

S-51 Emergency Bridge Replacement over Black Mingo Creek

**ROADWAY DRAINAGE
FOR THE REPLACEMENT OF
THE S-51 BRIDGE
OVER BLACK MINGO CREEK**



FINAL

Williamsburg County, South Carolina

February 2016

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Williamsburg County, South Carolina

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Prepared For:



The South Carolina Department of Transportation

**INFRASTRUCTURE CONSULTING AND ENGINEERING
COLUMBIA, SC**

S-51 Emergency Bridge Replacement over Mingo Creek

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INTRODUCTION AND BACKGROUND

This project is one of a four bridge emergency replacement project. Each bridge is being evaluated separately for roadway hydraulic design. A separate report will be provided for bridge hydraulic conditions. This bridge will be replaced on the existing alignment with a temporary detour during construction.

This project is located in Williamsburg County where S-51 crosses over Mingo Creek. The closest intersection is S-51 (Battery Park Road) with Harvest Road. The nearest major intersection is S-51 Rd and SC-261 (Hemingway Hwy). The flow area through this bridge crossing is approximately 107 square miles. The project location is shown in Figure 1. An aerial view of the project site is shown in Figure 2.



Figure 1. Project Location Map



Figure 2. Aerial View

TRAFFIC CONTROL

The bridge will be replaced on the same alignment as the existing bridge. Currently local traffic uses SC-261 (Hemingway Hwy to S-24 (Nesmith Road) to S-51 (Battery Park Road).

DESIGN APPROACH

This stormwater design report is the result of the drainage design completed by Infrastructure Consulting and Engineering for the S-51 bridge over Black Mingo Creek. The approach roadway will be widened for a distance of approximately 1200 feet before and approximately 1675 feet after the existing bridge. The widened roadway for the bridge approaches will have two 11-foot travel lanes with 2-foot paved shoulders and 4-foot grass shoulder along each side. Proposed right-of-way along the roadway approaches will vary from 66 to 150 feet.

Because stormwater from this project outfalls directly to a large creek which carries flow from 107 square miles of contributing area at this location, post-construction versus

pre-construction runoff rates were not anticipated to show an increase, and no storage was accounted for in the roadside ditches for this project.

SITE VISIT

Prior to initiating design, a site visit was performed by design personnel to verify existing drainage patterns, check existing outfalls and view cross line culverts.

ROADWAY WATERSHED DESCRIPTION

The contributing watershed for the roadway drainage of this project is from approximately 900 feet north of the Battery Park Road Bridge to approximately 1200 feet south of Battery Park Road Bridge. The watershed is rural with highly forested areas and a dammed pond. The areas shown in red in Figure 3, below, drain through the project right-of-way from outside of the right-of-way.

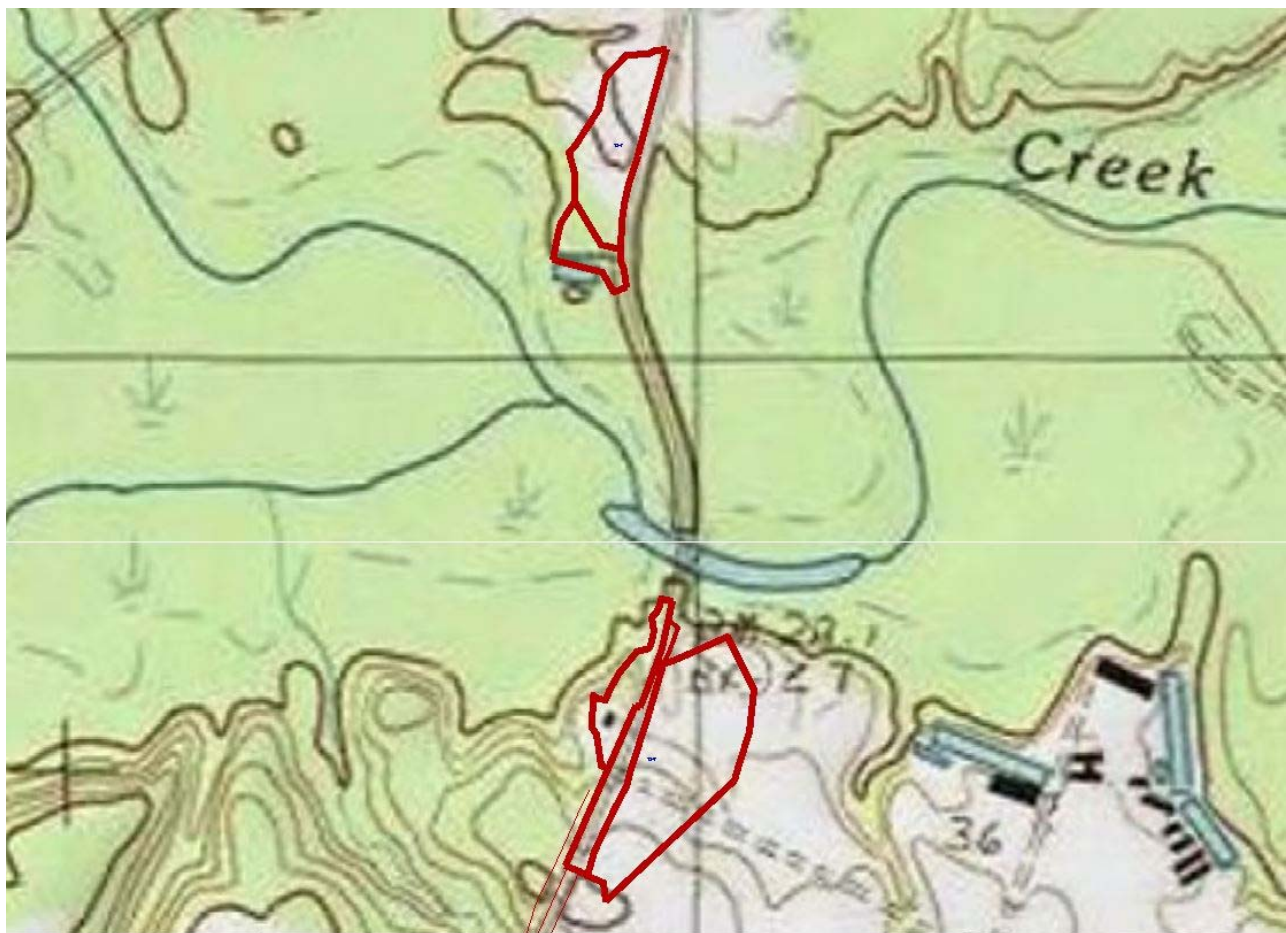


Figure 3. Offsite Flow Areas

DESIGN STANDARDS

All roadway drainage structures were designed in accordance with the SCDOT Requirements for Hydraulic Design Studies (May 26, 2009), SCDOT Hydrology Calculations and normal SCDOT practice. A combination of Geopak Drainage and HEC-22 was used to model and design the proposed closed storm system to carry the 10-year storm event. Cross line piping accepting offsite flow was designed to have capacity to carry the 25-year storm event without overtopping the roadway during the 100-year storm event. Design of cross line piping was completed using Geopak Drainage. The majority of the drainage for this project is conveyed within proposed existing and proposed roadway ditches.

Time of Concentration

The velocity method for estimating time of concentration was used for the offsite flows.

Time of concentration calculations for all locations are provided in Appendix B.

IDF curves for Florence were used to determine flow intensity given the calculated time of concentration at each location.

Runoff Coefficients

The final runoff coefficient for every area is a weighted average of the two factors based on the contributing area from each source.

Minimum Pipe/Ditch Grades

Pipe and ditch grades were set at a minimum of 0.3% and a maximum of 6% per SCDOT standards.

Pipe Material

Pipe materials shall be selected from those listed in Engineering Directive Memorandum 24. Because this project will be constructed as a design build, the contractor has selected the use of smooth wall piping. Corrugated piping has not been considered in the design.

Pipe Joints

Joint material and details shall meet the requirements of SC-M-714 and SCDOT standard drawings for the joints specified in the plans.

Sediment and Erosion Control

Turf reinforcement matting for permanent ditch stability improvements will be used where needed to prevent erosion based on the 10 year storm. Outlet protection in the form of rip-rap aprons have also been specified to prevent scour and erosion at selected pipe outfalls. The erosion control data sheet calls out necessary requirements for fill slopes to be lined. See appendix D.

Deck Drainage

The Battery Park Road Bridge was reviewed for scupper requirements using the 2006 SCDOT Bridge Design Manual and is under the maximum bridge length without scuppers per section 18.2.2. Therefore this bridge will not require a scupper system for deck drainage. See appendix H for calculations.

WATER QUALITY & STORMWATER MANAGEMENT

In regards to soil and erosion control, the erosion control data sheet calls out sediment tube spacing and rip-rap measures to be implemented during construction to minimize soil loss. Erosion control measures shall be used to meet the requirements of the South Carolina Department of Health & Environmental Control (SCDHEC) requirements for stormwater runoff. The total disturbed area for this project is 1.02 acres. Erosion control measures to be used for this project include:

Sediment Tubes / Ditch Checks

Ditch protection will be provided during construction through the use of sediment tubes and ditch checks as needed per the SCDOT Specifications. Sediment tubes will be used rather than installing sediment dams for this project because all ditches carry less than 1 acre disturbed area.

Soil Roughening

During earthwork operations, slopes will be roughened by grading equipment in an effort to retard runoff rates to non-erosive velocities.

Temporary Seeding & Mulching

Temporary seeding and mulching will be utilized on all disturbed areas where work has been suspended for 14 days or more.

Silt Fencing

A silt fence will be constructed around the area of disturbance as necessary to prevent sediment from leaving the construction areas.

Permanent Stabilization

All areas will be permanently stabilized with pavement, turf, or landscaping.

Rip-Rap Outlet Protection

All storm drain outlets will be equipped with rip-rap erosion control beds. Rip-rap requirements for pipe ends are shown in Appendix G. Open pipe ends for driveway piping and inlets will be provided protection per SCDOT Instructional bulletin 2009-2.

Creek Watershed Information

The Black Mingo Creek watershed is a freshwater creek. As an added water quality measure all ditches will be grassed and will be vegetated swales in the post construction condition.

PRE- & POST-CONSTRUCTION PEAK RUNOFF RATE ANALYSIS

Because all of the increased flow from this project outfalls directly to Black Mingo Creek or adjacent wetlands discharging to Black Mingo Creek, which has an upstream drainage area of 107 square miles, the minor increase in impervious area from the bridge and approach roadways will not affect the flow exiting the project site.

