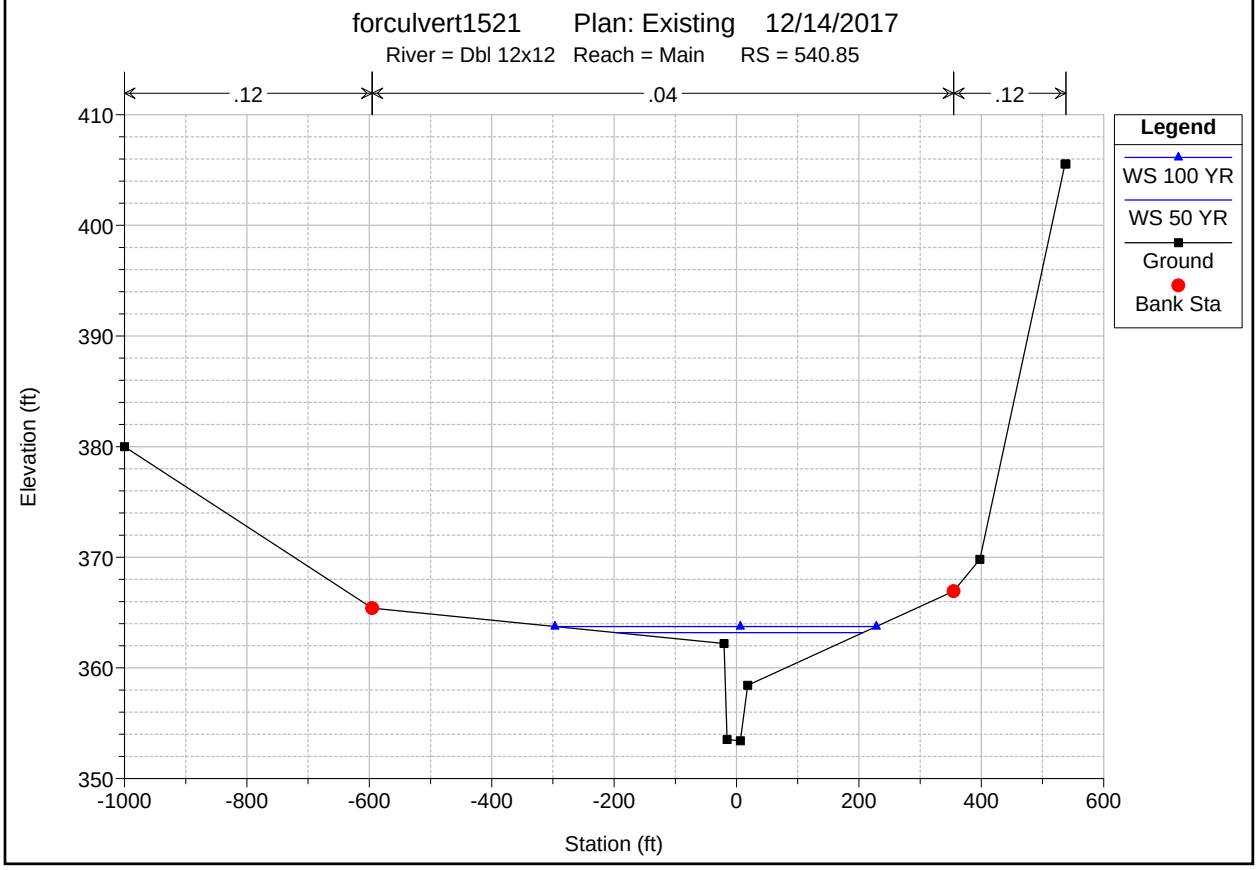
maximum: 9110 (for C&B region 2)

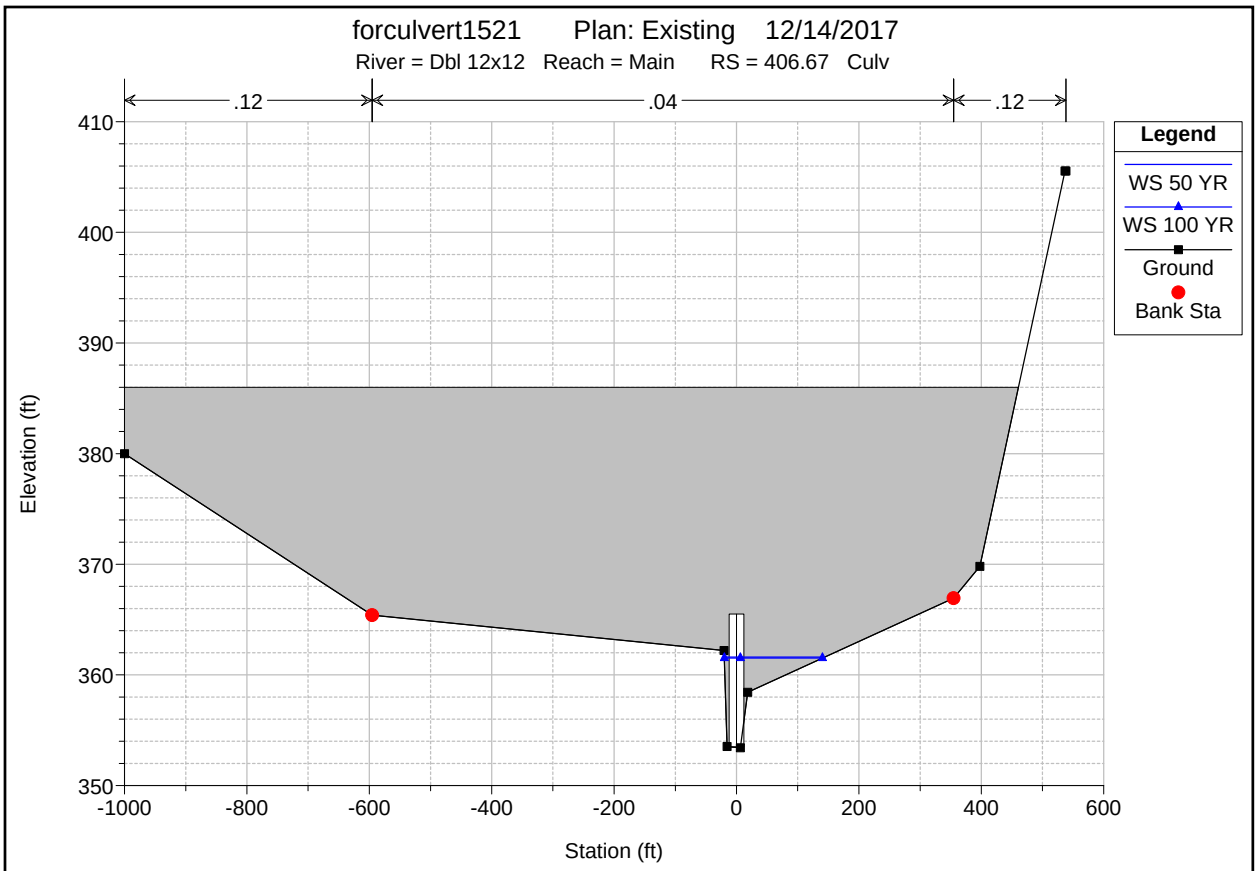


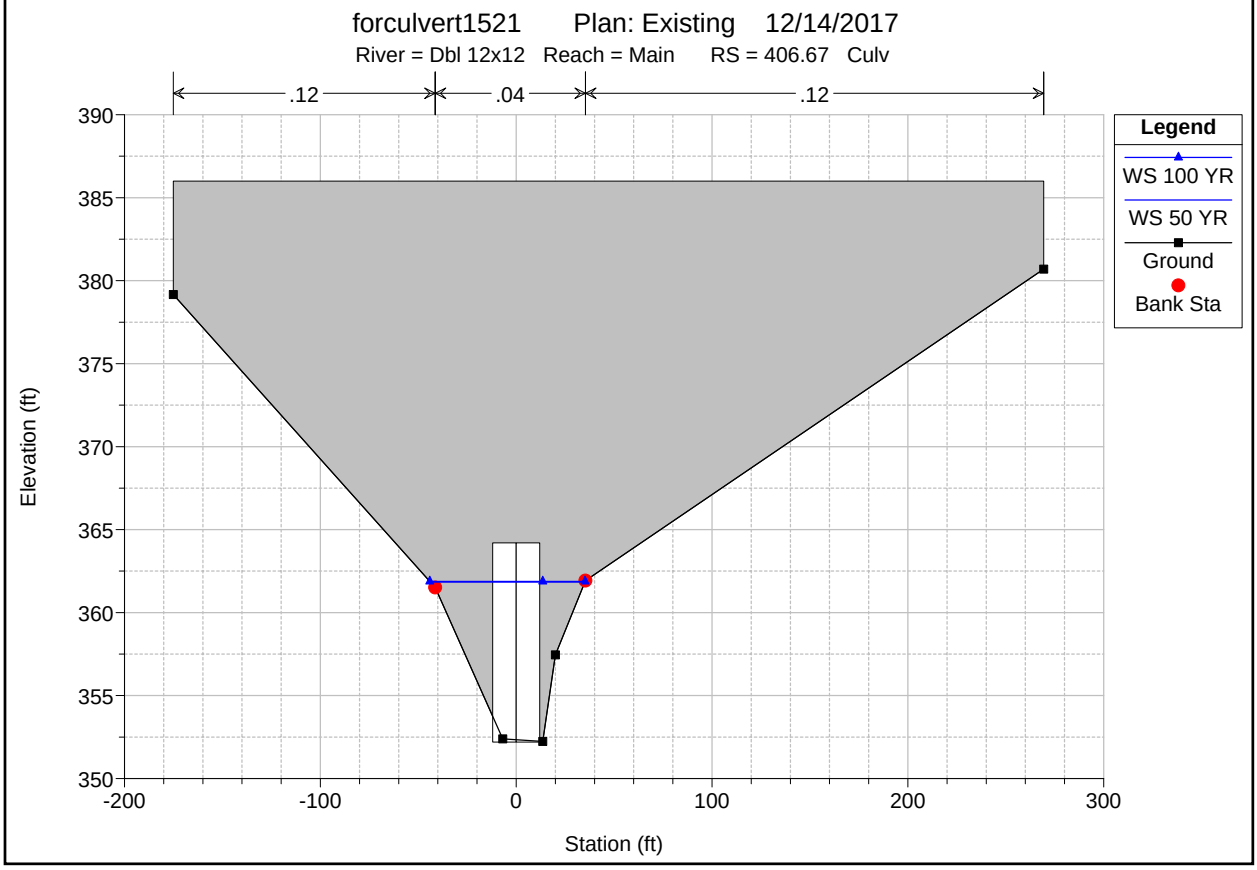
None of the XS's are Geo-Referenced (Geo-Ref user entered XS Geo-Ref interpolated XS Non Geo-Ref user entered XS Non Geo-Ref interpolated XS)

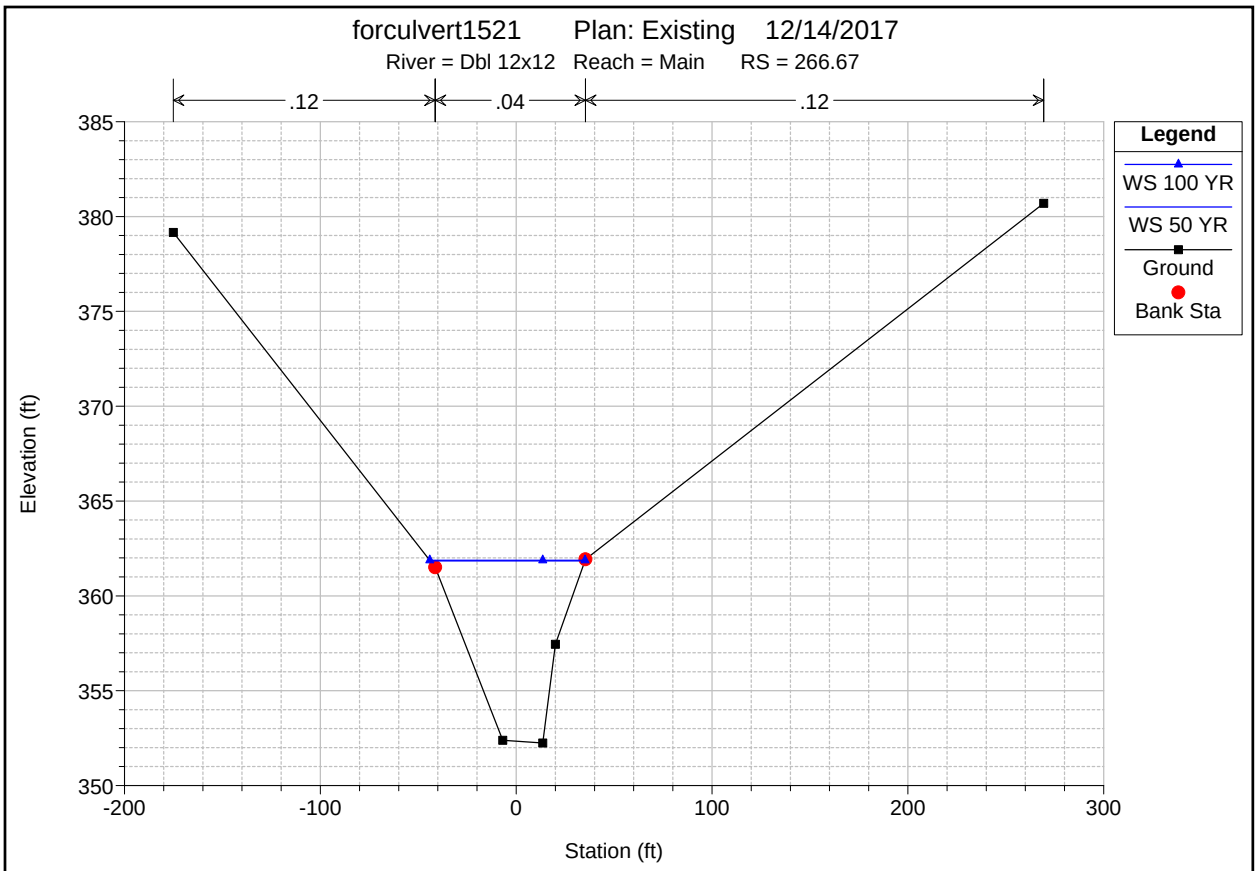

forculvert1521 Plan: Existing 12/14/2017
Legend
WS 50 YR
WS 100 YR
Ground
Elevation (ft)
Main Channel Distance (ft)
390
385
380
375
370
365
360
355
350
0
100
200
300
400
500
600
266.6...
406.67
540.85
622.65


forculvert1521 Plan: Existing 12/14/2017
River = Dbl 12x12 Reach = Main RS = 622.65
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
390
385
380
375
370
365
360
355
350
-1000
-800
-600
-400
-200
0
200
400
600
Station (ft)


forculvert1521 Plan: Existing 12/14/2017
River = Dbl 12x12 Reach = Main RS = 540.85
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
410
400
390
380
370
360
350
-1000
-800
-600
-400
-200
0
200
400
600
Station (ft)