Appendix A

Time of Concentration

Calculations for Offsite Flow

TIME OF CONCENTRATION SHEET

I.D. NO.: **15-42**
 PROJ. NO.:
 DESC: **S-51/BATTERY PARK RD @ BLACK MINGO CK**

STATE: **SC**
COUNTY: **WILLIAMSBURG**

CREATED ON: #####
REVISED ON: _____
APPROVED ON: _____

$$i = \frac{a}{(b + tc)^c}$$

where: i = rainfall intensity in inches per hour,
 t_c = time of concentration in minutes,
 and a , b , and c are coefficients.

DESIGNED BY: CAA
 REVISED BY: _____
 APPROVED BY: _____

NOTE: Channel & pipe geometry criteria estimated/assumed (i.e. are approximate)

[illegible]

Appendix B

Ditch Flow Calculations

I.D. NO.: **15-42**
 PROJ. NO.:
 DESC: **S-51/BATTERY PARK RD @ BLACK MINGO CK**
S-51 LEFT SIDE DITCH

STATE: **SC**
 COUNTY: **WILLIAMSBURG**

CREATED ON: **1/15/16**
 REVISED ON: **2/11/16**
 APPROVED ON:

DESIGNED BY: **CAA**
 REVISED BY: **CAA**
 APPROVED BY:

Ditch Q yr: 0 - 40 ac=10 yr, 40 - 500 ac=25 yr, >500 ac = 50 yr

Notes	Sec. Sta.	Elev. (ft)	Sect. Length (ft)	Sect. Width (ft)	Sect. Area (sf)	SX (%)	SL (%)	C	I (in/hr)	Inlet Dia. (in)	+ In Bypass (cfs)	Sec.Q + In Bypass (cfs)	Y value	water height at Curb, (in)	T (ft)	Weir Flow (cfs)	Orifice Flow (cfs)	Inlet Disch. Qin (cfs)	Bypass Flow, Qby (cfs)
S-51 sta 57+00 to 57+50 LT	57+00	22.4	50.0	27	1350	16.67	2.00	0.45	7.13	0.0	0.00	0.10	0.53	1.90	1.0	0.00	0.00	0.00	0.10
S-51 sta 57+00 to 57+50 LT	57+50	21.4	50.0	25	1250	20.00	1.96	0.45	7.13	0.0	0.10	0.19	0.57	2.61	1.1	0.00	0.00	0.00	0.19
S-51 sta 81+00 to 85+58 LT	81+00	45.2	100.0	49	4900	16.67	1.00	0.45	7.13	0.0	0.00	0.36	0.53	3.51	1.8	0.00	0.00	0.00	0.36
	82+00	44.0	100.0	49	4900	50.00	1.18	0.45	7.13	0.0	0.36	0.72	0.87	6.66	1.1	0.00	0.00	0.00	0.72
	83+00	41.7	100.0	48	4800	50.00	2.24	0.45	7.13	0.0	0.72	1.08	0.87	6.86	1.1	0.00	0.00	0.00	1.08
	84+00	39.0	100.0	46	4600	50.00	2.74	0.45	7.13	0.0	1.08	1.41	0.87	7.32	1.2	0.00	0.00	0.00	1.41
S-51 sta 81+00 to 85+58 LT	85+00	37.8	100.0	47	4700	50.00	1.25	0.45	7.13	0.0	1.41	1.76	0.87	9.21	1.5	0.00	0.00	0.00	1.76
S-51 sta 81+00 to 85+58 LT	85+58	37.5	58.0	21	1218	50.00	0.43	0.45	7.13	0.0	1.76	1.85	0.87	11.45	1.9	0.00	0.00	0.00	1.85
S-51 sta 81+00 to 71+00 LT	81+00	45.2	100.0	94	9400	16.67	1.00	0.45	7.13	0.0	0.00	0.69	0.53	4.49	2.2	0.00	0.00	0.00	0.69
	80+00	43.5	100.0	81	8100	25.00	1.66	0.45	7.13	0.0	0.69	1.29	0.63	5.99	2.0	0.00	0.00	0.00	1.29
	79+00	41.3	100.0	84	8400	25.00	2.23	0.45	7.13	0.0	1.29	1.91	0.63	6.57	2.2	0.00	0.00	0.00	1.91
	78+00	39.5	100.0	89	8900	16.67	1.77	0.45	7.13	0.0	1.91	2.56	0.53	6.59	3.3	0.00	0.00	0.00	2.56
	77+00	37.3	100.0	88	8800	16.67	2.25	0.45	7.13	0.0	2.56	3.21	0.53	6.85	3.4	0.00	0.00	0.00	3.21
	76+00	35.3	100.0	76	7600	16.67	2.00	0.45	7.13	0.0	3.21	3.77	0.53	7.44	3.7	0.00	0.00	0.00	3.77
	75+00	32.4	100.0	34	3400	16.67	2.90	0.45	7.13	0.0	3.77	4.02	0.53	7.11	3.6	0.00	0.00	0.00	4.02
	74+00	30.0	100.0	36	3600	25.00	2.35	0.45	7.13	0.0	4.02	4.29	0.63	8.81	2.9	0.00	0.00	0.00	4.29
	73+50	29.5	50.0	32	1600	50.00	1.00	0.45	7.13	0.0	10.98	11.09	0.87	19.14	3.2	0.00	0.00	0.00	11.09
	73+00	28.5	50.0	26	1300	50.00	2.00	0.45	7.13	0.0	11.09	11.19	0.87	16.87	2.8	0.00	0.00	0.00	11.19
	72+50	28.0	50.0	25	1250	50.00	1.00	0.45	7.13	0.0	11.19	11.28	0.87	19.27	3.2	0.00	0.00	0.00	11.28
	72+00	27.6	50.0	32	1600	50.00	0.84	0.45	7.13	0.0	11.28	11.40	0.87	19.98	3.3	0.00	0.00	0.00	11.40
S-51 sta 81+00 to 71+00 LT	71+50	26.2	50.0	36	1800	50.00	2.80	0.45	7.13	0.0	11.40	11.53	0.87	16.01	2.7	0.00	0.00	0.00	11.53
S-51 sta 81+00 to 71+00 LT	71+00	24.6	50.0	39	1950	50.00	3.14	0.45	7.13	0.0	11.53	11.68	0.87	15.75	2.6	0.00	0.00	0.00	11.68

I.D. NO.: **15-42**
 PROJ. NO.:
 DESC: **S-51/BATTERY PARK RD @ BLACK MINGO CK**
S-51 RIGHT SIDE DITCH

STATE: **SC**
 COUNTY: **WILLIAMSBURG**

CREATED ON: **1/15/16**
 REVISED ON: **2/11/16**
 APPROVED ON:

DESIGNED BY: **CAA**
 REVISED BY: **CAA**
 APPROVED BY:

Ditch Q yr: 0 - 40 ac=10 yr, 40 - 500 ac=25 yr, >500 ac = 50 yr

Notes	Sec. Sta.	Elev.	Sect. Length	Sect. Width	Sect. Area	SX	SL	C	I	Inlet Dia.	+ Bypass s Qin	Sec.Q + In Bypass	Y value	water height at Curb,	T	Weir Flow	Orifice Flow	Inlet Disch. Qin	Bypass Flow, Qby
		(ft)	(ft)	(ft)	(sf)	(%)	(%)		(in/hr)	(in)	(cfs)	(cfs)		(in)	(ft)	(cfs)	(cfs)	(cfs)	(cfs)
S-51 sta 55+60 to 56+10 RT	55+60	23.2	40.0	0	138726	52.63	1.00	0.30	5.17	0.0	0.00	4.94	0.89	15.15	2.40	0.00	0.00	0.00	4.94
S-51 sta 55+60 to 56+10 RT	56+00	22.7	40.0	0	0	58.82	1.37	0.45	5.90	0.0	4.94	4.94	0.94	14.87	2.11	0.00	0.00	0.00	4.94
S-51 sta 55+60 to 56+10 RT	56+10	22.5	10.0	0	0	50.00	1.90	0.45	5.90	0.0	4.94	4.94	0.87	13.17	2.20	0.00	0.00	0.00	4.94
S-51 sta 58+00 to 58+86 RT	58+00	20.6	50.0	0	41364	50.00	1.00	0.30	5.29	0.0	0.00	1.51	0.87	9.52	1.59	0.00	0.00	0.00	1.51
S-51 sta 58+00 to 58+86 RT	58+86	19.7	86.0	0	0	50.00	1.03	0.45	5.90	0.0	1.51	1.51	0.87	9.46	1.58	0.00	0.00	0.00	1.51
S-51 sta 76+00 to 70+50 RT	76+00	35.8	100.0	88	8800	16.67	2.00	0.40	6.25	0.0	0.00	0.51	0.53	3.68	1.84	0.00	0.00	0.00	0.51
	75+00	33.8	100.0	150	15000	16.67	1.95	0.40	6.25	0.0	0.51	1.37	0.53	5.37	2.68	0.00	0.00	0.00	1.37
	74+00	31.8	100.0	110	11000	16.67	2.05	0.40	6.25	0.0	1.37	2.00	0.53	6.13	3.07	0.00	0.00	0.00	2.00
	73+50	30.4	50.0	105	5250	16.67	2.62	0.40	6.25	0.0	2.00	2.30	0.53	6.18	3.09	0.00	0.00	0.00	2.30
	73+00	29.2	50.0	88	4400	16.67	2.50	0.40	6.25	0.0	2.30	2.55	0.53	6.48	3.24	0.00	0.00	0.00	2.55
	72+50	28.1	50.0	73	3650	16.67	2.12	0.45	6.25	0.0	2.55	2.79	0.53	6.91	3.45	0.00	0.00	0.00	2.79
	72+00	27.1	50.0	30	1500	16.67	2.10	0.45	6.25	0.0	2.79	2.88	0.53	7.01	3.50	0.00	0.00	0.00	2.88
	71+50	26.3	50.0	32	1600	50.00	1.66	0.45	6.25	0.0	2.88	2.99	0.87	11.19	1.86	0.00	0.00	0.00	2.99
S-51 sta 77+00 to 70+50 RT	71+00	25.3	50.0	48	2400	50.00	1.82	0.45	6.25	0.0	2.99	3.14	0.87	11.21	1.87	0.00	0.00	0.00	3.14
S-51 sta 77+00 to 70+50 RT	70+50	23.3	50.0	30	1500	50.00	4.14	0.45	6.25	0.0	3.14	3.24	0.87	9.72	1.62	0.00	0.00	0.00	3.24
S-51 sta 81+00 to 78+00 RT	81+00	44.5	100.0	36	3600	50.00	2.00	0.45	6.25	0.0	0.00	0.23	0.87	4.15	0.69	0.00	0.00	0.00	0.23
	80+00	43.0	100.0	35	3500	50.00	1.48	0.45	6.25	0.0	0.23	0.46	0.87	5.66	0.94	0.00	0.00	0.00	0.46
S-51 sta 82+00 to 78+00 RT	79+00	40.8	100.0	35	3500	25.00	2.21	0.45	6.25	0.0	0.46	0.68	0.63	4.71	1.57	0.00	0.00	0.00	0.68
S-51 sta 82+00 to 78+00 RT	78+00	38.5	100.0	31	3100	25.00	2.33	0.45	6.25	0.0	0.68	0.88	0.63	5.13	1.71	0.00	0.00	0.00	0.88
S-51 sta 81+00 to 84+00 RT	81+00	44.5	100.0	36	3600	50.00	1.00	0.45	6.25	0.0	0.00	0.23	0.87	4.72	0.79	0.00	0.00	0.00	0.23
	82+00	43.5	100.0	39	3900	50.00	0.94	0.45	6.25	0.0	0.23	0.48	0.87	6.29	1.05	0.00	0.00	0.00	0.48
S-51 sta 81+00 to 84+00 RT	83+00	40.8	100.0	40	4000	50.00	2.77	0.45	6.25	0.0	0.48	0.74	0.87	6.03	1.01	0.00	0.00	0.00	0.74
S-51 sta 81+00 to 84+00 RT	84+00	37.5	100.0	28	2800	50.00	3.23	0.45	6.25	0.0	0.74	0.92	0.87	6.36	1.06	0.00	0.00	0.00	0.92