forculvert1521 Plan: Existing 12/14/2017
River = Dbl 12x12 Reach = Main RS = 406.67 Culv
.12
.04
.12
Legend
WS 50 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
410
400
390
380
370
360
350
-1000
-800
-600
-400
-200
0
200
400
600


forculvert1521 Plan: Existing 12/14/2017
River = Dbl 12x12 Reach = Main RS = 406.67 Culv
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
390
385
380
375
370
365
360
355
350
-200
-100
0
100
200
300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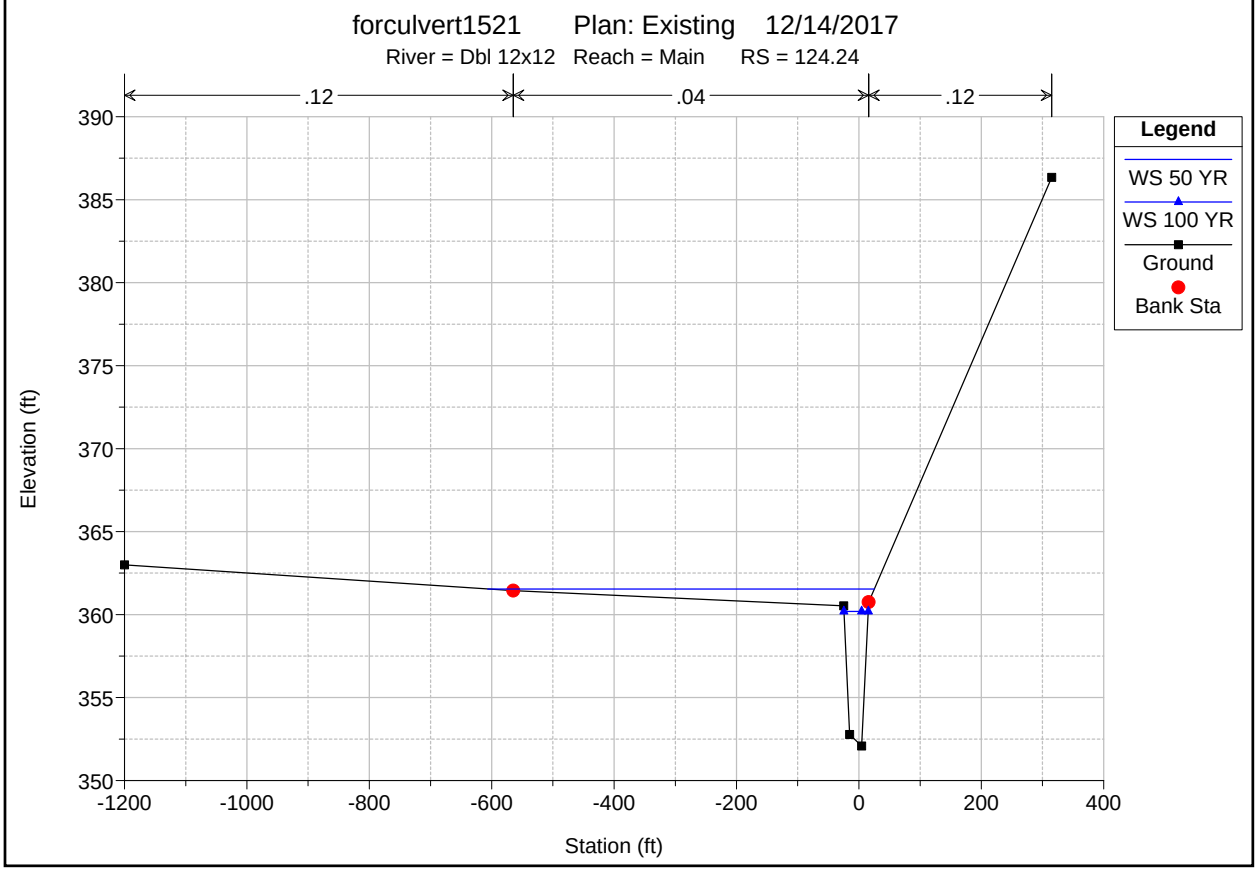
River = Dbl 12x12 Reach = Main RS = 266.67
.12
.04
.12
Legend
WS 100 YR
WS 50 YR
Ground
Bank Sta
Elevation (ft)
385
380
375
370
365
360
355
350
-200
-100
0
100
200
300
Station (ft)


forculvert1521 Plan: Existing 12/14/2017
River = Dbl 12x12 Reach = Main RS = 124.24
.12
.04
.12
Legend
WS 50 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
390
385
380
375
370
365
360
355
350
-1200
-1000
-800
-600
-400
-200
0
200
400
Station (ft)

HEC-RAS Plan: Existing River: Dbl 12x12 Reach: Main

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	622.65	50 YR	1830.00	353.53	363.29		363.41	0.001945	2.74	666.75	302.18	0.33
Main	622.65	100 YR	2130.00	353.53	363.83		363.92	0.001659	2.49	854.35	398.68	0.30
Main	540.85	50 YR	1830.00	353.42	363.19	359.38	363.26	0.001224	2.13	858.99	403.24	0.26
Main	540.85	100 YR	2130.00	353.42	363.74	359.81	363.80	0.000980	1.91	1116.68	525.24	0.23
Main	406.67		Culvert									
Main	266.67	50 YR	1830.00	352.24	361.84		362.11	0.001277	4.14	441.94	78.88	0.30
Main	266.67	100 YR	2130.00	352.24	361.88		362.24	0.001697	4.79	444.88	79.29	0.35
Main	124.24	50 YR	1830.00	352.08	361.54	358.08	361.69	0.007010	3.11	592.90	631.82	0.55
Main	124.24	100 YR	2130.00	352.08	360.19	358.60	361.51	0.007000	9.23	230.80	39.83	0.68

HEC-RAS Plan: Existing River: Dbl 12x12 Reach: Main

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Main	406.67 Culvert #1	50 YR	363.26	363.19	362.51	363.26	386.01	1830.00		1.35	9.40	7.91
Main	406.67 Culvert #1	100 YR	363.80	363.74	363.51	363.80	386.01	2130.00		1.86	11.07	9.17

CULVERT 181

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 181**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.24	0.2140
Grass	0.25	0.17	0.0414
Woods	0.15	0.00	0.0000
	Σ	**0.40**	0.2554

$C_{ave} = \frac{0.2554}{0.40} = 0.63$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.24	0.2140
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.24**	0.2140

$C_{ave} = \frac{0.2140}{0.24} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.63	**x**	6.23	**x**	0.40	**x**	1	=	**1.59**	cfs
Q_{10} =	0.63	**x**	6.98	**x**	0.40	**x**	1	=	**1.78**	cfs
Q_{25} =	0.63	**x**	8.08	**x**	0.40	**x**	1.1	=	**2.27**	cfs
Q_{50} =	0.63	**x**	8.93	**x**	0.40	**x**	1.2	=	**2.74**	cfs
Q_{100} =	0.63	**x**	9.81	**x**	0.40	**x**	1.25	=	**3.13**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.24	**x**	1	=	**1.33**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.24	**x**	1	=	**1.49**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.24	**x**	1.1	=	**1.90**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.24	**x**	1.2	=	**2.29**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.24	**x**	1.25	=	**2.62**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.27 cfs

Design Flow: 2.74 cfs

Maximum Flow: 3.13 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1528+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
407.45	2.27	2.27	0.00	1
407.47	2.36	2.36	0.00	1
407.49	2.44	2.44	0.00	1
407.51	2.53	2.53	0.00	1
407.53	2.61	2.61	0.00	1
407.55	2.70	2.70	0.00	1
407.56	2.74	2.74	0.00	1
407.58	2.87	2.87	0.00	1
407.60	2.96	2.96	0.00	1
407.62	3.04	3.04	0.00	1
407.64	3.13	3.13	0.00	1
409.38	8.68	8.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.27	2.27	407.45	0.748	0.0*	1-S2n	0.217	0.602	0.217	0.297	15.467	2.951
2.36	2.36	407.47	0.768	0.0*	1-S2n	0.221	0.614	0.221	0.303	15.648	2.985
2.44	2.44	407.49	0.788	0.0*	1-S2n	0.225	0.625	0.225	0.309	15.834	3.018
2.53	2.53	407.51	0.808	0.0*	1-S2n	0.229	0.637	0.229	0.315	16.048	3.051
2.61	2.61	407.53	0.827	0.0*	1-S2n	0.233	0.648	0.233	0.321	16.252	3.082
2.70	2.70	407.55	0.846	0.0*	1-S2n	0.236	0.658	0.236	0.327	16.448	3.113
2.74	2.74	407.56	0.855	0.0*	1-S2n	0.238	0.663	0.238	0.330	16.537	3.127
2.87	2.87	407.58	0.884	0.0*	1-S2n	0.244	0.679	0.244	0.338	16.502	3.172
2.96	2.96	407.60	0.903	0.0*	1-S2n	0.247	0.689	0.262	0.344	15.472	3.201
3.04	3.04	407.62	0.922	0.0*	1-S2n	0.251	0.699	0.251	0.349	16.806	3.228
3.13	3.13	407.64	0.940	0.0*	1-S2n	0.255	0.709	0.255	0.355	16.950	3.256

* Full Flow Headwater elevation is below inlet invert.

****

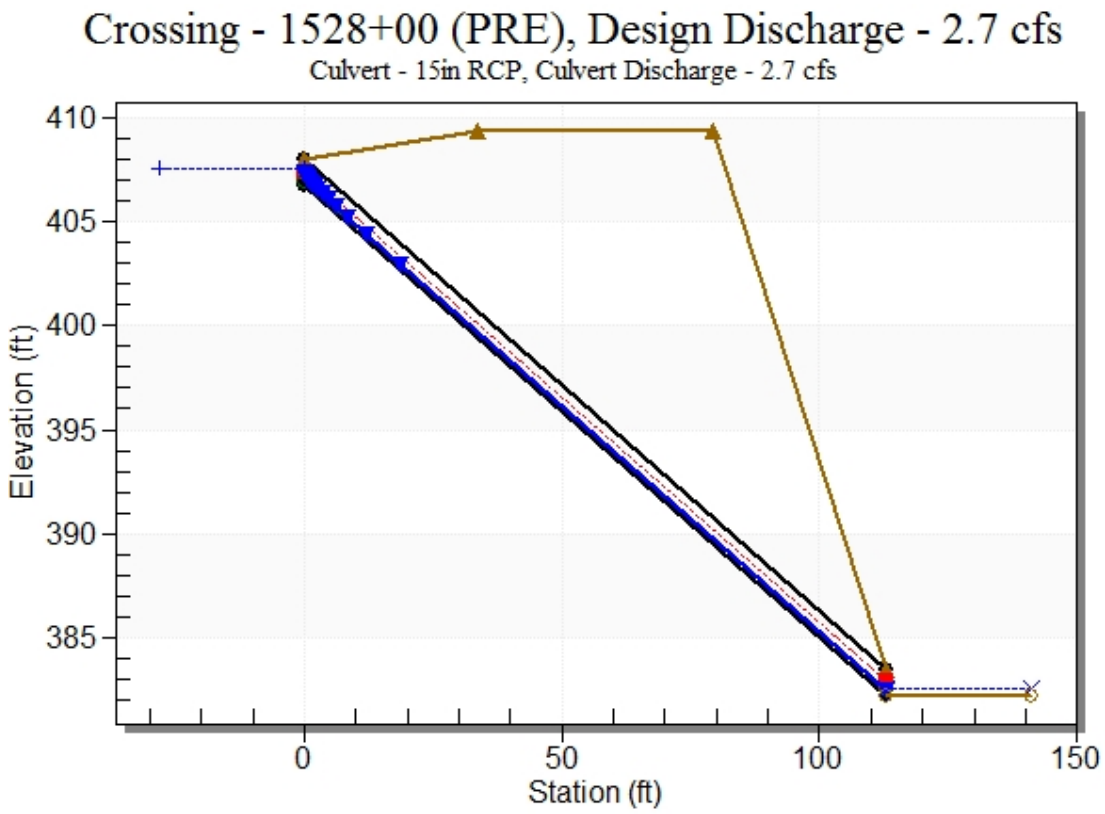
Straight Culvert

Inlet Elevation (invert): 406.70 ft, Outlet Elevation (invert): 382.25 ft

Culvert Length: 115.61 ft, Culvert Slope: 0.2164

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 406.70 ft

Outlet Station: 113.00 ft

Outlet Elevation: 382.25 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1528+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.27	382.55	0.30	2.95	1.85	1.06
2.36	382.55	0.30	2.99	1.89	1.06
2.44	382.56	0.31	3.02	1.93	1.06
2.53	382.57	0.32	3.05	1.97	1.07
2.61	382.57	0.32	3.08	2.00	1.07
2.70	382.58	0.33	3.11	2.04	1.07
2.74	382.58	0.33	3.13	2.06	1.07
2.87	382.59	0.34	3.17	2.11	1.08
2.96	382.59	0.34	3.20	2.15	1.08
3.04	382.60	0.35	3.23	2.18	1.08
3.13	382.60	0.35	3.26	2.21	1.08

Tailwater Channel Data - 1528+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 382.25 ft

Roadway Data for Crossing: 1528+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 409.38 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.9 cfs

Design Flow: 2.29 cfs

Maximum Flow: 2.62 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1528+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
407.36	1.90	1.90	0.00	1
407.37	1.97	1.97	0.00	1
407.39	2.04	2.04	0.00	1
407.41	2.12	2.12	0.00	1
407.43	2.19	2.19	0.00	1
407.45	2.26	2.26	0.00	1
407.45	2.29	2.29	0.00	1
407.48	2.40	2.40	0.00	1
407.50	2.48	2.48	0.00	1
407.51	2.55	2.55	0.00	1
407.53	2.62	2.62	0.00	1
409.38	8.68	8.68	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.90	1.90	407.36	0.656	0.0*	1-S2n	0.199	0.548	0.199	0.268	14.896	2.791
1.97	1.97	407.37	0.675	0.0*	1-S2n	0.203	0.559	0.203	0.274	15.115	2.824
2.04	2.04	407.39	0.693	0.0*	1-S2n	0.206	0.570	0.206	0.280	15.323	2.856
2.12	2.12	407.41	0.711	0.0*	1-S2n	0.210	0.580	0.210	0.285	15.523	2.887
2.19	2.19	407.43	0.728	0.0*	1-S2n	0.213	0.591	0.213	0.291	15.286	2.917
2.26	2.26	407.45	0.745	0.0*	1-S2n	0.217	0.601	0.217	0.296	15.445	2.946
2.29	2.29	407.45	0.752	0.0*	1-S2n	0.218	0.605	0.218	0.298	15.510	2.959
2.40	2.40	407.48	0.779	0.0*	1-S2n	0.224	0.620	0.224	0.306	15.745	3.004
2.48	2.48	407.50	0.796	0.0*	1-S2n	0.227	0.630	0.227	0.311	15.920	3.032
2.55	2.55	407.51	0.812	0.0*	1-S2n	0.230	0.639	0.230	0.316	16.096	3.058
2.62	2.62	407.53	0.828	0.0*	1-S2n	0.233	0.648	0.233	0.321	16.266	3.084

* Full Flow Headwater elevation is below inlet invert.