Appendix C

Ditch Calculations

I.D. NO.: 15-42
 PROJ. NO.:
 DESC: S-51/BATTERY PARK RD @ BLACK MINGO CK
S-51 LEFT SIDE DITCH

STATE: SC
 COUNTY: WILLIAMSBURG

CREATED ON: 1/15/16
 REVISED ON: 2/5/16
 APPROVED ON:

DESIGNED BY: CAA
 REVISED BY: CAA
 APPROVED BY:

DITCH ANALYSIS USING MANNINGS OPEN CHANNEL FOR VEGETATIVE LININGS																						
For Type <u>C</u> Vegetation (Enter A, B, C, D, or E)																						
Route	From Sta.	Ditch Elev.	Ditch Depth	SS LT z:1	SS RT z:1	BW ft.	To Sta.	Ditch Elev.	Ditch Depth	Q(Actual) c.f.s.	Depth ft.	Manning's n	Slope ft./ft.	Area sq. ft.	Wetted Perim.	Hyd. Rad. ft.	Velocity f.p.s.	Q(Cal.) c.f.s.	Depth ft.	Shear p.s.f.	Depth Comment	Shear Comment
S-51 sta 57+00 to 57+50 LT	57+00	22.42	2.0	3.7	6.0	0.0	57+50	21.44	1.0	0.2	0.52	0.500	0.0196	1.32	5.18	0.26	0.17	0.2	0.52	0.64	GOOD	GOOD
S-51 sta 81+00 to 85+58 LT	81+00	45.16	1.4	6.0	2.0	0.0	82+00	43.98	1.2	0.7	0.78	0.288	0.0118	2.46	6.52	0.38	0.29	0.7	0.78	0.58	GOOD	GOOD
	82+00	43.98	1.2	2.0	2.0	0.0	83+00	41.74	1.0	1.1	0.85	0.159	0.0224	1.46	3.82	0.38	0.74	1.1	0.85	1.19	GOOD	FIX
	83+00	41.74	1.0	2.0	2.0	0.0	84+00	39.00	1.6	1.4	0.86	0.138	0.0274	1.49	3.86	0.39	0.95	1.4	0.86	1.48	GOOD	FIX
	84+00	39	1.6	2.0	2.0	0.0	85+00	37.75	1.5	1.8	1.09	0.141	0.0125	2.39	4.89	0.49	0.74	1.8	1.09	0.85	GOOD	GOOD
S-51 sta 81+00 to 85+58 LT	85+00	37.75	1.5	2.0	2.0	0.0	85+58	37.50	1.5	1.9	1.42	0.159	0.0043	4.06	6.37	0.64	0.46	1.9	1.42	0.38	GOOD	GOOD
S-51 sta 81+00 to 71+00 LT	81+00	45.16	1.4	6.0	2.0	0.0	80+00	43.50	2.5	1.3	0.79	0.198	0.0166	2.53	6.61	0.38	0.51	1.3	0.79	0.82	GOOD	GOOD
	80+00	43.5	2.5	4.0	2.0	0.0	79+00	41.27	2.5	1.9	0.86	0.142	0.0223	2.22	5.47	0.41	0.86	1.9	0.86	1.20	GOOD	FIX
	79+00	41.27	2.5	4.0	2.0	0.0	78+00	39.50	1.7	2.6	0.97	0.130	0.0177	2.83	6.18	0.46	0.90	2.6	0.97	1.07	GOOD	FIX
	78+00	39.5	1.7	6.0	2.0	0.0	77+00	37.25	1.8	3.2	0.90	0.128	0.0225	3.21	7.46	0.43	1.00	3.2	0.90	1.26	GOOD	FIX
	77+00	37.25	1.8	6.0	2.0	0.0	76+00	35.25	1.6	3.8	0.96	0.122	0.0200	3.66	7.96	0.46	1.03	3.8	0.96	1.19	GOOD	FIX
	76+00	35.25	1.6	6.0	2.0	0.0	75+00	32.35	2.0	4.0	0.89	0.114	0.0290	3.18	7.41	0.43	1.27	4.0	0.89	1.61	GOOD	FIX
	75+00	32.35	2.0	6.0	2.0	0.0	74+00	30.00	2.1	4.3	0.95	0.114	0.0235	3.61	7.91	0.46	1.19	4.3	0.95	1.39	GOOD	FIX
	74+00	30	2.1	4.0	2.0	0.0	73+50	29.50	1.9	11.1	1.61	0.088	0.0100	7.82	10.26	0.76	1.42	11.1	1.61	1.01	GOOD	GOOD
	73+50	29.5	1.9	2.0	2.0	0.0	73+00	28.50	2.8	11.2	1.59	0.076	0.0200	5.05	7.11	0.71	2.22	11.2	1.59	1.98	GOOD	FIX
	73+00	28.5	2.8	2.0	2.0	0.0	72+50	28.00	3.3	11.3	1.86	0.081	0.0100	6.92	8.32	0.83	1.63	11.3	1.86	1.16	GOOD	FIX
	72+50	28	3.3	2.0	2.0	0.0	72+00	27.58	3.0	11.4	1.94	0.082	0.0084	7.53	8.68	0.87	1.51	11.4	1.94	1.02	GOOD	FIX
	72+00	27.58	3.0	2.0	2.0	0.0	71+50	26.18	3.5	11.5	1.49	0.073	0.0280	4.42	6.65	0.66	2.61	11.5	1.49	2.60	GOOD	FIX
	71+50	26.18	3.5	2.0	2.0	0.0	71+00	24.61	4.5	11.7	1.45	0.072	0.0314	4.23	6.50	0.65	2.76	11.7	1.45	2.85	GOOD	FIX

*** In cases where "fix" appears in the depth comment column the ditch segment was checked to confirm that the depth is okay. This issue typically occurs at the beginning (high point) of the ditch where there is little or no flow or at the end (low point) of the ditch where the ditch empties into a wetland.

I.D. NO.: 15-42

PROJ. NO.:

DESC: S-51/BATTERY PARK RD @ BLACK MINGO CK

S-51 RIGHT SIDE DITCH

STATE: SC

COUNTY: WILLIAMSBURG

CREATED ON: 1/15/16

REVISED ON: 2/11/16

APPROVED ON:

DESIGNED BY: CAA

REVISED BY: CAA

APPROVED BY:

DITCH ANALYSIS USING MANNINGS OPEN CHANNEL FOR VEGETATIVE LININGS

For Type C Vegetation (Enter A, B, C, D, or E)

Route	From Sta.	Ditch Elev.	Ditch Depth	SS Lt z:1	SS Rt z:1	BW ft.	To Sta.	Ditch Elev.	Ditch Depth	Q(Actual) c.f.s.	Depth ft.	Manning's n	Slope ft./ft.	Area sq. ft.	Wetted Perim.	Hyd. Rad. ft.	Velocity f.p.s.	Q(Cal.) c.f.s.	Depth ft.	Shear p.s.f.	Depth Comment	Shear Comment
S-51 sta 55+60 to 56+10 RT	55+60	23.24	2.5	1.9	2.0	0.0	56+00	22.69	3.1	4.9	1.39	0.097	0.0137	3.78	6.10	0.62	1.31	4.9	1.39	1.19	GOOD	FIX
S-51 sta 55+60 to 56+10 RT	56+00	22.69	3.1	1.7	2.0	0.0	56+10	22.50	3.1	4.9	1.32	0.093	0.0190	3.22	5.55	0.58	1.54	4.9	1.32	1.56	GOOD	FIX
S-51 sta 58+00 to 58+86 RT	58+00	20.59	1.2	2.0	2.0	0.0	58+86	19.70	1.2	1.5	1.11	0.154	0.0103	2.44	4.94	0.49	0.62	1.5	1.11	0.71	GOOD	GOOD
S-51 sta 76+00 to 70+50 RT	76+00	35.75	1.4	6.0	2.0	0.0	75+00	33.80	1.4	0.5	0.66	0.328	0.0195	1.72	5.45	0.32	0.29	0.5	0.66	0.80	GOOD	GOOD
	75+00	33.8	1.4	6.0	2.0	0.0	74+00	31.75	1.4	1.4	0.76	0.186	0.0205	2.33	6.35	0.37	0.59	1.4	0.76	0.98	GOOD	GOOD
	74+00	31.75	1.4	6.0	2.0	0.0	73+50	30.44	1.4	2.0	0.78	0.151	0.0262	2.41	6.46	0.37	0.83	2.0	0.78	1.27	GOOD	FIX
	73+50	30.44	1.4	6.0	2.0	0.0	73+00	29.19	1.4	2.3	0.81	0.143	0.0250	2.63	6.74	0.39	0.88	2.3	0.81	1.26	GOOD	FIX
	73+00	29.19	1.4	6.0	2.0	0.0	72+50	28.13	1.4	2.6	0.86	0.141	0.0212	2.97	7.17	0.41	0.86	2.6	0.86	1.14	GOOD	FIX
	72+50	28.13	1.4	6.0	2.0	0.0	72+00	27.08	1.4	2.8	0.88	0.136	0.0210	3.11	7.33	0.42	0.90	2.8	0.88	1.16	GOOD	FIX
	72+00	27.08	1.4	6.0	2.0	0.0	71+50	26.25	1.2	2.9	0.94	0.138	0.0166	3.53	7.81	0.45	0.82	2.9	0.94	0.97	GOOD	GOOD
	71+50	26.25	1.2	2.0	2.0	0.0	71+00	25.34	1.5	3.0	1.14	0.111	0.0182	2.58	5.08	0.51	1.16	3.0	1.14	1.29	GOOD	FIX
S-51 sta 77+00 to 70+50 RT	71+00	25.34	1.5	2.0	2.0	0.0	70+50	23.27	3.4	3.1	0.95	0.099	0.0414	1.81	4.25	0.43	1.74	3.1	0.95	2.46	GOOD	FIX
S-51 sta 81+00 to 78+00 RT	81+00	44.47	1.8	2.0	2.0	0.0	80+00	42.99	2.7	0.2	0.73	0.401	0.0148	1.08	3.29	0.33	0.22	0.2	0.73	0.68	GOOD	GOOD
	80+00	42.99	2.7	2.0	2.0	0.0	79+00	40.78	1.5	0.5	0.73	0.245	0.0221	1.07	3.27	0.33	0.43	0.5	0.73	1.01	GOOD	GOOD
S-51 sta 82+00 to 78+00 RT	79+00	40.78	1.5	4.0	2.0	0.0	78+00	38.45	1.5	0.7	0.70	0.229	0.0233	1.45	4.42	0.33	0.47	0.7	0.70	1.01	GOOD	FIX
S-51 sta 81+00 to 84+00 RT	81+00	44.47	1.8	2.0	2.0	0.0	82+00	43.53	1.8	0.2	0.83	0.438	0.0094	1.37	3.70	0.37	0.17	0.2	0.83	0.49	GOOD	GOOD
	82+00	43.53	1.8	2.0	2.0	0.0	83+00	40.76	2.0	0.5	0.70	0.229	0.0277	0.97	3.12	0.31	0.50	0.5	0.70	1.20	GOOD	FIX
S-51 sta 81+00 to 84+00 RT	83+00	40.76	2.0	2.0	2.0	0.0	84+00	37.53	1.0	0.7	0.73	0.179	0.0323	1.05	3.24	0.32	0.71	0.7	0.73	1.46	GOOD	FIX

*** In cases where "fix" appears in the depth comment column the ditch segment was checked to confirm that the depth is okay. This issue typically occurs at the beginning (high point) of the ditch where there is little or no flow or at the end (low point) of the ditch where the ditch empties into a wetland.

Appendix D

EC Data Sheet

Appendix E

Storm Line Calculations

NODE DATA

I.D. NO.: **15-42**
 PROJ. NO.:
 DESCRIPTION: **Battery Park Rd over Black Mingo Ck**

STATE SC
COUNTY: WILLIAMSBURG

CREATED:	1/8/2016
REVISED:	2/11/2016
APPROVED:	

DESIGNED BY: **CAA**
 REVISED BY: **CAA**
 APPROVED BY: _____

[illegible]

AREA DATA

I.D. NO.: **15-42**
 PROJ. NO.:
 DESCRIPTION: **Battery Park Rd over Black Mingo Cr**

STATE **SC**
COUNTY: **WILLIAMSBURG**

CREATED: **1/8/2016**
 REVISED: **2/11/2016**
 APPROVED: _____

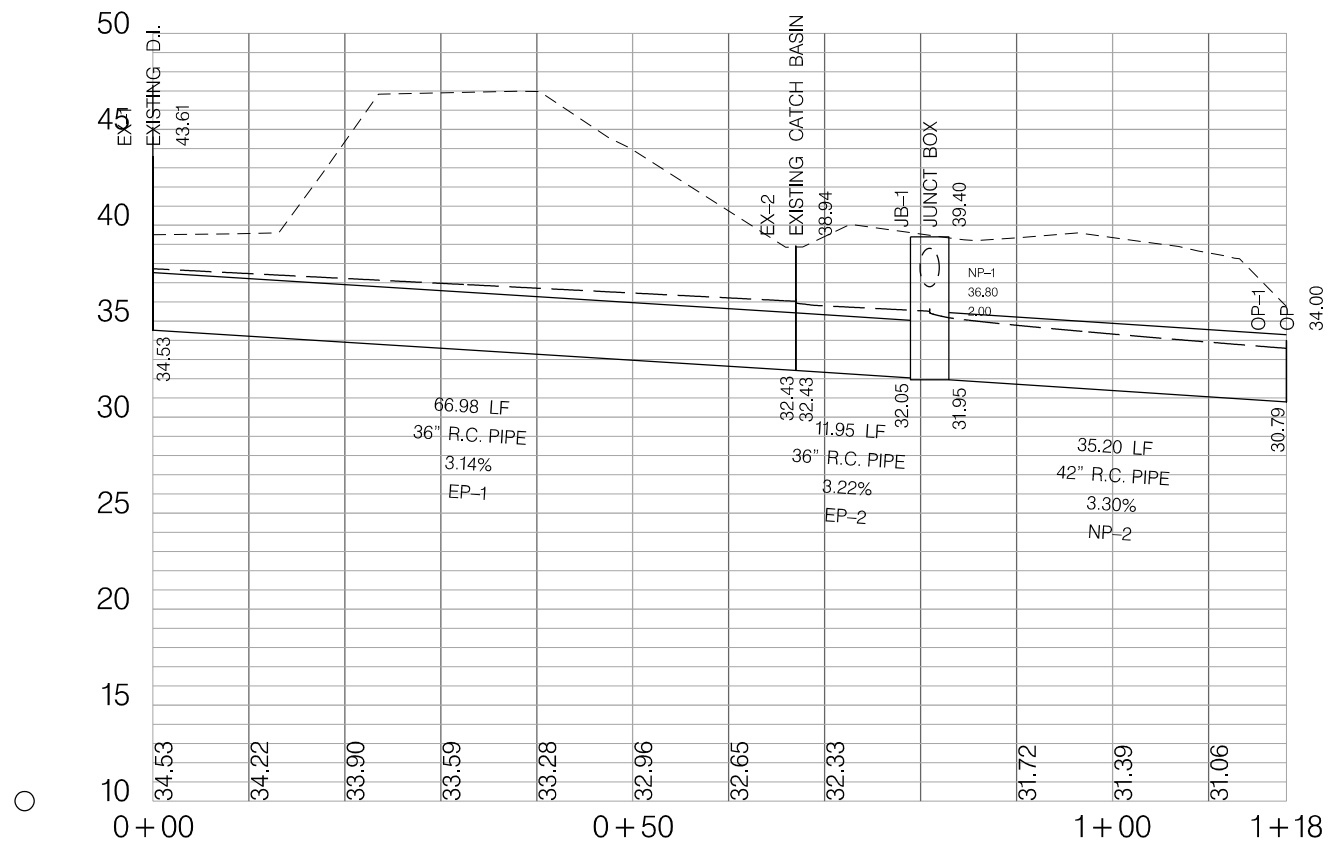
DESIGNED BY: **CAA**
 REVISED BY: **CAA**
 APPROVED BY: _____

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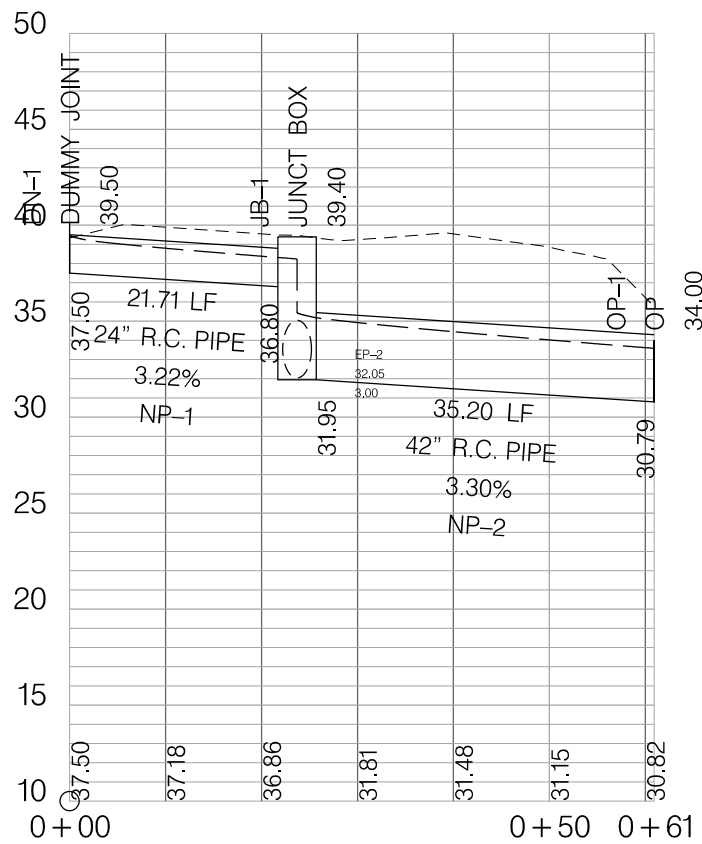
STATE: SC
COUNTY: WILLIAMSBURG

CREATED: **1/8/2016**
 REVISED: **2/11/2016**
 APPROVED: _____

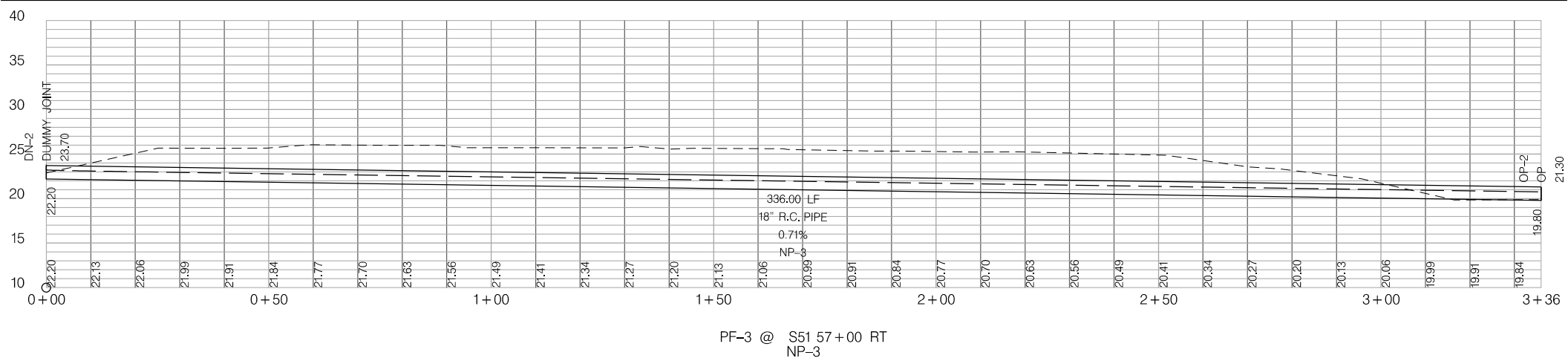
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PF-1 @ S51 85+40
 EP-1 TO NP-2
 Q25