****

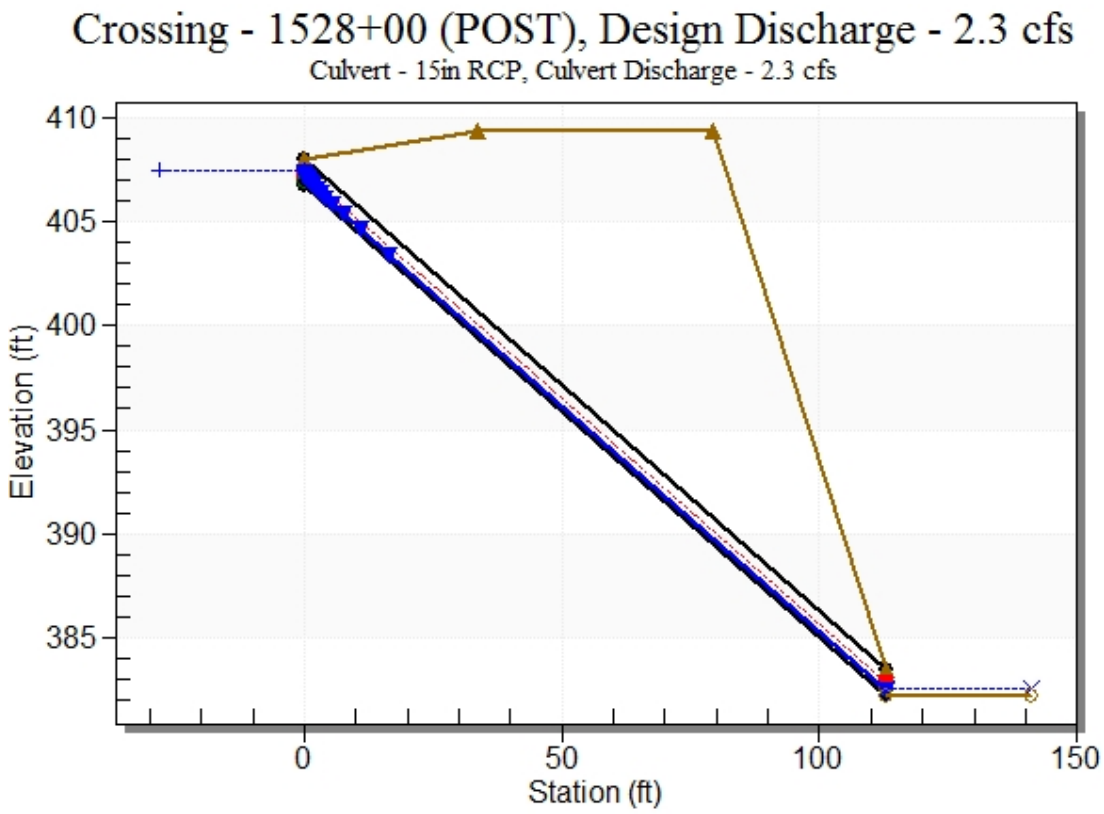
Straight Culvert

Inlet Elevation (invert): 406.70 ft, Outlet Elevation (invert): 382.25 ft

Culvert Length: 115.61 ft, Culvert Slope: 0.2164

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 406.70 ft

Outlet Station: 113.00 ft

Outlet Elevation: 382.25 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1528+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.90	382.52	0.27	2.79	1.67	1.05
1.97	382.52	0.27	2.82	1.71	1.05
2.04	382.53	0.28	2.86	1.75	1.05
2.12	382.54	0.29	2.89	1.78	1.05
2.19	382.54	0.29	2.92	1.81	1.06
2.26	382.55	0.30	2.95	1.85	1.06
2.29	382.55	0.30	2.96	1.86	1.06
2.40	382.56	0.31	3.00	1.91	1.06
2.48	382.56	0.31	3.03	1.94	1.07
2.55	382.57	0.32	3.06	1.97	1.07
2.62	382.57	0.32	3.08	2.01	1.07

Tailwater Channel Data - 1528+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 382.25 ft

Roadway Data for Crossing: 1528+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 409.38 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 182

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 182**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.26	0.2384
Grass	0.25	0.19	0.0480
Woods	0.15	0.00	0.0000
	Σ	**0.46**	0.2864

$C_{ave} = \frac{0.2864}{0.46} = 0.63$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.28	0.2520
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.28**	0.2520

$C_{ave} = \frac{0.2520}{0.28} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.63	**x**	6.23	**x**	0.46	**x**	1	=	**1.78**	cfs
Q_{10} =	0.63	**x**	6.98	**x**	0.46	**x**	1	=	**2.00**	cfs
Q_{25} =	0.63	**x**	8.08	**x**	0.46	**x**	1.1	=	**2.55**	cfs
Q_{50} =	0.63	**x**	8.93	**x**	0.46	**x**	1.2	=	**3.07**	cfs
Q_{100} =	0.63	**x**	9.81	**x**	0.46	**x**	1.25	=	**3.51**	cfs

Post Construction Runoff:

Q_{05} =	0.90	**x**	6.23	**x**	0.28	**x**	1	=	**1.57**	cfs
Q_{10} =	0.90	**x**	6.98	**x**	0.28	**x**	1	=	**1.76**	cfs
Q_{25} =	0.90	**x**	8.08	**x**	0.28	**x**	1.1	=	**2.24**	cfs
Q_{50} =	0.90	**x**	8.93	**x**	0.28	**x**	1.2	=	**2.70**	cfs
Q_{100} =	0.90	**x**	9.81	**x**	0.28	**x**	1.25	=	**3.09**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.55 cfs

Design Flow: 3.07 cfs

Maximum Flow: 3.51 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1530+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
420.42	2.55	2.55	0.00	1
420.44	2.65	2.65	0.00	1
420.46	2.74	2.74	0.00	1
420.49	2.84	2.84	0.00	1
420.51	2.93	2.93	0.00	1
420.53	3.03	3.03	0.00	1
420.54	3.07	3.07	0.00	1
420.57	3.22	3.22	0.00	1
420.59	3.32	3.32	0.00	1
420.61	3.41	3.41	0.00	1
420.63	3.51	3.51	0.00	1
422.86	9.83	9.83	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.55	2.55	420.42	0.891	0.0*	1-S2n	0.286	0.639	0.286	0.492	11.702	1.738
2.65	2.65	420.44	0.913	0.0*	1-S2n	0.291	0.652	0.291	0.502	11.845	1.756
2.74	2.74	420.46	0.934	0.0*	1-S2n	0.296	0.663	0.296	0.511	11.995	1.774
2.84	2.84	420.49	0.955	0.0*	1-S2n	0.301	0.675	0.301	0.521	12.139	1.792
2.93	2.93	420.51	0.976	0.0*	1-S2n	0.306	0.686	0.306	0.530	12.276	1.809
3.03	3.03	420.53	0.997	0.0*	1-S2n	0.311	0.697	0.311	0.539	12.274	1.825
3.07	3.07	420.54	1.006	0.0*	1-S2n	0.314	0.702	0.314	0.543	12.323	1.832
3.22	3.22	420.57	1.039	0.0*	1-S2n	0.322	0.719	0.322	0.557	12.505	1.858
3.32	3.32	420.59	1.059	0.0*	1-S2n	0.326	0.729	0.326	0.566	12.632	1.873
3.41	3.41	420.61	1.080	0.0*	1-S2n	0.331	0.743	0.331	0.574	12.754	1.888
3.51	3.51	420.63	1.101	0.0*	1-S2n	0.336	0.754	0.336	0.583	12.872	1.903

* Full Flow Headwater elevation is below inlet invert.

****

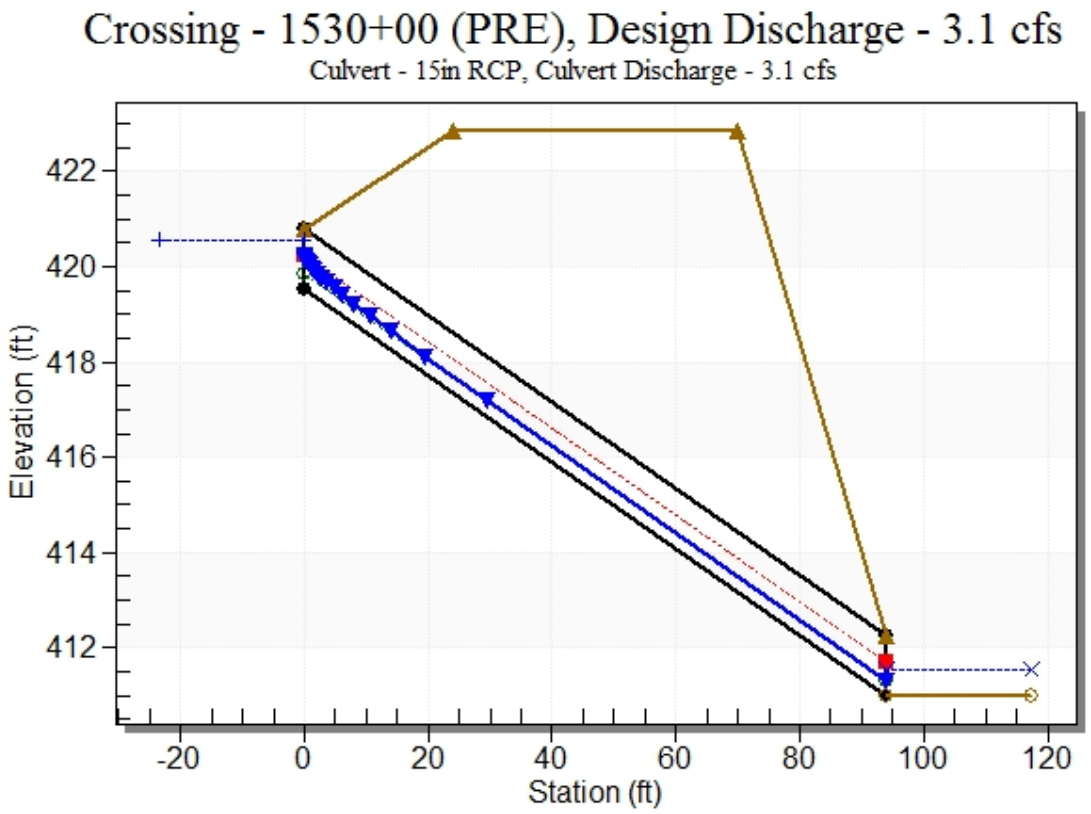
Straight Culvert

Inlet Elevation (invert): 419.53 ft, Outlet Elevation (invert): 411.01 ft

Culvert Length: 94.39 ft, Culvert Slope: 0.0906

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 419.53 ft

Outlet Station: 94.00 ft

Outlet Elevation: 411.01 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1530+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.55	411.50	0.49	1.74	0.61	0.50
2.65	411.51	0.50	1.76	0.63	0.50
2.74	411.52	0.51	1.77	0.64	0.51
2.84	411.53	0.52	1.79	0.65	0.51
2.93	411.54	0.53	1.81	0.66	0.51
3.03	411.55	0.54	1.83	0.67	0.51
3.07	411.55	0.54	1.83	0.68	0.51
3.22	411.57	0.56	1.86	0.70	0.51
3.32	411.58	0.57	1.87	0.71	0.51
3.41	411.58	0.57	1.89	0.72	0.51
3.51	411.59	0.58	1.90	0.73	0.51

Tailwater Channel Data - 1530+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 411.01 ft

Roadway Data for Crossing: 1530+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 422.86 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.24 cfs

Design Flow: 2.7 cfs

Maximum Flow: 3.09 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1530+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
420.35	2.24	2.24	0.00	1
420.37	2.33	2.33	0.00	1
420.39	2.41	2.41	0.00	1
420.41	2.50	2.50	0.00	1
420.43	2.58	2.58	0.00	1
420.45	2.67	2.67	0.00	1
420.45	2.70	2.70	0.00	1
420.48	2.84	2.84	0.00	1
420.50	2.92	2.92	0.00	1
420.52	3.00	3.00	0.00	1
420.54	3.09	3.09	0.00	1
422.86	9.83	9.83	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.24	2.24	420.35	0.819	0.0*	1-S2n	0.268	0.598	0.268	0.459	11.372	1.674
2.33	2.33	420.37	0.839	0.0*	1-S2n	0.273	0.610	0.273	0.468	11.522	1.692
2.41	2.41	420.39	0.859	0.0*	1-S2n	0.277	0.621	0.277	0.477	11.502	1.710
2.50	2.50	420.41	0.879	0.0*	1-S2n	0.282	0.632	0.282	0.486	11.625	1.727
2.58	2.58	420.43	0.898	0.0*	1-S2n	0.287	0.643	0.287	0.495	11.743	1.744
2.67	2.67	420.45	0.917	0.0*	1-S2n	0.292	0.654	0.292	0.504	11.875	1.760
2.70	2.70	420.45	0.925	0.0*	1-S2n	0.294	0.658	0.294	0.507	11.930	1.766
2.84	2.84	420.48	0.955	0.0*	1-S2n	0.301	0.675	0.301	0.520	12.134	1.791
2.92	2.92	420.50	0.973	0.0*	1-S2n	0.306	0.685	0.306	0.529	12.256	1.806
3.00	3.00	420.52	0.992	0.0*	1-S2n	0.310	0.694	0.310	0.537	12.244	1.821
3.09	3.09	420.54	1.010	0.0*	1-S2n	0.315	0.704	0.315	0.545	12.347	1.836

* Full Flow Headwater elevation is below inlet invert.