PF-2 @ S51 85 + 40
 NP-1 TO NP-2
 Q25



Appendix F

Water Quality Information



1/18/2016

Watershed and Water Quality Information

General Information

Applicant Name: ICE

Permit Type: Construction

Latitude: 33.7108

Longitude: -79.5756

MS4 Designation: Not in designated area

Monitoring Station:

Within Coastal Critical Area: NO

Water Classification (Provisional): FW

Waterbody Name: Unnamed Trib

Entered Waterbody Name:

Parameter Descriptions

NH3N	Ammonia	FC	Fecal Coliform
CR	Chromium	FCB	Fecal Coliform (Shellfish)
CU	Copper	BIO	Macroinvertebrates (Bio)
HG	Mercury	TP	(Lakes) Phosphorus
NI	Nickel	TN	(Lakes) Nitrogen
PB	Lead	CHLA	(Lakes) Chlorophyll a
ZN	Zinc	ENTERO	(Beach) Enterococcus
DO	Dissolved Oxygen	HGF	Mercury (Fish)
PH	pH	PCB	PCB (Fish)

Impaired Status (downstream sites)

Station

F = Standards Fully Supported

A = Assessed at Upstream Station

T = Within TMDL Approved Watershed

N = Standards Not Supported

X = Parameter Not Assessed at Station

Parameters to be addressed (those not supporting standards)

Fish Consumption Advisory

TMDL Information - TMDL Parameters to be addressed

In TMDL Watershed: No

TMDL Site:

TMDL Report No:

TMDL Parameter:

TMDL Document Link:

Appendix G

Rip-Rap Calculations

RIP RAP CALCULATION SHEET

I.D. NO.: **15-42**
 PROJ. NO.:
 DESCRIPTION: **Battery Park Rd over Black Mingo Ck**

STATE SC
COUNTY: WILLIAMSBURG

CREATED: 1/15/16
REVISED: 2/17/16
APPROVED:

DESIGNED BY:	CAA
REVISED BY:	CAA
APPROVED BY:	

[illegible]

Appendix H

Bridge Deck Spread Calculations

Traffic Data
Q year 10
Interstate? NO
ADT 900 (2036)
Des Speed 45 mph
Rdy Class Rural Minor Collector

Bridge Profile
PVI Sta (ft): 68+50.00 PVC Sta: 67+50
PVI Elev (ft): 28.49 PVC Elev: 27.96
Vert Curv L (ft): 200.00 PVT Sta: 69+50
Back Tan g₁ (%): 0.53 PVT Elev: 27.99
Frnt Tan g₂ (%): -0.50 S_L (%): 0.50

Bridge Typical
Bridge: Cored Slab Rdy: Superead
T_{ALLOW} (ft): 11.00 S_x (%): 3.20
Beg Ap Slab/Bridge: 67+60 W_{OUT-OUT} (ft): 36
End Bridge/HP: 68+53 W_{CURB-CURB} (ft): 32.83
Note: HP @ 68+52.45

Flow
Q = C * I * A
I Source= FLORENCE
C = 0.9
I (in/hr) = 7.13
A (sf) = 3348
Q (cfs) = 0.493

Method 1: L=max allowable bridge length W/O scuppers. See eqn 18.2-1
n_{conc} = 0.016
k_g = 0.56
S_x (ft/ft) = 0.0320
S_L (ft/ft) = 0.0050 @ Bridge midpoint
W_p (ft) = 36.00 Bridge deck width
T_{MAX} (ft) = 11.00 Spread not allowed on eot
Q_{MAX} (cfs) = 4.768 (varies according to SL)
L_{MAX} (ft) = 899.3 (varies according to SL)

Method 1 Scupper Check
L_{MAX} < ? > L_{BRIDGE}
899.34 > 93.00
Scuppers Not Needed

If SL varies...
T needs to be checked at many points along bridge

Methd 2: hec21 calc (w/o Scuppers)
T (ft) = 4.70 FHWA toolbox
T (ft) = 4.75 HEC 21 method
...SPREAD CHECK CALCS...OK

Scupper Check per hec21 calcs
T_{ACTUAL} < ? > T_{ALLOW}
4.75 < 11.00
Scuppers Not Needed

T w/ Scuppers (if needed)
T (ft) FHWA Hyd toolbox
T (ft) HEC 21 method

Scupper Placement: NONE REQUIRED

REFERENCES

FLORENCE COUNTY

Tc (min)	I ₁₀ Value				I ₂₅ Value				I ₅₀ Value				I ₁₀₀ Value			
	a	b	c	I ₁₀ (in/hr)	a	b	c	I ₂₅ (in/hr)	a	b	c	I ₅₀ (in/hr)	a	b	c	I ₁₀₀ (in/hr)
10.0	267.809	31.360	1.009	6.25	280.164	29.533	0.997	7.17	288.486	28.295	0.989	7.86	296.134	27.130	0.982	8.57
5.0	267.809	31.360	1.009	7.13	280.164	29.533	0.997	8.20	288.486	28.295	0.989	9.02	296.134	27.130	0.982	9.85

Type of Facility		Design Flood Frequency	Allowable Water Spread
All Interstate Routes; Other Facilities with Design ADT > 10,000	≤ 45 mph	10-year	Shoulder + 3 ft
	> 45 mph	10-year	Shoulder
	Low point on bridge	50-year	Shoulder + 3 ft
Non-Interstate Routes and Other Facilities with Design ADT ≤ 10,000	≤ 45 mph	10-year	½ driving lane
	> 45 mph	10-year	Shoulder
	Low point on bridge	10-year	½ driving lane

HYDRAULIC DESIGN CRITERIA (For Bridge Decks)

Figure 18.2-1

18-6

April 2006

$$L = \frac{24,393.6(S_x^{1.67})(S^{0.5})(T^{2.67})}{Cn^2W} \quad (\text{Equation 18.2-1})$$

L = Maximum allowable bridge length without drainage inlets, ft
S = Longitudinal slope, ft/ft
S_x = Cross slope, ft/ft
W = Width of drained deck*, ft
C = Runoff coefficient**
i = Rainfall intensity, in/hr
n = Manning's n**
T = Maximum allowable spread, ft

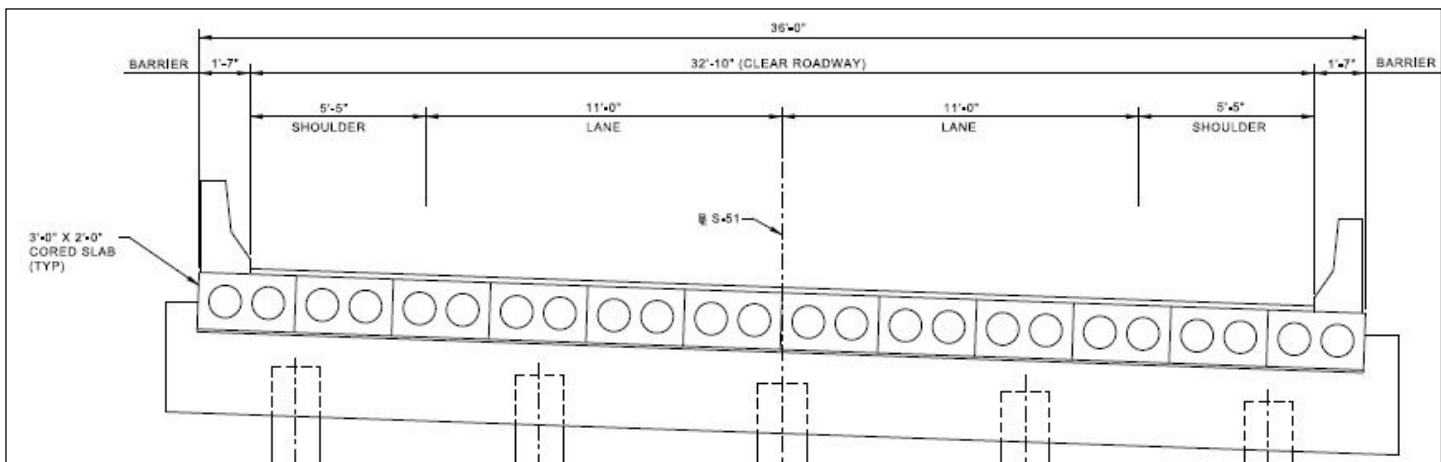
$$i = \frac{a}{(b + tc)^c}$$

i = rainfall intensity in inches per hour,
tc = time of concentration in minutes,
and a, b, and c are coefficients.

HEC 21 4.2 Gutters of uniform S_x
 $Q = \left(\frac{kg}{n}\right) S_x^{1.67} S^{0.5} T^{2.67}$
Q = Flow rate, cfs
kg = a constant.
n = manning's constant.
T = Width of flow (spread), ft.
S_x = Cross slope, ft/ft.
S = Longitudinal slope, ft/ft.
T = [Q*n / (Kg*S_x^{1.67}*SL^{0.5})]^{0.375}
H = T * S_x

Table 2.2. Modified weir and orifice flow equations for varying cross-slope and scupper diameter.

Longitudinal Slope (%)	Weir Flow Equations (cfs)	Orifice Flow Equations (cfs)
0.0	15.75 d ^{2.8} (aYH)	0.023125 d ² (aYH) ^{0.5}
0.2	0.505 d ^{1.5} (aYH)	0.027500 d ² (aYH) ^{0.7}
1.0	0.525 d ^{1.8} (aYH)	0.023750 d ² (aYH) ^{0.6}
2.0	1.700 d ^{1.8} (aYH)	0.024375 d ² (aYH) ^{0.6}
5.0	1.050 d ^{1.5} (aYH)	0.014375 d ² (aYH) ^{0.4}



I.D. NO.: 14-52
PROJ. NO.:
DESC: S51 / BATTERY PARK RD OVER BLACK MINGO CK
BRIDGE DECK ANALYSIS W/O SCUPPERS

STATE SC
COUNTY: WILLIAMSBURG

CREATED ON: 1/15/2016
REVISED ON:
APPROVED ON:

DESIGNED BY: CAA
REVISED BY:
APPROVED BY:

C_{impervious} = 0.9 n_{conc} = 0.016 i_(in/hr) = 7.128 K_g = 0.56 Scupper blockage(%) = 0

Notes	Inlet Dist. (ft)	Sec Sta.	Sec L (ft)	Sec W (ft)	Sec S _y (%)	Sec S _x (%)	Scupper Dia. (in)	Sec Flow + Incomin g Bypass (cfs)	Y value	H at Curb (in)	T (ft)	Weir Flow (cfs)	Orifice Flow (cfs)	Scupper Flow, Q _{in} (cfs)	Bypass Flow, Q _{by} (cfs)	Drain Efficiency (%)
HP		68+53														
		68+52	1.0	36.00	0.00	3.20		0.01	0.28	0.91	2.36	0.00	0.00	0.00	0.01	0
		68+51	1.0	36.00	0.01	3.20		0.01	0.28	0.95	2.46	0.00	0.00	0.00	0.01	0
		68+50	1.0	36.00	0.01	3.20		0.02	0.28	1.00	2.59	0.00	0.00	0.00	0.02	0
		68+49	1.0	36.00	0.02	3.20		0.02	0.28	1.04	2.71	0.00	0.00	0.00	0.02	0
		68+48	1.0	36.00	0.02	3.20		0.03	0.28	1.08	2.81	0.00	0.00	0.00	0.03	0
		68+47	1.0	36.00	0.03	3.20		0.03	0.28	1.11	2.90	0.00	0.00	0.00	0.03	0
		68+46	1.0	36.00	0.03	3.20		0.04	0.28	1.14	2.97	0.00	0.00	0.00	0.04	0
		68+45	1.0	36.00	0.04	3.20		0.04	0.28	1.17	3.04	0.00	0.00	0.00	0.04	0
		68+44	1.0	36.00	0.04	3.20		0.05	0.28	1.19	3.10	0.00	0.00	0.00	0.05	0
		68+43	1.0	36.00	0.05	3.20		0.05	0.28	1.22	3.16	0.00	0.00	0.00	0.05	0
		68+42	1.0	36.00	0.05	3.20		0.06	0.28	1.24	3.22	0.00	0.00	0.00	0.06	0
		68+41	1.0	36.00	0.06	3.20		0.06	0.28	1.26	3.27	0.00	0.00	0.00	0.06	0
		68+40	1.0	36.00	0.06	3.20		0.07	0.28	1.27	3.31	0.00	0.00	0.00	0.07	0
		68+39	1.0	36.00	0.07	3.20		0.07	0.28	1.29	3.36	0.00	0.00	0.00	0.07	0
		68+38	1.0	36.00	0.07	3.20		0.08	0.28	1.31	3.40	0.00	0.00	0.00	0.08	0
		68+37	1.0	36.00	0.08	3.20		0.08	0.28	1.32	3.44	0.00	0.00	0.00	0.08	0
		68+36	1.0	36.00	0.08	3.20		0.09	0.28	1.34	3.48	0.00	0.00	0.00	0.09	0
		68+35	1.0	36.00	0.09	3.20		0.10	0.28	1.35	3.51	0.00	0.00	0.00	0.10	0
		68+34	1.0	36.00	0.09	3.20		0.10	0.28	1.36	3.55	0.00	0.00	0.00	0.10	0
		68+33	1.0	36.00	0.10	3.20		0.11	0.28	1.38	3.58	0.00	0.00	0.00	0.11	0
		68+32	1.0	36.00	0.10	3.20		0.11	0.28	1.39	3.61	0.00	0.00	0.00	0.11	0
		68+31	1.0	36.00	0.11	3.20		0.12	0.28	1.40	3.65	0.00	0.00	0.00	0.12	0
		68+30	1.0	36.00	0.12	3.20		0.12	0.28	1.41	3.67	0.00	0.00	0.00	0.12	0
		68+29	1.0	36.00	0.12	3.20		0.13	0.28	1.42	3.70	0.00	0.00	0.00	0.13	0
		68+28	1.0	36.00	0.13	3.20		0.13	0.28	1.43	3.73	0.00	0.00	0.00	0.13	0
		68+27	1.0	36.00	0.13	3.20		0.14	0.28	1.44	3.76	0.00	0.00	0.00	0.14	0
		68+26	1.0	36.00	0.14	3.20		0.14	0.28	1.45	3.78	0.00	0.00	0.00	0.14	0
		68+25	1.0	36.00	0.14	3.20		0.15	0.28	1.46	3.81	0.00	0.00	0.00	0.15	0
		68+24	1.0	36.00	0.15	3.20		0.15	0.28	1.47	3.83	0.00	0.00	0.00	0.15	0
		68+23	1.0	36.00	0.15	3.20		0.16	0.28	1.48	3.86	0.00	0.00	0.00	0.16	0
		68+22	1.0	36.00	0.16	3.20		0.16	0.28	1.49	3.88	0.00	0.00	0.00	0.16	0
		68+21	1.0	36.00	0.16	3.20		0.17	0.28	1.50	3.90	0.00	0.00	0.00	0.17	0
		68+20	1.0	36.00	0.17	3.20		0.17	0.28	1.51	3.93	0.00	0.00	0.00	0.17	0
		68+19	1.0	36.00	0.17	3.20		0.18	0.28	1.52	3.95	0.00	0.00	0.00	0.18	0
		68+18	1.0	36.00	0.18	3.20		0.19	0.28	1.53	3.97	0.00	0.00	0.00	0.19	0
		68+17	1.0	36.00	0.18	3.20		0.19	0.28	1.53	3.99	0.00	0.00	0.00	0.19	0
		68+16	1.0	36.00	0.19	3.20		0.20	0.28	1.54	4.01	0.00	0.00	0.00	0.20	0
		68+15	1.0	36.00	0.19	3.20		0.20	0.28	1.55	4.03	0.00	0.00	0.00	0.20	0
		68+14	1.0	36.00	0.20	3.20		0.21	0.28	1.56	4.05	0.00	0.00	0.00	0.21	0
		68+13	1.0	36.00	0.20	3.20		0.21	0.28	1.56	4.07	0.00	0.00	0.00	0.21	0
		68+12	1.0	36.00	0.21	3.20		0.22	0.28	1.57	4.09	0.00	0.00	0.00	0.22	0
		68+11	1.0	36.00	0.21	3.20		0.22	0.28	1.58	4.11	0.00	0.00	0.00	0.22	0
		68+10	1.0	36.00	0.22	3.20		0.23	0.28	1.58	4.12	0.00	0.00	0.00	0.23	0
		68+09	1.0	36.00	0.22	3.20		0.23	0.28	1.59	4.14	0.00	0.00	0.00	0.23	0
		68+08	1.0	36.00	0.23	3.20		0.24	0.28	1.60	4.16	0.00	0.00	0.00	0.24	0
		68+07	1.0	36.00	0.23	3.20		0.24	0.28	1.60	4.18	0.00	0.00	0.00	0.24	0
		68+06	1.0	36.00	0.24	3.20		0.25	0.28	1.61	4.19	0.00	0.00	0.00	0.25	0
		68+05	1.0	36.00	0.24	3.20		0.25	0.28	1.62	4.21	0.00	0.00	0.00	0.25	0
		68+04	1.0	36.00	0.25	3.20		0.26	0.28	1.62	4.22	0.00	0.00	0.00	0.26	0
		68+03	1.0	36.00	0.25	3.20		0.27	0.28	1.63	4.24	0.00	0.00	0.00	0.27	0
		68+02	1.0	36.00	0.26	3.20		0.27	0.28	1.64	4.26	0.00	0.00	0.00	0.27	0
		68+01	1.0	36.00	0.26	3.20		0.28	0.28	1.64	4.27	0.00	0.00	0.00	0.28	0
		68+00	1.0	36.00	0.27	3.20		0.28	0.28	1.65	4.29	0.00	0.00	0.00	0.28	0
Bent		67+99	1.0	36.00	0.27	3.20		0.29	0.28	1.65	4.30	0.00	0.00	0.00	0.29	0
		67+98	1.0	36.00	0.28	3.20		0.29	0.28	1.66	4.32	0.00	0.00	0.00	0.29	0
		67+97	1.0	36.00	0.28	3.20		0.30	0.28	1.66	4.33	0.00	0.00	0.00	0.30	0
		67+96	1.0	36.00	0.29	3.20		0.30	0.28	1.67	4.34	0.00	0.00	0.00	0.30	0
		67+95	1.0	36.00	0.29	3.20		0.31	0.28	1.68	4.36	0.00	0.00	0.00	0.31	0
		67+94	1.0	36.00	0.30	3.20		0.31	0.28	1.68	4.37	0.00	0.00	0.00	0.31	0
		67+93	1.0	36.00	0.30	3.20		0.32	0.28	1.69	4.39	0.00	0.00	0.00	0.32	0
		67+92	1.0	36.00	0.31	3.20		0.32	0.28	1.69	4.40	0.00	0.00	0.00	0.32	0
		67+91	1.0	36.00	0.32	3.20		0.33	0.28	1.70	4.41	0.00	0.00	0.00	0.33	0
		67+90	1.0	36.00	0.32	3.20		0.33	0.28	1.70	4.43	0.00	0.00	0.00	0.33	0
		67+89	1.0	36.00	0.33	3.20		0.34	0.28	1.71	4.44	0.00	0.00	0.00	0.34	0
		67+88	1.0	36.00	0.33	3.20		0.34	0.28	1.71	4.45	0.00	0.00	0.00	0.34	0
		67+87	1.0	36.00	0.34	3.20		0.35	0.28	1.72	4.46	0.00	0.00	0.00	0.35	0
		67+86	1.0	36.00	0.34	3.20		0.36	0.28	1.72	4.48	0.00	0.00	0.00	0.36	0
		67+85	1.0	36.00	0.35	3.20		0.36	0.28	1.73	4.49	0.00	0.00	0.00	0.36	0
		67+84	1.0	36.00	0.35	3.20		0.37	0.28	1.73	4.50	0.00	0.00	0.00	0.37	0
		67+83	1.0	36.00	0.36	3.20		0.37	0.28	1.73	4.51	0.00	0.00	0.00	0.37	0
		67+82	1.0	36.00	0.36	3.20		0.38	0.28	1.74	4.53	0.00	0.00	0.00	0.38	0
		67+81	1.0	36.00	0.37	3.20		0.38	0.28	1.74	4.54	0.00	0.00	0.00	0.38	0

I.D. NO.: 14-52
PROJ. NO.:
DESC: S51 / BATTERY PARK RD OVER BLACK MINGO CK
BRIDGE DECK ANALYSIS W/O SCUPPERS

STATE SC
COUNTY: WILLIAMSBURG

CREATED ON: 1/15/2016
REVISED ON:
APPROVED ON:

DESIGNED BY: CAA
REVISED BY:
APPROVED BY:

C_{impervious} = 0.9 n_{conc} = 0.016 i_(in/hr) = 7.128 K_g = 0.56 Scupper blockage(%) = 0