****

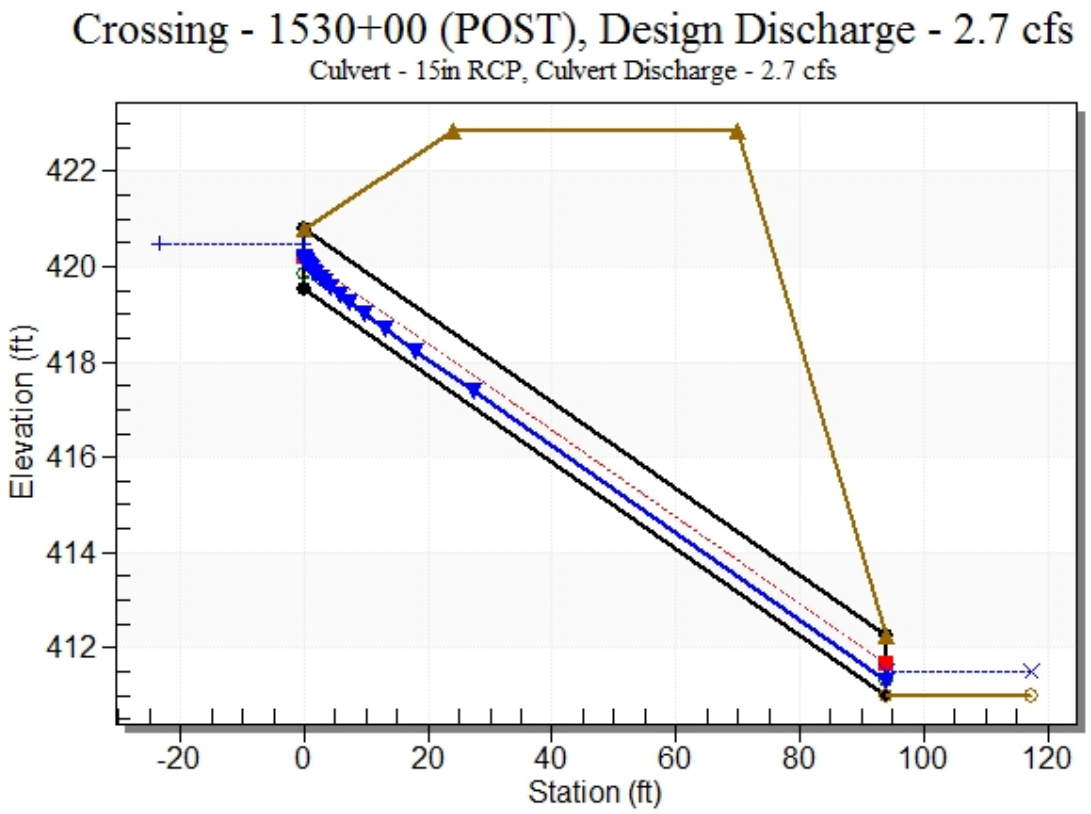
Straight Culvert

Inlet Elevation (invert): 419.53 ft, Outlet Elevation (invert): 411.01 ft

Culvert Length: 94.39 ft, Culvert Slope: 0.0906

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 419.53 ft

Outlet Station: 94.00 ft

Outlet Elevation: 411.01 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1530+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.24	411.47	0.46	1.67	0.57	0.50
2.33	411.48	0.47	1.69	0.58	0.50
2.41	411.49	0.48	1.71	0.60	0.50
2.50	411.50	0.49	1.73	0.61	0.50
2.58	411.50	0.49	1.74	0.62	0.50
2.67	411.51	0.50	1.76	0.63	0.51
2.70	411.52	0.51	1.77	0.63	0.51
2.84	411.53	0.52	1.79	0.65	0.51
2.92	411.54	0.53	1.81	0.66	0.51
3.00	411.55	0.54	1.82	0.67	0.51
3.09	411.55	0.54	1.84	0.68	0.51

Tailwater Channel Data - 1530+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0600

Channel Invert Elevation: 411.01 ft

Roadway Data for Crossing: 1530+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 422.86 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 183

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 183**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.51	1.3614
Grass	0.25	6.93	1.7313
Woods	0.15	29.17	4.3751
	Σ	**37.61**	7.4679

$C_{ave} = \frac{7.4679}{37.61} = 0.20$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.72	1.5485
Grass	0.25	6.72	1.6794
Woods	0.15	29.17	4.3751
	Σ	**37.61**	7.6029

$C_{ave} = \frac{7.6029}{37.61} = 0.20$

T_c =	47.74	min.
I_{05} =	2.89	in / hr
I_{10} =	3.20	in / hr
I_{25} =	3.63	in / hr
I_{50} =	3.95	in / hr
I_{100} =	4.28	in / hr

Pre Construction Runoff:

Q_{05} =	0.20	x	2.89	x	37.61	x	1	=	**21.61**	cfs
Q_{10} =	0.20	x	3.20	x	37.61	x	1	=	**23.86**	cfs
Q_{25} =	0.20	x	3.63	x	37.61	x	1.1	=	**29.81**	cfs
Q_{50} =	0.20	x	3.95	x	37.61	x	1.2	=	**35.39**	cfs
Q_{100} =	0.20	x	4.28	x	37.61	x	1.25	=	**39.92**	cfs

Post Construction Runoff:

Q_{05} =	0.20	x	2.89	x	37.61	x	1	=	**22.01**	cfs
Q_{10} =	0.20	x	3.20	x	37.61	x	1	=	**24.29**	cfs
Q_{25} =	0.20	x	3.63	x	37.61	x	1.1	=	**30.34**	cfs
Q_{50} =	0.20	x	3.95	x	37.61	x	1.2	=	**36.03**	cfs
Q_{100} =	0.20	x	4.28	x	37.61	x	1.25	=	**40.64**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 183	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**100**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0300**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.501**	+		=	**0.501**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)			unpaved				
8	Flow length, L		ft	**2600**				
9	Watercourse slope, s		ft/ft	**0.0231**				
10	Average velocity, V (figure 3-1)		ft/s	**2.45**				
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**0.295**	+		=	**0.295**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.796**
							min	**47.74**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 29.81 cfs

Design Flow: 35.39 cfs

Maximum Flow: 39.92 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1541+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
415.24	29.81	29.81	0.00	1
415.29	30.82	30.82	0.00	1
415.34	31.83	31.83	0.00	1
415.39	32.84	32.84	0.00	1
415.44	33.85	33.85	0.00	1
415.49	34.87	34.87	0.00	1
415.52	35.39	35.39	0.00	1
415.59	36.89	36.89	0.00	1
415.64	37.90	37.90	0.00	1
415.70	38.91	38.91	0.00	1
415.75	39.92	39.92	0.00	1
436.00	178.15	178.15	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
29.81	29.81	415.24	2.526	0.0*	1-S2n	0.981	1.764	1.024	1.191	13.509	4.652
30.82	30.82	415.29	2.577	0.0*	1-S2n	0.999	1.794	0.999	1.211	14.444	4.693
31.83	31.83	415.34	2.628	0.0*	1-S2n	1.016	1.827	1.072	1.231	13.546	4.735
32.84	32.84	415.39	2.678	0.0*	1-S2n	1.033	1.857	1.088	1.250	13.698	4.775
33.85	33.85	415.44	2.729	0.0*	1-S2n	1.049	1.886	1.101	1.270	13.910	4.814
34.87	34.87	415.49	2.780	0.0*	1-S2n	1.066	1.915	1.066	1.289	14.947	4.852
35.39	35.39	415.52	2.807	0.0*	1-S2n	1.075	1.930	1.075	1.298	15.007	4.872
36.89	36.89	415.59	2.883	0.0*	1-S2n	1.099	1.971	1.161	1.325	14.101	4.926
37.90	37.90	415.64	2.935	0.0*	1-S2n	1.115	1.998	1.177	1.343	14.225	4.962
38.91	38.91	415.70	2.987	0.0*	1-S2n	1.131	2.025	1.191	1.361	14.383	4.997
39.92	39.92	415.75	3.040	0.0*	5-S2n	1.147	2.055	1.147	1.378	15.509	5.031

* Full Flow Headwater elevation is below inlet invert.

****

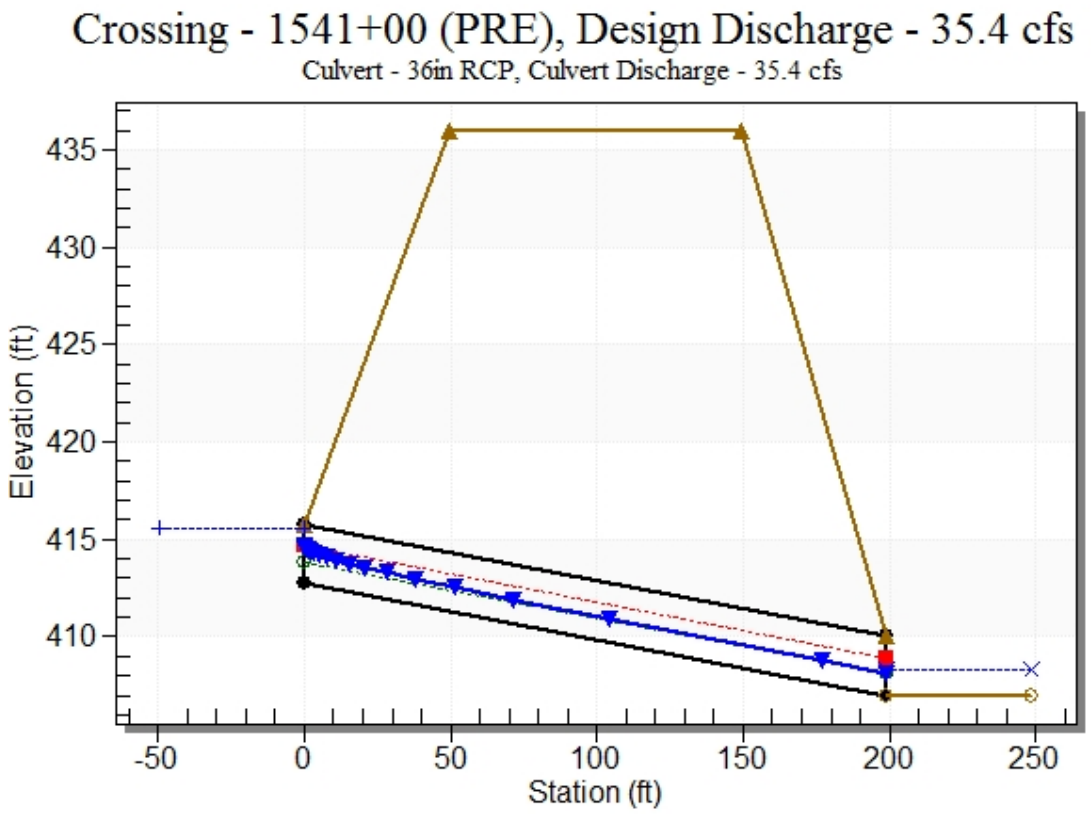
Straight Culvert

Inlet Elevation (invert): 412.71 ft, Outlet Elevation (invert): 407.00 ft

Culvert Length: 199.08 ft, Culvert Slope: 0.0287

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 412.71 ft

Outlet Station: 199.00 ft

Outlet Elevation: 407.00 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1541+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
29.81	408.19	1.19	4.65	3.72	0.90
30.82	408.21	1.21	4.69	3.78	0.90
31.83	408.23	1.23	4.73	3.84	0.91
32.84	408.25	1.25	4.77	3.90	0.91
33.85	408.27	1.27	4.81	3.96	0.91
34.87	408.29	1.29	4.85	4.02	0.91
35.39	408.30	1.30	4.87	4.05	0.91
36.89	408.33	1.33	4.93	4.13	0.91
37.90	408.34	1.34	4.96	4.19	0.92
38.91	408.36	1.36	5.00	4.25	0.92
39.92	408.38	1.38	5.03	4.30	0.92

Tailwater Channel Data - 1541+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 407.00 ft

Roadway Data for Crossing: 1541+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 30.34 cfs

Design Flow: 36.03 cfs

Maximum Flow: 40.64 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1541+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	36in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
415.26	30.34	30.34	0.00	1
415.31	31.37	31.37	0.00	1
415.37	32.40	32.40	0.00	1
415.42	33.43	33.43	0.00	1
415.47	34.46	34.46	0.00	1
415.52	35.49	35.49	0.00	1
415.55	36.03	36.03	0.00	1
415.63	37.55	37.55	0.00	1
415.68	38.58	38.58	0.00	1
415.73	39.61	39.61	0.00	1
415.79	40.64	40.64	0.00	1
436.00	178.15	178.15	0.00	Overtopping

Table 2 - Culvert Summary Table: 36in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.34	30.34	415.26	2.553	0.0*	1-S2n	0.990	1.779	0.990	1.202	14.383	4.673
31.37	31.37	415.31	2.605	0.0*	1-S2n	1.008	1.814	1.063	1.222	13.507	4.716
32.40	32.40	415.37	2.656	0.0*	1-S2n	1.025	1.844	1.082	1.242	13.622	4.757
33.43	33.43	415.42	2.708	0.0*	1-S2n	1.042	1.874	1.096	1.262	13.816	4.797
34.46	34.46	415.47	2.760	0.0*	1-S2n	1.060	1.904	1.107	1.281	14.055	4.836
35.49	35.49	415.52	2.812	0.0*	1-S2n	1.077	1.932	1.077	1.300	15.018	4.876
36.03	36.03	415.55	2.839	0.0*	1-S2n	1.085	1.947	1.145	1.310	14.037	4.895
37.55	37.55	415.63	2.917	0.0*	1-S2n	1.109	1.989	1.172	1.337	14.178	4.949
38.58	38.58	415.68	2.970	0.0*	1-S2n	1.126	2.016	1.187	1.355	14.329	4.985
39.61	39.61	415.73	3.024	0.0*	5-S2n	1.142	2.047	1.197	1.373	14.546	5.020
40.64	40.64	415.79	3.079	0.0*	5-S2n	1.158	2.074	1.222	1.391	14.515	5.055

* Full Flow Headwater elevation is below inlet invert.

****

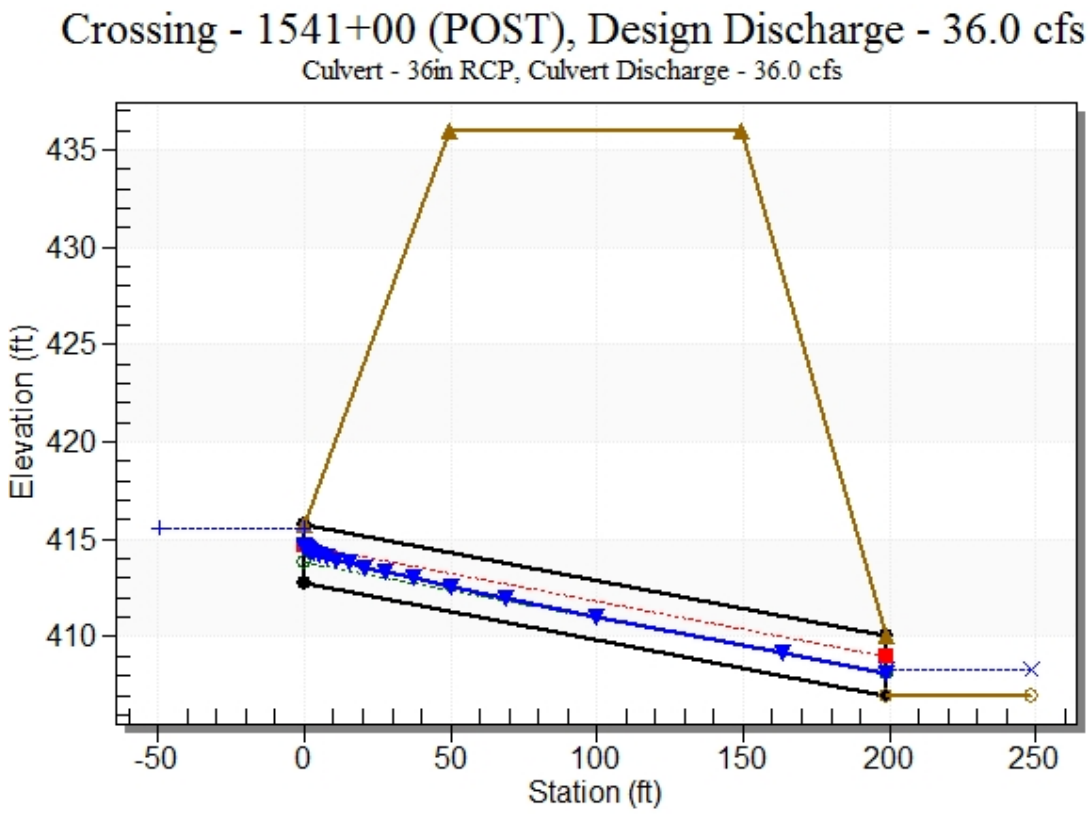
Straight Culvert

Inlet Elevation (invert): 412.71 ft, Outlet Elevation (invert): 407.00 ft

Culvert Length: 199.08 ft, Culvert Slope: 0.0287

****

Water Surface Profile Plot for Culvert: 36in RCP



Site Data - 36in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 412.71 ft

Outlet Station: 199.00 ft

Outlet Elevation: 407.00 ft

Number of Barrels: 1

Culvert Data Summary - 36in RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1541+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.34	408.20	1.20	4.67	3.75	0.90
31.37	408.22	1.22	4.72	3.81	0.91
32.40	408.24	1.24	4.76	3.88	0.91
33.43	408.26	1.26	4.80	3.94	0.91
34.46	408.28	1.28	4.84	4.00	0.91
35.49	408.30	1.30	4.88	4.06	0.91
36.03	408.31	1.31	4.90	4.09	0.91
37.55	408.34	1.34	4.95	4.17	0.91
38.58	408.36	1.36	4.99	4.23	0.92
39.61	408.37	1.37	5.02	4.28	0.92
40.64	408.39	1.39	5.05	4.34	0.92