Notes	Inlet Dist. (ft)	Sec Sta.	Sec L (ft)	Sec W (ft)	Sec S ₁ (%)	Sec S ₂ (%)	Scupper Dia. (in)	Sec Flow + Incomin g Bypass (cfs)	Y value	H at Curb (in)	T (ft)	Weir Flow (cfs)	Orifice Flow (cfs)	Scupper Flow, Q _{in} (cfs)	Bypass Flow, Q _{by} (cfs)	Drain Efficiency (%)
begin bridge		67+80	1.0	36.00	0.37	3.20		0.39	0.28	1.75	4.55	0.00	0.00	0.00	0.39	0
		67+79	1.0	36.00	0.38	3.20		0.39	0.28	1.75	4.56	0.00	0.00	0.00	0.39	0
		67+78	1.0	36.00	0.38	3.20		0.40	0.28	1.76	4.57	0.00	0.00	0.00	0.40	0
		67+77	1.0	36.00	0.39	3.20		0.40	0.28	1.76	4.58	0.00	0.00	0.00	0.40	0
		67+76	1.0	36.00	0.39	3.20		0.41	0.28	1.77	4.59	0.00	0.00	0.00	0.41	0
		67+75	1.0	36.00	0.40	3.20		0.41	0.28	1.77	4.61	0.00	0.00	0.00	0.41	0
		67+74	1.0	36.00	0.40	3.20		0.42	0.28	1.77	4.62	0.00	0.00	0.00	0.42	0
		67+73	1.0	36.00	0.41	3.20		0.42	0.28	1.78	4.63	0.00	0.00	0.00	0.42	0
		67+72	1.0	36.00	0.41	3.20		0.43	0.28	1.78	4.64	0.00	0.00	0.00	0.43	0
		67+71	1.0	36.00	0.42	3.20		0.43	0.28	1.79	4.65	0.00	0.00	0.00	0.43	0
		67+70	1.0	36.00	0.42	3.20		0.44	0.28	1.79	4.66	0.00	0.00	0.00	0.44	0
		67+69	1.0	36.00	0.43	3.20		0.45	0.28	1.79	4.67	0.00	0.00	0.00	0.45	0
		67+68	1.0	36.00	0.43	3.20		0.45	0.28	1.80	4.68	0.00	0.00	0.00	0.45	0
		67+67	1.0	36.00	0.44	3.20		0.46	0.28	1.80	4.69	0.00	0.00	0.00	0.46	0
		67+66	1.0	36.00	0.44	3.20		0.46	0.28	1.81	4.70	0.00	0.00	0.00	0.46	0
		67+65	1.0	36.00	0.45	3.20		0.47	0.28	1.81	4.71	0.00	0.00	0.00	0.47	0
		67+64	1.0	36.00	0.45	3.20		0.47	0.28	1.81	4.72	0.00	0.00	0.00	0.47	0
		67+63	1.0	36.00	0.46	3.20		0.48	0.28	1.82	4.73	0.00	0.00	0.00	0.48	0
		67+62	1.0	36.00	0.46	3.20		0.48	0.28	1.82	4.74	0.00	0.00	0.00	0.48	0
		67+61	1.0	36.00	0.47	3.20		0.49	0.28	1.83	4.75	0.00	0.00	0.00	0.49	0
		67+60	1.0	36.00	0.47	3.20		0.49	0.28	1.83	4.76	0.00	0.00	0.00	0.49	0
		67+59	1.0	36.00	0.48	3.20		0.50	0.28	1.83	4.77	0.00	0.00	0.00	0.50	0
		67+58	1.0	36.00	0.48	3.20		0.50	0.28	1.84	4.78	0.00	0.00	0.00	0.50	0
		67+57	1.0	36.00	0.49	3.20		0.51	0.28	1.84	4.79	0.00	0.00	0.00	0.51	0
		67+56	1.0	36.00	0.49	3.20		0.51	0.28	1.84	4.80	0.00	0.00	0.00	0.51	0
		67+55	1.0	36.00	0.50	3.20		0.52	0.28	1.85	4.81	0.00	0.00	0.00	0.52	0
		67+54	1.0	36.00	0.50	3.20		0.52	0.28	1.85	4.81	0.00	0.00	0.00	0.52	0
		67+53	1.0	36.00	0.51	3.20		0.53	0.28	1.85	4.82	0.00	0.00	0.00	0.53	0
		67+52	1.0	36.00	0.51	3.20		0.54	0.28	1.86	4.83	0.00	0.00	0.00	0.54	0
		67+51	1.0	36.00	0.52	3.20		0.54	0.28	1.86	4.84	0.00	0.00	0.00	0.54	0
		67+50	1.0	36.00	0.53	3.20		0.55	0.28	1.86	4.85	0.00	0.00	0.00	0.55	0
		67+49	1.0	36.00	0.53	3.20		0.55	0.28	1.87	4.87	0.00	0.00	0.00	0.55	0
		67+48	1.0	36.00	0.53	3.20		0.56	0.28	1.88	4.89	0.00	0.00	0.00	0.56	0
		67+47	1.0	36.00	0.53	3.20		0.56	0.28	1.88	4.90	0.00	0.00	0.00	0.56	0
		67+46	1.0	36.00	0.53	3.20		0.57	0.28	1.89	4.92	0.00	0.00	0.00	0.57	0
		67+45	1.0	36.00	0.53	3.20		0.57	0.28	1.90	4.94	0.00	0.00	0.00	0.57	0
		67+44	1.0	36.00	0.53	3.20		0.58	0.28	1.90	4.95	0.00	0.00	0.00	0.58	0
		67+43	1.0	36.00	0.53	3.20		0.58	0.28	1.91	4.97	0.00	0.00	0.00	0.58	0
		67+42	1.0	36.00	0.53	3.20		0.59	0.28	1.92	4.99	0.00	0.00	0.00	0.59	0
approach slab		67+41	1.0	36.00	0.53	3.20		0.59	0.28	1.92	5.01	0.00	0.00	0.00	0.59	0

HP		68+53														
bent		68+54	1.0	36.00	0.01	3.20		0.01	0.28	0.72	1.87	0.00	0.00	0.00	0.01	0
		68+55	1.0	36.00	0.01	3.20		0.01	0.28	0.85	2.21	0.00	0.00	0.00	0.01	0
		68+56	1.0	36.00	0.02	3.20		0.02	0.28	0.93	2.42	0.00	0.00	0.00	0.02	0
		68+57	1.0	36.00	0.02	3.20		0.02	0.28	0.99	2.57	0.00	0.00	0.00	0.02	0
		68+58	1.0	36.00	0.03	3.20		0.03	0.28	1.04	2.69	0.00	0.00	0.00	0.03	0
		68+59	1.0	36.00	0.03	3.20		0.03	0.28	1.07	2.80	0.00	0.00	0.00	0.03	0
		68+60	1.0	36.00	0.04	3.20		0.04	0.28	1.11	2.89	0.00	0.00	0.00	0.04	0
		68+61	1.0	36.00	0.04	3.20		0.04	0.28	1.14	2.96	0.00	0.00	0.00	0.04	0
		68+62	1.0	36.00	0.05	3.20		0.05	0.28	1.17	3.03	0.00	0.00	0.00	0.05	0
		68+63	1.0	36.00	0.05	3.20		0.05	0.28	1.19	3.10	0.00	0.00	0.00	0.05	0
		68+64	1.0	36.00	0.06	3.20		0.06	0.28	1.21	3.16	0.00	0.00	0.00	0.06	0
		68+65	1.0	36.00	0.06	3.20		0.06	0.28	1.23	3.21	0.00	0.00	0.00	0.06	0
		68+66	1.0	36.00	0.07	3.20		0.07	0.28	1.25	3.26	0.00	0.00	0.00	0.07	0
		68+67	1.0	36.00	0.07	3.20		0.07	0.28	1.27	3.31	0.00	0.00	0.00	0.07	0
		68+68	1.0	36.00	0.08	3.20		0.08	0.28	1.29	3.35	0.00	0.00	0.00	0.08	0
		68+69	1.0	36.00	0.08	3.20		0.08	0.28	1.31	3.40	0.00	0.00	0.00	0.08	0
		68+70	1.0	36.00	0.09	3.20		0.09	0.28	1.32	3.44	0.00	0.00	0.00	0.09	0
		68+71	1.0	36.00	0.10	3.20		0.10	0.28	1.34	3.47	0.00	0.00	0.00	0.10	0
		68+72	1.0	36.00	0.10	3.20		0.10	0.28	1.35	3.51	0.00	0.00	0.00	0.10	0
		68+73	1.0	36.00	0.11	3.20		0.11	0.28	1.36	3.55	0.00	0.00	0.00	0.11	0
		68+74	1.0	36.00	0.11	3.20		0.11	0.28	1.38	3.58	0.00	0.00	0.00	0.11	0
		68+75	1.0	36.00	0.12	3.20		0.12	0.28	1.39	3.61	0.00	0.00	0.00	0.12	0
		68+76	1.0	36.00	0.12	3.20		0.12	0.28	1.40	3.64	0.00	0.00	0.00	0.12	0
		68+77	1.0	36.00	0.13	3.20		0.13	0.28	1.41	3.67	0.00	0.00	0.00	0.13	0
		68+78	1.0	36.00	0.13	3.20		0.13	0.28	1.42	3.70	0.00	0.00	0.00	0.13	0
		68+79	1.0	36.00	0.14	3.20		0.14	0.28	1.43	3.73	0.00	0.00	0.00	0.14	0
		68+80	1.0	36.00	0.14	3.20		0.14	0.28	1.44	3.76	0.00	0.00	0.00	0.14	0
		68+81	1.0	36.00	0.15	3.20		0.15	0.28	1.45	3.78	0.00	0.00	0.00	0.15	0
		68+82	1.0	36.00	0.15	3.20		0.15	0.28	1.46	3.81	0.00	0.00	0.00	0.15	0
		68+83	1.0	36.00	0.16	3.20		0.16	0.28	1.47	3.83	0.00	0.00	0.00	0.16	0
		68+84	1.0	36.00	0.16	3.20		0.16	0.28	1.48	3.86	0.00	0.00	0.00	0.16	0
		68+85	1.0	36.00	0.17	3.20		0.17	0.28	1.49	3.88	0.00	0.00	0.00	0.17	0

I.D. NO.: 14-52
PROJ. NO.:
DESC: S51 / BATTERY PARK RD OVER BLACK MINGO CK
BRIDGE DECK ANALYSIS W/O SCUPPERS

STATE SC
COUNTY: WILLIAMSBURG

CREATED ON: 1/15/2016
REVISED ON:
APPROVED ON:

DESIGNED BY: CAA
REVISED BY:
APPROVED BY:

C_{impervious} = 0.9 n_{conc} = 0.016 i_(in/hr) = 7.128 K_g = 0.56 Scupper blockage(%) = 0

Notes	Inlet Dist. (ft)	Sec Sta.	Sec L (ft)	Sec W (ft)	Sec S _y (%)	Sec S _x (%)	Scupper Dia. (in)	Sec Flow + Incomin g Bypass (cfs)	Y value	H at Curb (in)	T (ft)	Weir Flow (cfs)	Orifice Flow (cfs)	Scupper Flow, Q _{in} (cfs)	Bypass Flow, Q _{by} (cfs)	Drain Efficien cy (%)
end bridge		68+86	1.0	36.00	0.17	3.20		0.17	0.28	1.50	3.90	0.00	0.00	0.00	0.17	0
		68+87	1.0	36.00	0.18	3.20		0.18	0.28	1.51	3.92	0.00	0.00	0.00	0.18	0
		68+88	1.0	36.00	0.18	3.20		0.19	0.28	1.52	3.95	0.00	0.00	0.00	0.19	0
		68+89	1.0	36.00	0.19	3.20		0.19	0.28	1.53	3.97	0.00	0.00	0.00	0.19	0
		68+90	1.0	36.00	0.19	3.20		0.20	0.28	1.53	3.99	0.00	0.00	0.00	0.20	0
		68+91	1.0	36.00	0.20	3.20		0.20	0.28	1.54	4.01	0.00	0.00	0.00	0.20	0
		68+92	1.0	36.00	0.20	3.20		0.21	0.28	1.55	4.03	0.00	0.00	0.00	0.21	0
		68+93	1.0	36.00	0.21	3.20		0.21	0.28	1.56	4.05	0.00	0.00	0.00	0.21	0
		68+94	1.0	36.00	0.21	3.20		0.22	0.28	1.56	4.07	0.00	0.00	0.00	0.22	0
		68+95	1.0	36.00	0.22	3.20		0.22	0.28	1.57	4.09	0.00	0.00	0.00	0.22	0
		68+96	1.0	36.00	0.22	3.20		0.23	0.28	1.58	4.10	0.00	0.00	0.00	0.23	0
		68+97	1.0	36.00	0.23	3.20		0.23	0.28	1.58	4.12	0.00	0.00	0.00	0.23	0
		68+98	1.0	36.00	0.23	3.20		0.24	0.28	1.59	4.14	0.00	0.00	0.00	0.24	0
		68+99	1.0	36.00	0.24	3.20		0.24	0.28	1.60	4.16	0.00	0.00	0.00	0.24	0
		69+00	1.0	36.00	0.24	3.20		0.25	0.28	1.60	4.17	0.00	0.00	0.00	0.25	0
		69+01	1.0	36.00	0.25	3.20		0.25	0.28	1.61	4.19	0.00	0.00	0.00	0.25	0
		69+02	1.0	36.00	0.25	3.20		0.26	0.28	1.62	4.21	0.00	0.00	0.00	0.26	0
		69+03	1.0	36.00	0.26	3.20		0.27	0.28	1.62	4.22	0.00	0.00	0.00	0.27	0
		69+04	1.0	36.00	0.26	3.20		0.27	0.28	1.63	4.24	0.00	0.00	0.00	0.27	0
		69+05	1.0	36.00	0.27	3.20		0.28	0.28	1.64	4.25	0.00	0.00	0.00	0.28	0
		69+06	1.0	36.00	0.27	3.20		0.28	0.28	1.64	4.27	0.00	0.00	0.00	0.28	0
		69+07	1.0	36.00	0.28	3.20		0.29	0.28	1.65	4.29	0.00	0.00	0.00	0.29	0
		69+08	1.0	36.00	0.28	3.20		0.29	0.28	1.65	4.30	0.00	0.00	0.00	0.29	0
		69+09	1.0	36.00	0.29	3.20		0.30	0.28	1.66	4.31	0.00	0.00	0.00	0.30	0
		69+10	1.0	36.00	0.30	3.20		0.30	0.28	1.66	4.33	0.00	0.00	0.00	0.30	0
		69+11	1.0	36.00	0.30	3.20		0.31	0.28	1.67	4.34	0.00	0.00	0.00	0.31	0
		69+12	1.0	36.00	0.31	3.20		0.31	0.28	1.67	4.36	0.00	0.00	0.00	0.31	0
		69+13	1.0	36.00	0.31	3.20		0.32	0.28	1.68	4.37	0.00	0.00	0.00	0.32	0
		69+14	1.0	36.00	0.32	3.20		0.32	0.28	1.69	4.38	0.00	0.00	0.00	0.32	0
		69+15	1.0	36.00	0.32	3.20		0.33	0.28	1.69	4.40	0.00	0.00	0.00	0.33	0
		69+16	1.0	36.00	0.33	3.20		0.33	0.28	1.70	4.41	0.00	0.00	0.00	0.33	0
		69+17	1.0	36.00	0.33	3.20		0.34	0.28	1.70	4.42	0.00	0.00	0.00	0.34	0
		69+18	1.0	36.00	0.34	3.20		0.34	0.28	1.71	4.44	0.00	0.00	0.00	0.34	0
		69+19	1.0	36.00	0.34	3.20		0.35	0.28	1.71	4.45	0.00	0.00	0.00	0.35	0
		69+20	1.0	36.00	0.35	3.20		0.36	0.28	1.72	4.46	0.00	0.00	0.00	0.36	0
		69+21	1.0	36.00	0.35	3.20		0.36	0.28	1.72	4.48	0.00	0.00	0.00	0.36	0
		69+22	1.0	36.00	0.36	3.20		0.37	0.28	1.73	4.49	0.00	0.00	0.00	0.37	0
		69+23	1.0	36.00	0.36	3.20		0.37	0.28	1.73	4.50	0.00	0.00	0.00	0.37	0
		69+24	1.0	36.00	0.37	3.20		0.38	0.28	1.73	4.51	0.00	0.00	0.00	0.38	0
		69+25	1.0	36.00	0.37	3.20		0.38	0.28	1.74	4.52	0.00	0.00	0.00	0.38	0
		69+26	1.0	36.00	0.38	3.20		0.39	0.28	1.74	4.54	0.00	0.00	0.00	0.39	0
		69+27	1.0	36.00	0.38	3.20		0.39	0.28	1.75	4.55	0.00	0.00	0.00	0.39	0
		69+28	1.0	36.00	0.39	3.20		0.40	0.28	1.75	4.56	0.00	0.00	0.00	0.40	0
		69+29	1.0	36.00	0.39	3.20		0.40	0.28	1.76	4.57	0.00	0.00	0.00	0.40	0
		69+30	1.0	36.00	0.40	3.20		0.41	0.28	1.76	4.58	0.00	0.00	0.00	0.41	0
		69+31	1.0	36.00	0.40	3.20		0.41	0.28	1.77	4.59	0.00	0.00	0.00	0.41	0
		69+32	1.0	36.00	0.41	3.20		0.42	0.28	1.77	4.60	0.00	0.00	0.00	0.42	0
		69+33	1.0	36.00	0.41	3.20		0.42	0.28	1.77	4.62	0.00	0.00	0.00	0.42	0
		69+34	1.0	36.00	0.42	3.20		0.43	0.28	1.78	4.63	0.00	0.00	0.00	0.43	0
		69+35	1.0	36.00	0.42	3.20		0.43	0.28	1.78	4.64	0.00	0.00	0.00	0.43	0
		69+36	1.0	36.00	0.43	3.20		0.44	0.28	1.79	4.65	0.00	0.00	0.00	0.44	0
		69+37	1.0	36.00	0.43	3.20		0.45	0.28	1.79	4.66	0.00	0.00	0.00	0.45	0
		69+38	1.0	36.00	0.44	3.20		0.45	0.28	1.79	4.67	0.00	0.00	0.00	0.45	0
		69+39	1.0	36.00	0.44	3.20		0.46	0.28	1.80	4.68	0.00	0.00	0.00	0.46	0
		69+40	1.0	36.00	0.45	3.20		0.46	0.28	1.80	4.69	0.00	0.00	0.00	0.46	0
		69+41	1.0	36.00	0.45	3.20		0.47	0.28	1.81	4.70	0.00	0.00	0.00	0.47	0
		69+42	1.0	36.00	0.46	3.20		0.47	0.28	1.81	4.71	0.00	0.00	0.00	0.47	0
		69+43	1.0	36.00	0.46	3.20		0.48	0.28	1.81	4.72	0.00	0.00	0.00	0.48	0
		69+44	1.0	36.00	0.47	3.20		0.48	0.28	1.82	4.73	0.00	0.00	0.00	0.48	0
approach slab		69+45	1.0	36.00	0.47	3.20		0.49	0.28	1.82	4.74	0.00	0.00	0.00	0.49	0

Hydraulic Analysis Report

Project Data

Project Title: Battery Park Rd over Mingo Creek
Designer: CAA
Project Date: Wednesday, December 30, 2015
Project Units: U.S. Customary Units
Notes:

Curb and Gutter Analysis: T Check W/O Scuppers Beg Section

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0050 ft/ft
Cross-Slope of Pavement: 0.0320 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0160
Gutter Width: 2.0000 ft
Design Flow: 0.4930 cfs

Gutter Result Parameters

Width of Spread: 4.6937 ft
Gutter Depression: 0.0000 in
Area of Flow: 0.3525 ft²
Eo (Gutter Flow to Total Flow): 0.7730
Gutter Depth at Curb: 1.8024 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Grate
Grate Type: P - 1-7/8
Grate Width: 0.0000 ft
Grate Length: 0.0000 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 0.0000 cfs
Bypass Flow: 0.4930 cfs
Approach Velocity: 1.3986 ft/s
Splash-over Velocity: 2.2186 ft/s
Efficiency: 0.0000

Hydraulic Analysis Report

Project Data

Project Title: Battery Park Rd over Mingo Creek
Designer: CAA
Project Date: Wednesday, December 30, 2015
Project Units: U.S. Customary Units
Notes:

Curb and Gutter Analysis: T Check W/O Scuppers End Section

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0037 ft/ft
Cross-Slope of Pavement: 0.0320 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0160
Gutter Width: 2.0000 ft
Design Flow: 0.3800 cfs

Gutter Result Parameters

Width of Spread: 4.5044 ft
Gutter Depression: 0.0000 in
Area of Flow: 0.3246 ft²
Eo (Gutter Flow to Total Flow): 0.7914
Gutter Depth at Curb: 1.7297 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Grate
Grate Type: P - 1-7/8
Grate Width: 0.0000 ft
Grate Length: 0.0000 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 0.0000 cfs
Bypass Flow: 0.3800 cfs
Approach Velocity: 1.1706 ft/s
Splash-over Velocity: 2.2186 ft/s
Efficiency: 0.0000