Tailwater Channel Data - 1541+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0600

Channel Invert Elevation: 407.00 ft

Roadway Data for Crossing: 1541+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 436.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 184

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 184**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.06	0.0140
Woods	0.15	2.05	0.3076
	Σ	**2.11**	0.3216

$C_{ave} = \frac{0.3216}{2.11} = 0.15$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.00	0.0000
Grass	0.25	0.06	0.0140
Woods	0.15	2.05	0.3076
	Σ	**2.11**	0.3216

$C_{ave} = \frac{0.3216}{2.11} = 0.15$

T_c =	36.79	min.
I_{05} =	3.36	in / hr
I_{10} =	3.71	in / hr
I_{25} =	4.22	in / hr
I_{50} =	4.61	in / hr
I_{100} =	4.99	in / hr

Pre Construction Runoff:

Q_{05} =	0.15	x	3.36	x	2.11	x	1	=	**1.08**	cfs
Q_{10} =	0.15	x	3.71	x	2.11	x	1	=	**1.19**	cfs
Q_{25} =	0.15	x	4.22	x	2.11	x	1.1	=	**1.49**	cfs
Q_{50} =	0.15	x	4.61	x	2.11	x	1.2	=	**1.78**	cfs
Q_{100} =	0.15	x	4.99	x	2.11	x	1.25	=	**2.01**	cfs

Post Construction Runoff:

Q_{05} =	0.15	x	3.36	x	2.11	x	1	=	**1.08**	cfs
Q_{10} =	0.15	x	3.71	x	2.11	x	1	=	**1.19**	cfs
Q_{25} =	0.15	x	4.22	x	2.11	x	1.1	=	**1.49**	cfs
Q_{50} =	0.15	x	4.61	x	2.11	x	1.2	=	**1.78**	cfs
Q_{100} =	0.15	x	4.99	x	2.11	x	1.25	=	**2.01**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 184	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0200**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.589**	+		=	**0.589**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**380**				
9	Watercourse slope, s	----------	ft/ft	**0.0737**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**4.38**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.024**	+		=	**0.024**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------			hr		**0.613**
						min		**36.79**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.49 cfs

Design Flow: 1.78 cfs

Maximum Flow: 2.01 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1543+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
419.20	1.49	1.49	0.00	1
419.21	1.54	1.54	0.00	1
419.23	1.59	1.59	0.00	1
419.24	1.65	1.65	0.00	1
419.25	1.70	1.70	0.00	1
419.26	1.75	1.75	0.00	1
419.26	1.78	1.78	0.00	1
419.28	1.85	1.85	0.00	1
419.29	1.91	1.91	0.00	1
419.30	1.96	1.96	0.00	1
419.31	2.01	2.01	0.00	1
432.00	26.48	26.48	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.49	1.49	419.20	0.623	0.0*	1-S2n	0.320	0.452	0.320	0.303	5.217	1.888
1.54	1.54	419.21	0.634	0.0*	1-S2n	0.325	0.461	0.325	0.309	5.276	1.908
1.59	1.59	419.23	0.646	0.0*	1-S2n	0.331	0.469	0.331	0.315	5.332	1.928
1.65	1.65	419.24	0.656	0.0*	1-S2n	0.336	0.477	0.336	0.320	5.385	1.947
1.70	1.70	419.25	0.667	0.0*	1-S2n	0.342	0.485	0.342	0.326	5.436	1.965
1.75	1.75	419.26	0.678	0.0*	1-S2n	0.347	0.493	0.347	0.331	5.487	1.983
1.78	1.78	419.26	0.684	0.0*	1-S2n	0.350	0.498	0.350	0.334	5.521	1.994
1.85	1.85	419.28	0.700	0.0*	1-S2n	0.357	0.509	0.357	0.342	5.601	2.019
1.91	1.91	419.29	0.709	0.0*	1-S2n	0.362	0.517	0.362	0.347	5.602	2.036
1.96	1.96	419.30	0.720	0.0*	1-S2n	0.367	0.524	0.367	0.353	5.650	2.053
2.01	2.01	419.31	0.730	0.0*	1-S2n	0.372	0.532	0.372	0.358	5.696	2.069

* Full Flow Headwater elevation is below inlet invert.

****

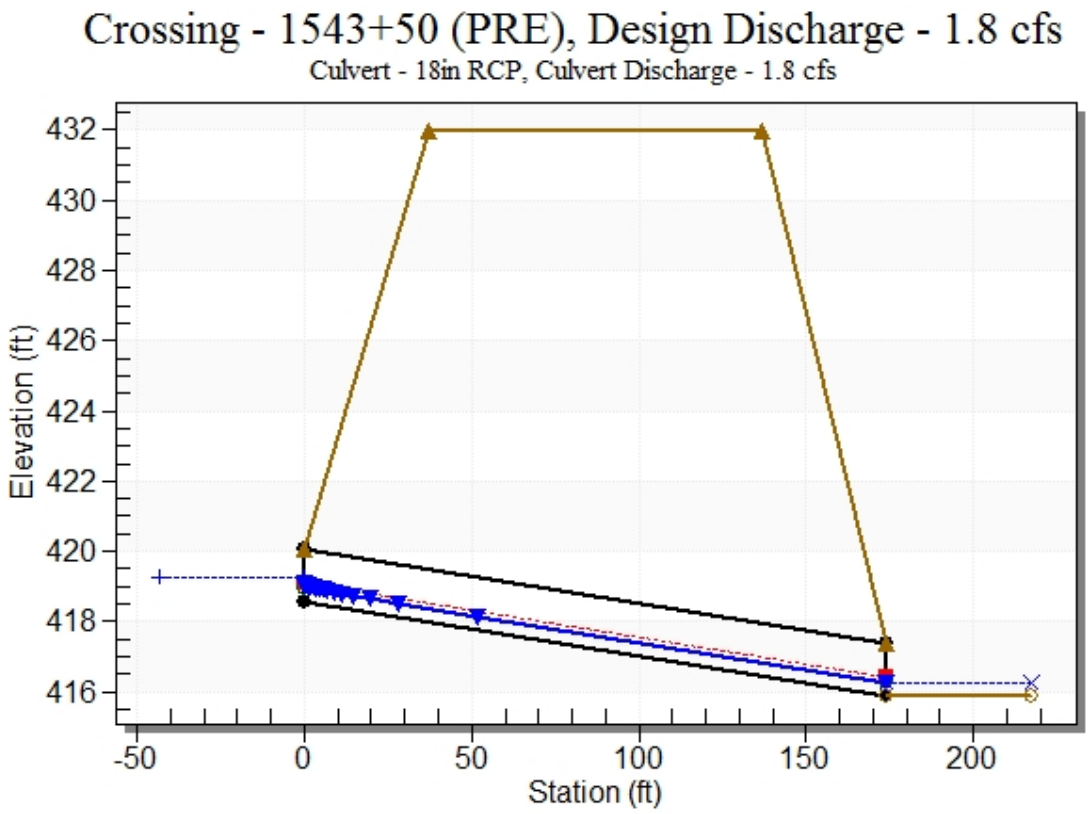
Straight Culvert

Inlet Elevation (invert): 418.58 ft, Outlet Elevation (invert): 415.90 ft

Culvert Length: 174.02 ft, Culvert Slope: 0.0154

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 418.58 ft

Outlet Station: 174.00 ft

Outlet Elevation: 415.90 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1543+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.49	416.20	0.30	1.89	0.76	0.67
1.54	416.21	0.31	1.91	0.77	0.67
1.59	416.21	0.31	1.93	0.79	0.67
1.65	416.22	0.32	1.95	0.80	0.68
1.70	416.23	0.33	1.97	0.81	0.68
1.75	416.23	0.33	1.98	0.83	0.68
1.78	416.23	0.33	1.99	0.83	0.68
1.85	416.24	0.34	2.02	0.85	0.68
1.91	416.25	0.35	2.04	0.87	0.68
1.96	416.25	0.35	2.05	0.88	0.68
2.01	416.26	0.36	2.07	0.89	0.69

Tailwater Channel Data - 1543+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.90 ft

Roadway Data for Crossing: 1543+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.49 cfs

Design Flow: 1.78 cfs

Maximum Flow: 2.01 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1543+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
419.20	1.49	1.49	0.00	1
419.21	1.54	1.54	0.00	1
419.23	1.59	1.59	0.00	1
419.24	1.65	1.65	0.00	1
419.25	1.70	1.70	0.00	1
419.26	1.75	1.75	0.00	1
419.26	1.78	1.78	0.00	1
419.28	1.85	1.85	0.00	1
419.29	1.91	1.91	0.00	1
419.30	1.96	1.96	0.00	1
419.31	2.01	2.01	0.00	1
432.00	26.48	26.48	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.49	1.49	419.20	0.623	0.0*	1-S2n	0.320	0.452	0.320	0.303	5.217	1.888
1.54	1.54	419.21	0.634	0.0*	1-S2n	0.325	0.461	0.325	0.309	5.276	1.908
1.59	1.59	419.23	0.646	0.0*	1-S2n	0.331	0.469	0.331	0.315	5.332	1.928
1.65	1.65	419.24	0.656	0.0*	1-S2n	0.336	0.477	0.336	0.320	5.385	1.947
1.70	1.70	419.25	0.667	0.0*	1-S2n	0.342	0.485	0.342	0.326	5.436	1.965
1.75	1.75	419.26	0.678	0.0*	1-S2n	0.347	0.493	0.347	0.331	5.487	1.983
1.78	1.78	419.26	0.684	0.0*	1-S2n	0.350	0.498	0.350	0.334	5.521	1.994
1.85	1.85	419.28	0.700	0.0*	1-S2n	0.357	0.509	0.357	0.342	5.601	2.019
1.91	1.91	419.29	0.709	0.0*	1-S2n	0.362	0.517	0.362	0.347	5.602	2.036
1.96	1.96	419.30	0.720	0.0*	1-S2n	0.367	0.524	0.367	0.353	5.650	2.053
2.01	2.01	419.31	0.730	0.0*	1-S2n	0.372	0.532	0.372	0.358	5.696	2.069

* Full Flow Headwater elevation is below inlet invert.

****

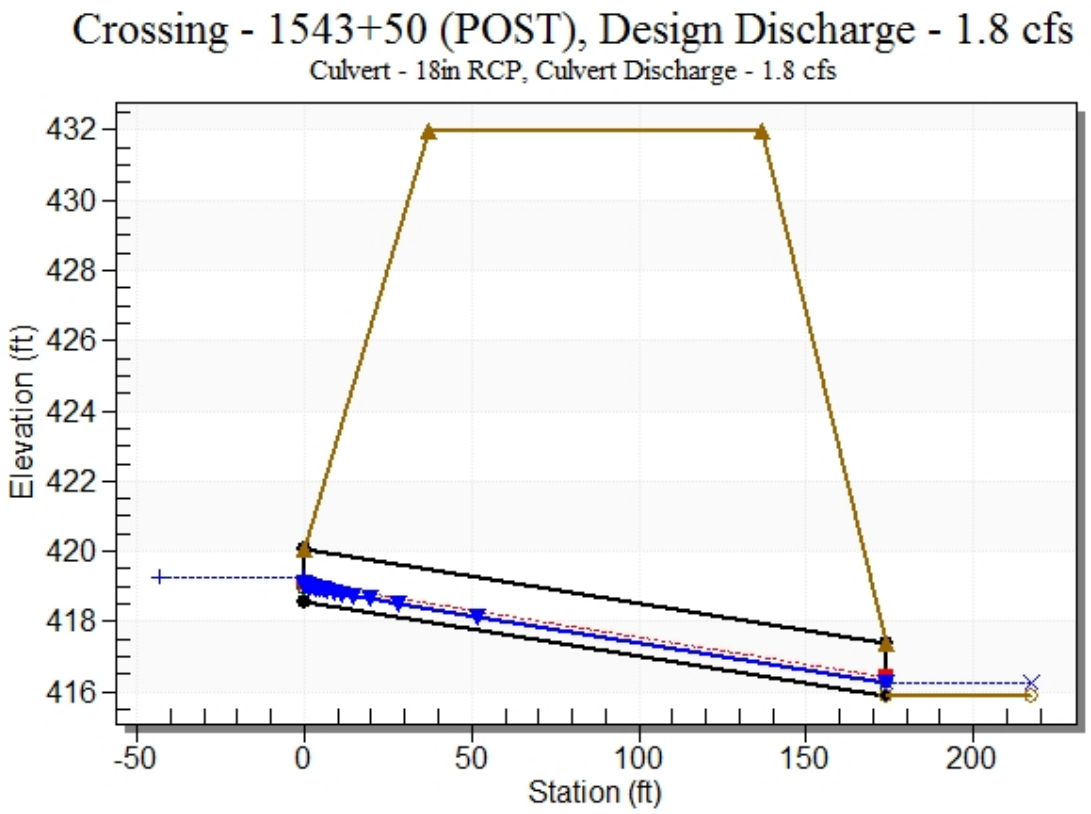
Straight Culvert

Inlet Elevation (invert): 418.58 ft, Outlet Elevation (invert): 415.90 ft

Culvert Length: 174.02 ft, Culvert Slope: 0.0154

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 418.58 ft

Outlet Station: 174.00 ft

Outlet Elevation: 415.90 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1543+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.49	416.20	0.30	1.89	0.76	0.67
1.54	416.21	0.31	1.91	0.77	0.67
1.59	416.21	0.31	1.93	0.79	0.67
1.65	416.22	0.32	1.95	0.80	0.68
1.70	416.23	0.33	1.97	0.81	0.68
1.75	416.23	0.33	1.98	0.83	0.68
1.78	416.23	0.33	1.99	0.83	0.68
1.85	416.24	0.34	2.02	0.85	0.68
1.91	416.25	0.35	2.04	0.87	0.68
1.96	416.25	0.35	2.05	0.88	0.68
2.01	416.26	0.36	2.07	0.89	0.69

Tailwater Channel Data - 1543+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.90 ft

Roadway Data for Crossing: 1543+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 432.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 185

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 185**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.57	0.5129
Grass	0.25	0.55	0.1387
Woods	0.15	0.00	0.0000
	Σ	**1.12**	0.6516

$C_{ave} = \frac{0.6516}{1.12} = 0.58$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.85	0.7650
Grass	0.25	0.00	0.0000
Woods	0.15	0.00	0.0000
	Σ	**0.85**	0.7650

$C_{ave} = \frac{0.7650}{0.85} = 0.90$

T_c =	5.00	min.								
I_{05} =	6.23	in / hr								
I_{10} =	6.98	in / hr								
I_{25} =	8.08	in / hr								
I_{50} =	8.93	in / hr								
I_{100} =	9.81	in / hr								

Pre Construction Runoff:

Q_{05} =	0.58	x	6.23	x	1.12	x	1	=	**4.06**	cfs
Q_{10} =	0.58	x	6.98	x	1.12	x	1	=	**4.55**	cfs
Q_{25} =	0.58	x	8.08	x	1.12	x	1.1	=	**5.79**	cfs
Q_{50} =	0.58	x	8.93	x	1.12	x	1.2	=	**6.98**	cfs
Q_{100} =	0.58	x	9.81	x	1.12	x	1.25	=	**7.99**	cfs

Post Construction Runoff:

Q_{05} =	0.90	x	6.23	x	0.85	x	1	=	**4.77**	cfs
Q_{10} =	0.90	x	6.98	x	0.85	x	1	=	**5.34**	cfs
Q_{25} =	0.90	x	8.08	x	0.85	x	1.1	=	**6.80**	cfs
Q_{50} =	0.90	x	8.93	x	0.85	x	1.2	=	**8.19**	cfs
Q_{100} =	0.90	x	9.81	x	0.85	x	1.25	=	**9.38**	cfs

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.79 cfs

Design Flow: 6.98 cfs

Maximum Flow: 7.99 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1546+50 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
421.24	5.79	5.79	0.00	1
421.30	6.01	6.01	0.00	1
421.37	6.23	6.23	0.00	1
421.44	6.45	6.45	0.00	1
421.52	6.67	6.67	0.00	1
421.59	6.89	6.89	0.00	1
421.63	6.98	6.98	0.00	1
421.76	7.33	7.33	0.00	1
421.84	7.55	7.55	0.00	1
421.93	7.77	7.77	0.00	1
422.02	7.99	7.99	0.00	1
422.55	9.14	9.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.79	5.79	421.24	1.695	0.0*	5-S2n	0.538	0.970	0.538	0.496	11.082	3.902
6.01	6.01	421.30	1.762	0.0*	5-S2n	0.549	0.987	0.549	0.506	11.193	3.945
6.23	6.23	421.37	1.831	0.0*	5-S2n	0.561	1.004	0.604	0.516	10.265	3.985
6.45	6.45	421.44	1.902	0.0*	5-S2n	0.572	1.020	0.614	0.525	10.405	4.025
6.67	6.67	421.52	1.977	0.0*	5-S2n	0.583	1.035	0.624	0.535	10.545	4.064
6.89	6.89	421.59	2.054	0.0*	5-S2n	0.594	1.050	0.634	0.544	10.676	4.101
6.98	6.98	421.63	2.087	0.0*	5-S2n	0.599	1.056	0.638	0.548	10.729	4.117
7.33	7.33	421.76	2.218	0.0*	5-S2n	0.616	1.078	0.654	0.562	10.912	4.174
7.55	7.55	421.84	2.304	0.0*	5-S2n	0.627	1.091	0.665	0.571	11.009	4.209
7.77	7.77	421.93	2.393	0.0*	5-S2n	0.638	1.103	0.677	0.580	11.091	4.243
7.99	7.99	422.02	2.484	0.0*	5-S2n	0.649	1.114	0.689	0.588	11.160	4.277

* Full Flow Headwater elevation is below inlet invert.

****

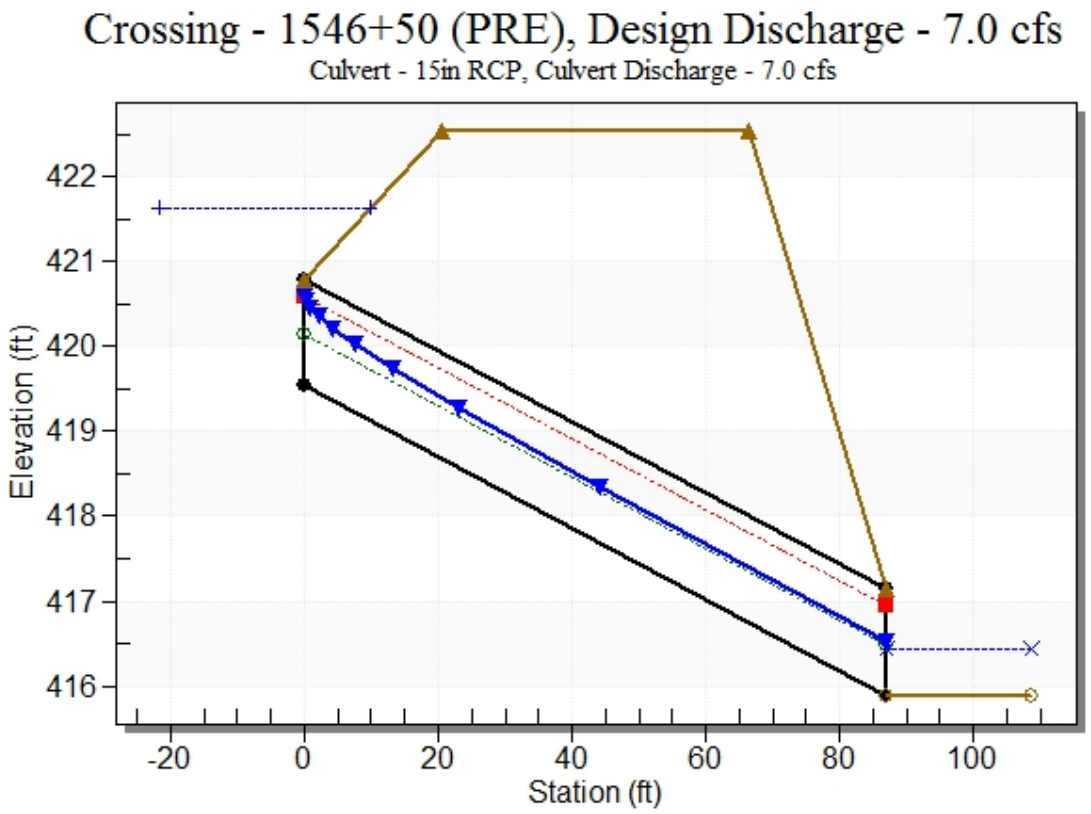
Straight Culvert

Inlet Elevation (invert): 419.54 ft, Outlet Elevation (invert): 415.89 ft

Culvert Length: 87.08 ft, Culvert Slope: 0.0420

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 419.54 ft

Outlet Station: 87.00 ft

Outlet Elevation: 415.89 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1546+50 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.79	416.39	0.50	3.90	3.09	1.13
6.01	416.40	0.51	3.94	3.16	1.13
6.23	416.41	0.52	3.99	3.22	1.13
6.45	416.42	0.53	4.03	3.28	1.13
6.67	416.42	0.53	4.06	3.34	1.14
6.89	416.43	0.54	4.10	3.39	1.14
6.98	416.44	0.55	4.12	3.42	1.14
7.33	416.45	0.56	4.17	3.51	1.14
7.55	416.46	0.57	4.21	3.56	1.15
7.77	416.47	0.58	4.24	3.62	1.15
7.99	416.48	0.59	4.28	3.67	1.15

Tailwater Channel Data - 1546+50 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.89 ft

Roadway Data for Crossing: 1546+50 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 422.55 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.8 cfs

Design Flow: 8.19 cfs

Maximum Flow: 9.38 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1546+50 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	15in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
421.56	6.80	6.80	0.00	1
421.66	7.06	7.06	0.00	1
421.75	7.32	7.32	0.00	1
421.85	7.57	7.57	0.00	1
421.96	7.83	7.83	0.00	1
422.07	8.09	8.09	0.00	1
422.11	8.19	8.19	0.00	1
422.30	8.61	8.61	0.00	1
422.42	8.86	8.86	0.00	1
422.54	9.12	9.12	0.00	1
422.56	9.38	9.17	0.17	8
422.55	9.14	9.14	0.00	Overtopping

Table 2 - Culvert Summary Table: 15in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.80	6.80	421.56	2.022	0.0*	5-S2n	0.590	1.044	0.630	0.540	10.623	4.086
7.06	7.06	421.66	2.115	0.0*	5-S2n	0.603	1.061	0.641	0.551	10.772	4.130
7.32	7.32	421.75	2.212	0.0*	5-S2n	0.616	1.077	0.654	0.561	10.905	4.172
7.57	7.57	421.85	2.313	0.0*	5-S2n	0.628	1.092	0.667	0.572	11.018	4.212
7.83	7.83	421.96	2.418	0.0*	5-S2n	0.641	1.106	0.680	0.582	11.112	4.253
8.09	8.09	422.07	2.527	0.0*	5-S2n	0.654	1.119	0.694	0.592	11.190	4.291
8.19	8.19	422.11	2.570	0.0*	5-S2n	0.659	1.124	0.700	0.596	11.216	4.306
8.61	8.61	422.30	2.756	0.001	5-S2n	0.679	1.141	0.724	0.612	11.311	4.366
8.86	8.86	422.42	2.876	0.155	5-S2n	0.692	1.151	0.739	0.621	11.367	4.402
9.12	9.12	422.54	3.000	0.312	5-S2n	0.705	1.158	0.753	0.630	11.439	4.438
9.38	9.17	422.56	3.021	0.339	5-S2n	0.707	1.160	0.755	0.640	11.462	4.472

* Full Flow Headwater elevation is below inlet invert.

****

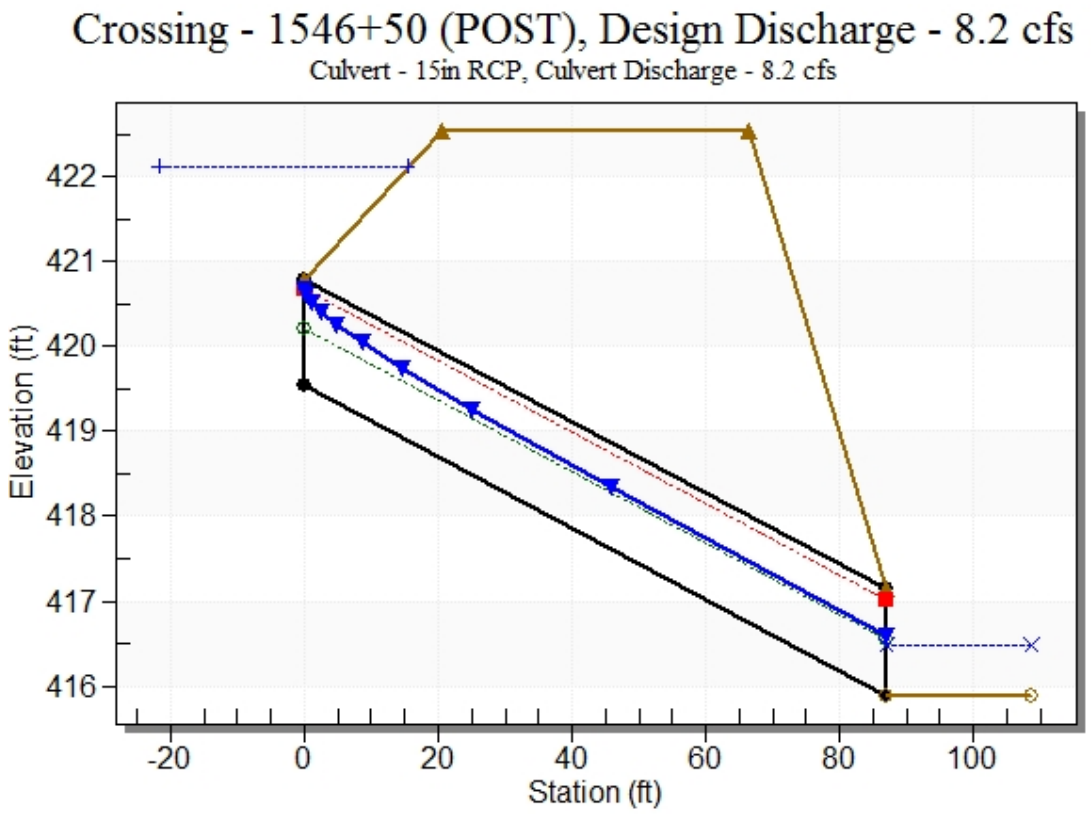
Straight Culvert

Inlet Elevation (invert): 419.54 ft, Outlet Elevation (invert): 415.89 ft

Culvert Length: 87.08 ft, Culvert Slope: 0.0420

****

Water Surface Profile Plot for Culvert: 15in RCP



Site Data - 15in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 419.54 ft

Outlet Station: 87.00 ft

Outlet Elevation: 415.89 ft

Number of Barrels: 1

Culvert Data Summary - 15in RCP

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1546+50 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.80	416.43	0.54	4.09	3.37	1.14
7.06	416.44	0.55	4.13	3.44	1.14
7.32	416.45	0.56	4.17	3.50	1.14
7.57	416.46	0.57	4.21	3.57	1.15
7.83	416.47	0.58	4.25	3.63	1.15
8.09	416.48	0.59	4.29	3.69	1.15
8.19	416.49	0.60	4.31	3.72	1.15
8.61	416.50	0.61	4.37	3.82	1.16
8.86	416.51	0.62	4.40	3.88	1.16
9.12	416.52	0.63	4.44	3.93	1.16
9.38	416.53	0.64	4.47	3.99	1.16

Tailwater Channel Data - 1546+50 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.1000

Channel Manning's n: 0.0600

Channel Invert Elevation: 415.89 ft

Roadway Data for Crossing: 1546+50 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 422.55 ft

Roadway Surface: Paved

Roadway Top Width: 46.00 ft

CULVERT 186

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 186**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	2.36	2.1204
Grass	0.25	5.51	1.3768
Woods	0.15	55.26	8.2891
	Σ	**63.12**	11.7863

$C_{ave} = \frac{11.7863}{63.12} = 0.19$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	3.10	2.7932
Grass	0.25	4.76	1.1900
Woods	0.15	55.26	8.2891
	Σ	**63.12**	12.2722

$C_{ave} = \frac{12.2722}{63.12} = 0.19$

T_c =	37.01	min.
I_{05} =	3.35	in / hr
I_{10} =	3.70	in / hr
I_{25} =	4.21	in / hr
I_{50} =	4.59	in / hr
I_{100} =	4.98	in / hr

Pre Construction Runoff:

Q_{05} =	0.19	x	3.35	x	63.12	x	1	=	**39.44**	cfs
Q_{10} =	0.19	x	3.70	x	63.12	x	1	=	**43.61**	cfs
Q_{25} =	0.19	x	4.21	x	63.12	x	1.1	=	**54.59**	cfs
Q_{50} =	0.19	x	4.59	x	63.12	x	1.2	=	**64.92**	cfs
Q_{100} =	0.19	x	4.98	x	63.12	x	1.25	=	**73.33**	cfs

Post Construction Runoff:

Q_{05} =	0.19	x	3.35	x	63.12	x	1	=	**41.07**	cfs
Q_{10} =	0.19	x	3.70	x	63.12	x	1	=	**45.41**	cfs
Q_{25} =	0.19	x	4.21	x	63.12	x	1.1	=	**56.84**	cfs
Q_{50} =	0.19	x	4.59	x	63.12	x	1.2	=	**67.59**	cfs
Q_{100} =	0.19	x	4.98	x	63.12	x	1.25	=	**76.35**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 186	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)	----------		Woods				
2	Manning's roughness coeff., n (table 3-1)	----------		**0.800**				
3	Flow length, L (total L < or = 100)	----------	ft	**100**				
4	Two-yr 24-hr rainfall, P_2	----------	in	**3.58**				
5	Land slope, s	----------	ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t ----------	hr	**0.446**	+		=	**0.446**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)	----------		unpaved				
8	Flow length, L	----------	ft	**1900**				
9	Watercourse slope, s	----------	ft/ft	**0.0368**				
10	Average velocity, V (figure 3-1)	----------	ft/s	**3.10**				
11	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**0.170**	+		=	**0.170**
Channel Flow			Segment ID					
	Front Slope, (_ : 1)	----------						
	Back Slope, (_ : 1)	----------						
	Bottom Width	----------	ft					
	Flow Depth	----------	ft					
12	Cross sectional flow area, a	----------	ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w	----------	ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r ----------	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s	----------	ft/ft					
16	Manning's roughness coeff., n	----------						
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V ----------	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L	----------	ft					
19	$T_t = L / (3600\ V)$	Compute T_t ----------	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)		----------				hr	**0.617**
							min	**37.01**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 54.24 cfs

Design Flow: 64.51 cfs

Maximum Flow: 72.86 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1548+10 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	60in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
409.12	54.24	54.24	0.00	1
409.18	56.10	56.10	0.00	1
409.24	57.96	57.96	0.00	1
409.30	59.83	59.83	0.00	1
409.35	61.69	61.69	0.00	1
409.41	63.55	63.55	0.00	1
409.43	64.51	64.51	0.00	1
409.51	67.27	67.27	0.00	1
409.56	69.14	69.14	0.00	1
409.62	71.00	71.00	0.00	1
409.67	72.86	72.86	0.00	1
428.00	464.13	464.13	0.00	Overtopping

Table 2 - Culvert Summary Table: 60in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
54.24	54.24	409.12	2.874	0.820	1-S2n	1.461	2.065	1.539	2.408	10.192	2.294
56.10	56.10	409.18	2.932	0.875	1-S2n	1.487	2.099	1.565	2.449	10.304	2.315
57.96	57.96	409.24	2.989	0.930	1-S2n	1.513	2.136	1.588	2.488	10.437	2.335
59.83	59.83	409.30	3.046	0.984	1-S2n	1.539	2.173	1.620	2.527	10.472	2.354
61.69	61.69	409.35	3.101	1.039	1-S2n	1.563	2.209	1.650	2.565	10.532	2.373
63.55	63.55	409.41	3.155	1.093	1-S2n	1.587	2.245	1.678	2.603	10.610	2.392
64.51	64.51	409.43	3.183	1.121	1-S2n	1.600	2.263	1.691	2.622	10.655	2.402
67.27	67.27	409.51	3.262	1.201	1-S2n	1.636	2.313	1.728	2.676	10.788	2.428
69.14	69.14	409.56	3.314	1.255	1-S2n	1.660	2.347	1.751	2.712	10.886	2.446
71.00	71.00	409.62	3.365	1.309	1-S2n	1.683	2.380	1.778	2.747	10.951	2.463
72.86	72.86	409.67	3.416	1.363	1-S2n	1.706	2.412	1.806	2.782	11.002	2.480

****

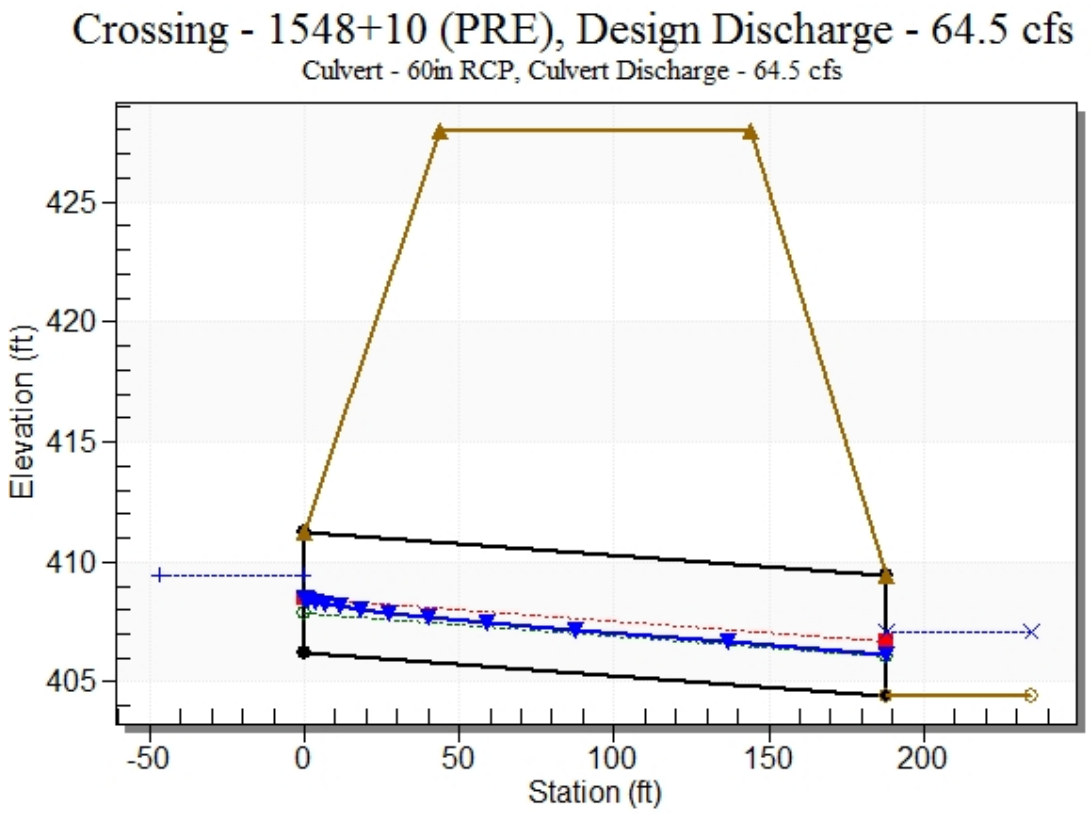
Straight Culvert

Inlet Elevation (invert): 406.25 ft, Outlet Elevation (invert): 404.45 ft

Culvert Length: 188.01 ft, Culvert Slope: 0.0096

****

Water Surface Profile Plot for Culvert: 60in RCP



Site Data - 60in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 406.25 ft

Outlet Station: 188.00 ft

Outlet Elevation: 404.45 ft

Number of Barrels: 1

Culvert Data Summary - 60in RCP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1548+10 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
54.24	406.86	2.41	2.29	0.75	0.32
56.10	406.90	2.45	2.31	0.76	0.32
57.96	406.94	2.49	2.33	0.78	0.32
59.83	406.98	2.53	2.35	0.79	0.32
61.69	407.02	2.57	2.37	0.80	0.32
63.55	407.05	2.60	2.39	0.81	0.32
64.51	407.07	2.62	2.40	0.82	0.32
67.27	407.13	2.68	2.43	0.83	0.32
69.14	407.16	2.71	2.45	0.85	0.32
71.00	407.20	2.75	2.46	0.86	0.32
72.86	407.23	2.78	2.48	0.87	0.32

Tailwater Channel Data - 1548+10 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0600

Channel Invert Elevation: 404.45 ft

Roadway Data for Crossing: 1548+10 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 56.84 cfs

Design Flow: 67.59 cfs

Maximum Flow: 76.35 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1548+10 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	60in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
409.20	56.84	56.84	0.00	1
409.26	58.79	58.79	0.00	1
409.32	60.74	60.74	0.00	1
409.38	62.69	62.69	0.00	1
409.44	64.64	64.64	0.00	1
409.49	66.59	66.59	0.00	1
409.52	67.59	67.59	0.00	1
409.60	70.50	70.50	0.00	1
409.65	72.45	72.45	0.00	1
409.71	74.40	74.40	0.00	1
409.76	76.35	76.35	0.00	1
428.00	464.13	464.13	0.00	Overtopping

Table 2 - Culvert Summary Table: 60in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
56.84	56.84	409.20	2.955	0.897	1-S2n	1.497	2.114	1.575	2.465	10.356	2.323
58.79	58.79	409.26	3.014	0.954	1-S2n	1.524	2.153	1.602	2.506	10.451	2.343
60.74	60.74	409.32	3.073	1.011	1-S2n	1.551	2.191	1.635	2.546	10.499	2.364
62.69	62.69	409.38	3.130	1.068	1-S2n	1.576	2.228	1.665	2.586	10.572	2.384
64.64	64.64	409.44	3.187	1.125	1-S2n	1.601	2.265	1.693	2.625	10.662	2.403
66.59	66.59	409.49	3.243	1.181	1-S2n	1.627	2.301	1.719	2.663	10.753	2.422
67.59	67.59	409.52	3.271	1.210	1-S2n	1.640	2.319	1.732	2.682	10.804	2.431
70.50	70.50	409.60	3.351	1.294	1-S2n	1.677	2.371	1.770	2.738	10.939	2.458
72.45	72.45	409.65	3.405	1.351	1-S2n	1.701	2.405	1.800	2.774	10.990	2.476
74.40	74.40	409.71	3.457	1.407	1-S2n	1.725	2.439	1.828	2.810	11.053	2.493
76.35	76.35	409.76	3.509	1.464	1-S2n	1.749	2.472	1.856	2.845	11.115	2.510

****

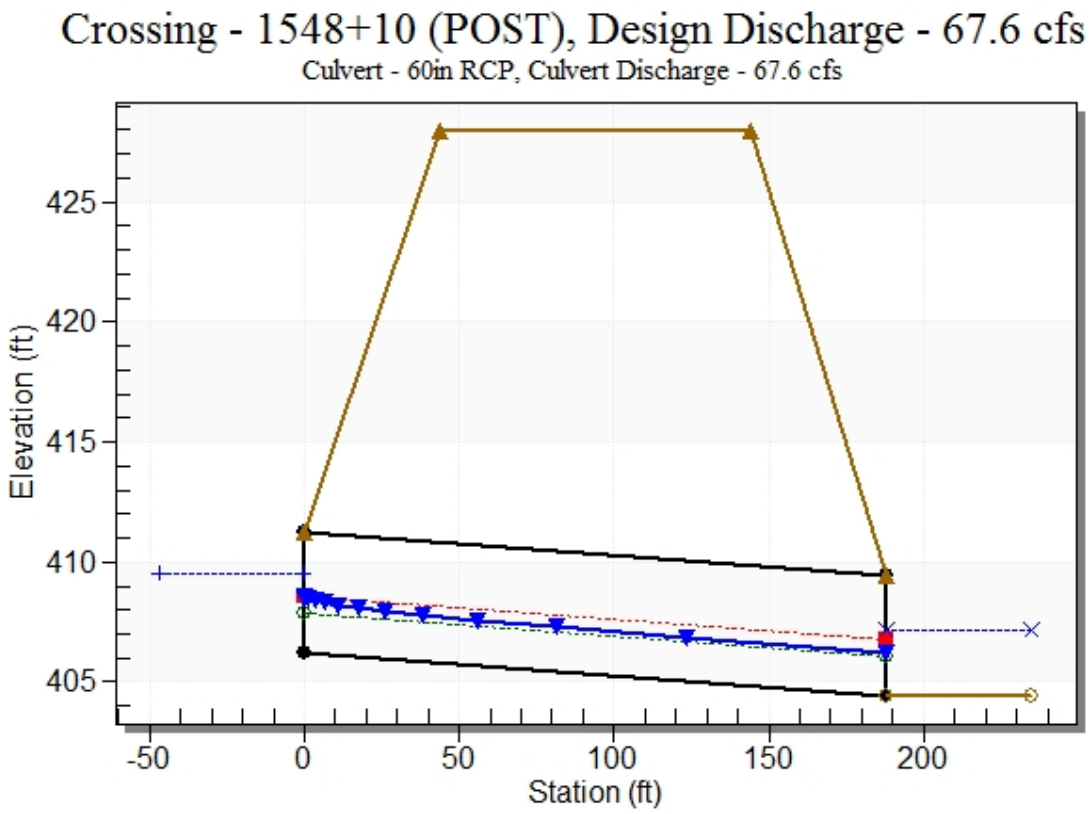
Straight Culvert

Inlet Elevation (invert): 406.25 ft, Outlet Elevation (invert): 404.45 ft

Culvert Length: 188.01 ft, Culvert Slope: 0.0096

****

Water Surface Profile Plot for Culvert: 60in RCP



Site Data - 60in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 406.25 ft

Outlet Station: 188.00 ft

Outlet Elevation: 404.45 ft

Number of Barrels: 1

Culvert Data Summary - 60in RCP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1548+10 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
56.84	406.91	2.46	2.32	0.77	0.32
58.79	406.96	2.51	2.34	0.78	0.32
60.74	407.00	2.55	2.36	0.79	0.32
62.69	407.04	2.59	2.38	0.81	0.32
64.64	407.07	2.62	2.40	0.82	0.32
66.59	407.11	2.66	2.42	0.83	0.32
67.59	407.13	2.68	2.43	0.84	0.32
70.50	407.19	2.74	2.46	0.85	0.32
72.45	407.22	2.77	2.48	0.87	0.32
74.40	407.26	2.81	2.49	0.88	0.32
76.35	407.30	2.85	2.51	0.89	0.32

Tailwater Channel Data - 1548+10 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0600

Channel Invert Elevation: 404.45 ft

Roadway Data for Crossing: 1548+10 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 428.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

CULVERT 187

MICHAEL BAKER INTERNATIONAL
700 Huger Street
Columbia, South Carolina 29201
(803) 254-2211

Job ***I-26 DB Prep MM 85-101***
Sheet _____ of _____
Calculated By: _____ Date: _____
Checked By: _____ Date: _____

Location: **Site 187**

$Q = CIAC_f$

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.70	0.6288
Grass	0.25	0.77	0.1921
Woods	0.15	0.98	0.1476
	Σ	**2.45**	0.9685

$C_{ave} = \frac{0.9685}{2.45} = 0.40$

Post Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.86	0.7728
Grass	0.25	0.45	0.1121
Woods	0.15	0.98	0.1476
	Σ	**2.29**	1.0325

$C_{ave} = \frac{1.0325}{2.29} = 0.45$

T_c =	15.39	min.
I_{05} =	4.87	in / hr
I_{10} =	5.42	in / hr
I_{25} =	6.22	in / hr
I_{50} =	6.83	in / hr
I_{100} =	7.45	in / hr

Pre Construction Runoff:

Q_{05} =	0.40	x	4.87	x	2.45	x	1	=	**4.72**	cfs
Q_{10} =	0.40	x	5.42	x	2.45	x	1	=	**5.25**	cfs
Q_{25} =	0.40	x	6.22	x	2.45	x	1.1	=	**6.63**	cfs
Q_{50} =	0.40	x	6.83	x	2.45	x	1.2	=	**7.93**	cfs
Q_{100} =	0.40	x	7.45	x	2.45	x	1.25	=	**9.02**	cfs

Post Construction Runoff:

Q_{05} =	0.45	x	4.87	x	2.29	x	1	=	**5.03**	cfs
Q_{10} =	0.45	x	5.42	x	2.29	x	1	=	**5.60**	cfs
Q_{25} =	0.45	x	6.22	x	2.29	x	1.1	=	**7.07**	cfs
Q_{50} =	0.45	x	6.83	x	2.29	x	1.2	=	**8.46**	cfs
Q_{100} =	0.45	x	7.45	x	2.29	x	1.25	=	**9.62**	cfs

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project	***I-26 DB PREP***	By	Date
Location	Site 187	Checked	Date

Circle one: Present Developed

Circle one: T_c T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet
Include a map, schematic, or description of flow segment

Sheet Flow (Applicable to T_c only)			Segment ID					
1	Surface Desciption (table 3-1)			Woods				
2	Manning's roughness coeff., n (table 3-1)			**0.800**				
3	Flow length, L (total L < or = 100)		ft	**50**				
4	Two-yr 24-hr rainfall, P_2		in	**3.58**				
5	Land slope, s		ft/ft	**0.0400**				
6	$T_t = 0.007\ (nL)^{0.8}/(P_2^{0.5}s^{0.4})$	Compute T_t	hr	**0.256**	+		=	**0.256**
Shallow Concentrated Flow			Segment ID					
7	Surface Desciption (paved or unpaved)							
8	Flow length, L		ft					
9	Watercourse slope, s		ft/ft					
10	Average velocity, V (figure 3-1)		ft/s	**0.00**		**0.00**		
11	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	
Channel Flow			Segment ID					
	Front Slope, (_ : 1)							
	Back Slope, (_ : 1)							
	Bottom Width		ft					
	Flow Depth		ft					
12	Cross sectional flow area, a		ft^2	**0.00**		**0.00**		
13	Wetted perimeter, p_w		ft	**0.00**		**0.00**		
14	Hydraulic radius, $r = a / p_w$	Compute r	ft	**#DIV/0!**		**#DIV/0!**		
15	Channel Slope, s		ft/ft					
16	Manning's roughness coeff., n							
17	$V = 1.49\ r^{2/3}\ s^{1/2} / n$	Compute V	ft/s	**#DIV/0!**		**#DIV/0!**		
18	Flow length, L		ft					
19	$T_t = L / (3600\ V)$	Compute T_t	hr	**#DIV/0!**	+	**#DIV/0!**	=	
20	Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)						hr	**0.256**
							min	**15.39**

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.63 cfs

Design Flow: 7.93 cfs

Maximum Flow: 9.02 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1554+00 (PRE)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
442.86	6.63	6.63	0.00	1
442.90	6.87	6.87	0.00	1
442.93	7.11	7.11	0.00	1
442.97	7.35	7.35	0.00	1
443.01	7.59	7.59	0.00	1
443.04	7.82	7.82	0.00	1
443.06	7.93	7.93	0.00	1
443.12	8.30	8.30	0.00	1
443.16	8.54	8.54	0.00	1
443.20	8.78	8.78	0.00	1
443.24	9.02	9.02	0.00	1
448.00	23.12	23.12	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.63	6.63	442.86	1.422	0.0*	1-S2n	0.455	0.994	0.455	0.677	14.164	2.917
6.87	6.87	442.90	1.457	0.0*	1-S2n	0.463	1.012	0.479	0.690	13.652	2.946
7.11	7.11	442.93	1.492	0.0*	1-S2n	0.472	1.029	0.472	0.702	14.471	2.974
7.35	7.35	442.97	1.528	0.0*	5-S2n	0.480	1.047	0.480	0.714	14.561	3.001
7.59	7.59	443.01	1.565	0.0*	5-S2n	0.488	1.064	0.488	0.726	14.697	3.027
7.82	7.82	443.04	1.603	0.0*	5-S2n	0.496	1.080	0.496	0.738	14.828	3.052
7.93	7.93	443.06	1.619	0.0*	5-S2n	0.500	1.087	0.500	0.743	14.883	3.064
8.30	8.30	443.12	1.681	0.0*	5-S2n	0.512	1.112	0.532	0.760	14.298	3.102
8.54	8.54	443.16	1.721	0.0*	5-S2n	0.520	1.127	0.520	0.771	15.179	3.127
8.78	8.78	443.20	1.762	0.0*	5-S2n	0.527	1.143	0.527	0.782	15.299	3.150
9.02	9.02	443.24	1.805	0.0*	5-S2n	0.535	1.157	0.535	0.793	15.414	3.173

* Full Flow Headwater elevation is below inlet invert.

****

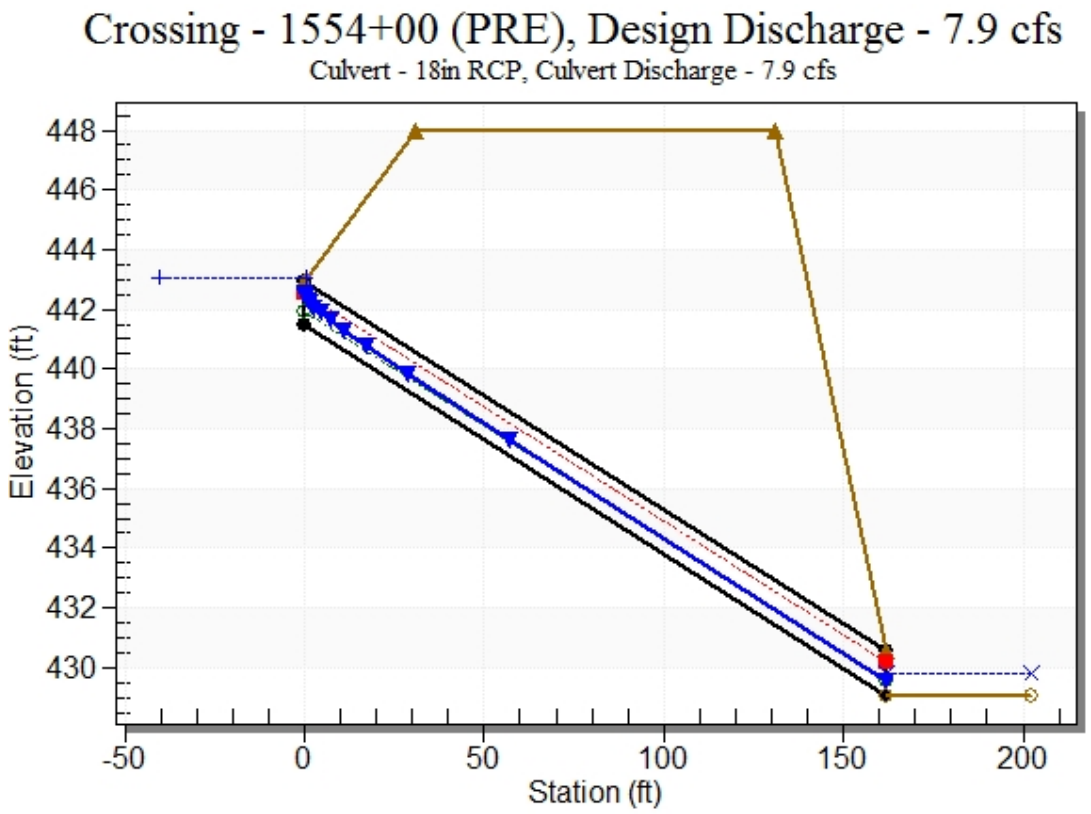
Straight Culvert

Inlet Elevation (invert): 441.44 ft, Outlet Elevation (invert): 429.07 ft

Culvert Length: 162.47 ft, Culvert Slope: 0.0764

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 441.44 ft

Outlet Station: 162.00 ft

Outlet Elevation: 429.07 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1554+00 (PRE))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.63	429.75	0.68	2.92	1.69	0.74
6.87	429.76	0.69	2.95	1.72	0.74
7.11	429.77	0.70	2.97	1.75	0.74
7.35	429.78	0.71	3.00	1.78	0.74
7.59	429.80	0.73	3.03	1.81	0.75
7.82	429.81	0.74	3.05	1.84	0.75
7.93	429.81	0.74	3.06	1.85	0.75
8.30	429.83	0.76	3.10	1.90	0.75
8.54	429.84	0.77	3.13	1.93	0.75
8.78	429.85	0.78	3.15	1.95	0.75
9.02	429.86	0.79	3.17	1.98	0.75

Tailwater Channel Data - 1554+00 (PRE)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 429.07 ft

Roadway Data for Crossing: 1554+00 (PRE)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 448.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.07 cfs

Design Flow: 8.46 cfs

Maximum Flow: 9.62 cfs

Table 1 - Summary of Culvert Flows at Crossing: 1554+00 (POST)

Headwater Elevation (ft)	Total Discharge (cfs)	18in RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
442.93	7.07	7.07	0.00	1
442.96	7.33	7.33	0.00	1
443.00	7.58	7.58	0.00	1
443.04	7.84	7.84	0.00	1
443.09	8.09	8.09	0.00	1
443.13	8.34	8.34	0.00	1
443.15	8.46	8.46	0.00	1
443.22	8.86	8.86	0.00	1
443.26	9.11	9.11	0.00	1
443.31	9.36	9.36	0.00	1
443.36	9.62	9.62	0.00	1
448.00	23.12	23.12	0.00	Overtopping

Table 2 - Culvert Summary Table: 18in RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.07	7.07	442.93	1.486	0.0*	1-S2n	0.470	1.027	0.470	0.700	14.447	2.969
7.33	7.33	442.96	1.525	0.0*	5-S2n	0.479	1.045	0.479	0.713	14.548	2.998
7.58	7.58	443.00	1.564	0.0*	5-S2n	0.488	1.063	0.488	0.726	14.694	3.026
7.84	7.84	443.04	1.604	0.0*	5-S2n	0.497	1.081	0.497	0.738	14.833	3.053
8.09	8.09	443.09	1.645	0.0*	5-S2n	0.505	1.098	0.544	0.750	13.520	3.080
8.34	8.34	443.13	1.688	0.0*	5-S2n	0.513	1.115	0.530	0.762	14.463	3.106
8.46	8.46	443.15	1.707	0.0*	5-S2n	0.517	1.122	0.522	0.768	14.934	3.118
8.86	8.86	443.22	1.775	0.0*	5-S2n	0.530	1.147	0.530	0.785	15.335	3.157
9.11	9.11	443.26	1.821	0.0*	5-S2n	0.538	1.163	0.538	0.797	15.456	3.182
9.36	9.36	443.31	1.868	0.0*	5-S2n	0.546	1.181	0.546	0.808	15.586	3.205
9.62	9.62	443.36	1.916	0.0*	5-S2n	0.554	1.196	0.554	0.819	15.675	3.228

* Full Flow Headwater elevation is below inlet invert.

****

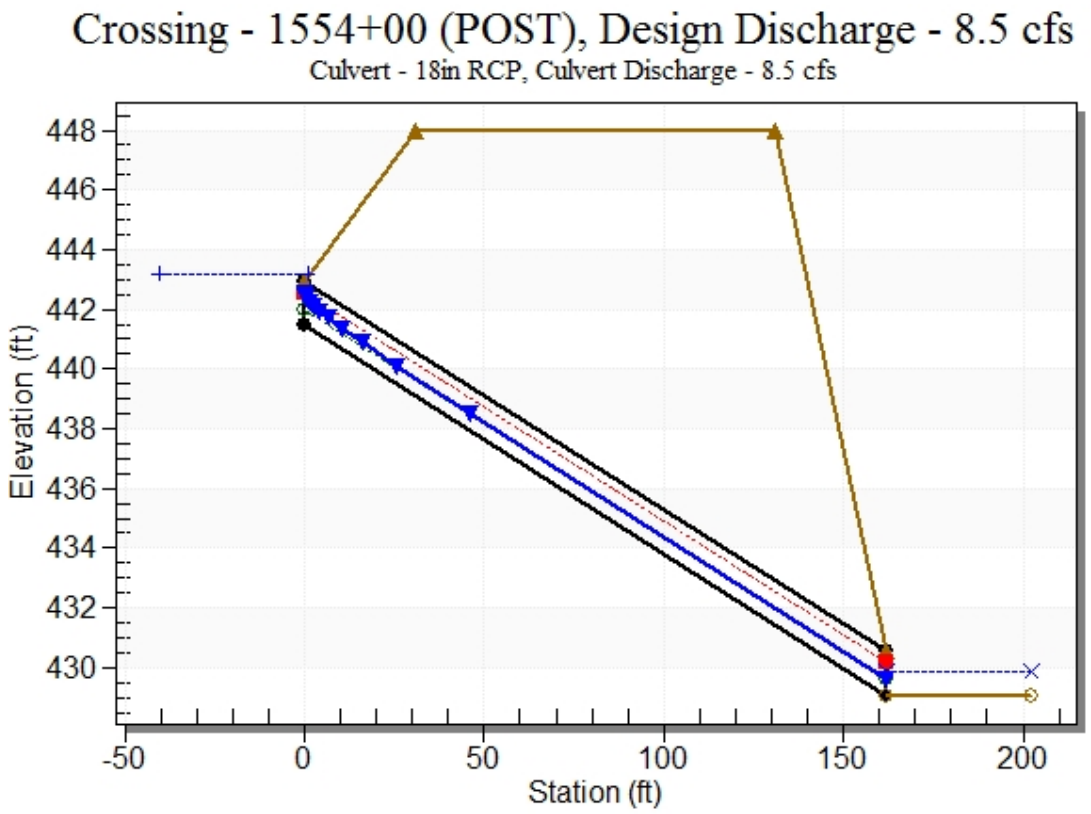
Straight Culvert

Inlet Elevation (invert): 441.44 ft, Outlet Elevation (invert): 429.07 ft

Culvert Length: 162.47 ft, Culvert Slope: 0.0764

****

Water Surface Profile Plot for Culvert: 18in RCP



Site Data - 18in RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 441.44 ft

Outlet Station: 162.00 ft

Outlet Elevation: 429.07 ft

Number of Barrels: 1

Culvert Data Summary - 18in RCP

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 1554+00 (POST))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
7.07	429.77	0.70	2.97	1.75	0.74
7.33	429.78	0.71	3.00	1.78	0.74
7.58	429.80	0.73	3.03	1.81	0.75
7.84	429.81	0.74	3.05	1.84	0.75
8.09	429.82	0.75	3.08	1.87	0.75
8.34	429.83	0.76	3.11	1.90	0.75
8.46	429.84	0.77	3.12	1.92	0.75
8.86	429.86	0.79	3.16	1.96	0.75
9.11	429.87	0.80	3.18	1.99	0.75
9.36	429.88	0.81	3.21	2.02	0.76
9.62	429.89	0.82	3.23	2.04	0.76

Tailwater Channel Data - 1554+00 (POST)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0600

Channel Invert Elevation: 429.07 ft

Roadway Data for Crossing: 1554+00 (POST)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 448.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft