



Memo

Project: SCDOT CLRB Package 21

Subject: Preliminary Hydraulic Analysis

Route: Road S-37-133 (Burns Mill Rd.) Bridge over Little Cane Creek (Asset ID 1893)

Date: March 10, 2025

To: SCDOT

McCormick Taylor is providing preliminary hydrologic and hydraulic assessment of the Little Cane Creek Bridge Replacement along Road S-23-133 (Burns Mill Rd.) in Oconee County, South Carolina. Burns Mill Road in the vicinity of Little Cane Creek is designated as a Secondary Route and provides access to residential and rural areas. The Flood Insurance Study (FIS) for Oconee County and Flood Insurance Rate Map (FIRM) Panel No. 45073C0195D (attached) indicates the project is located in a Special Flood Hazard Area Zone AE without established floodways.

Model Setup:

A HEC-RAS model was provided by the SCDOT for Little Cane Creek. However, the vicinity of the S-133 bridge was not included in the model extents. Therefore, HEC-RAS v6.3 was used to construct the existing conditions, unrestricted conditions, and proposed conditions models using publicly available LiDAR and surveys provided by SCDOT. The model extends approximately 2,000 feet downstream and approximately 400 feet upstream of the bridge. The main channel roughness was assumed to be $n=0.035$. Manning's roughness in the floodplain was determined by land cover from the 2019 USGS National Land Cover Database.

The USGS Rural and Urban regression equations using the StreamStats web application was used to estimate flow rates for a drainage area of 14.3 square miles at the bridge. The SCS Unit Hydrograph method was used to develop the watershed flows using land cover and soils data from the NLCD and USDA, respectively, to compare with the USGS flow rates. The flows used for this analysis are shown in Table 1. The USGS flows were used for the analysis.

Table 1: Comparison of flows

Design Event (% AEP)	SCS Unit Hydrograph (cfs)	USGS StreamStats
2 YR (50% AEP)	1136	832
10 YR (10% AEP)	2721	1900
25 YR (4% AEP)	3720	2520
50 YR (2% AEP)	4743	3070
100 YR (1% AEP)	5759	3610
500 YR (0.2% AEP)	-	4870

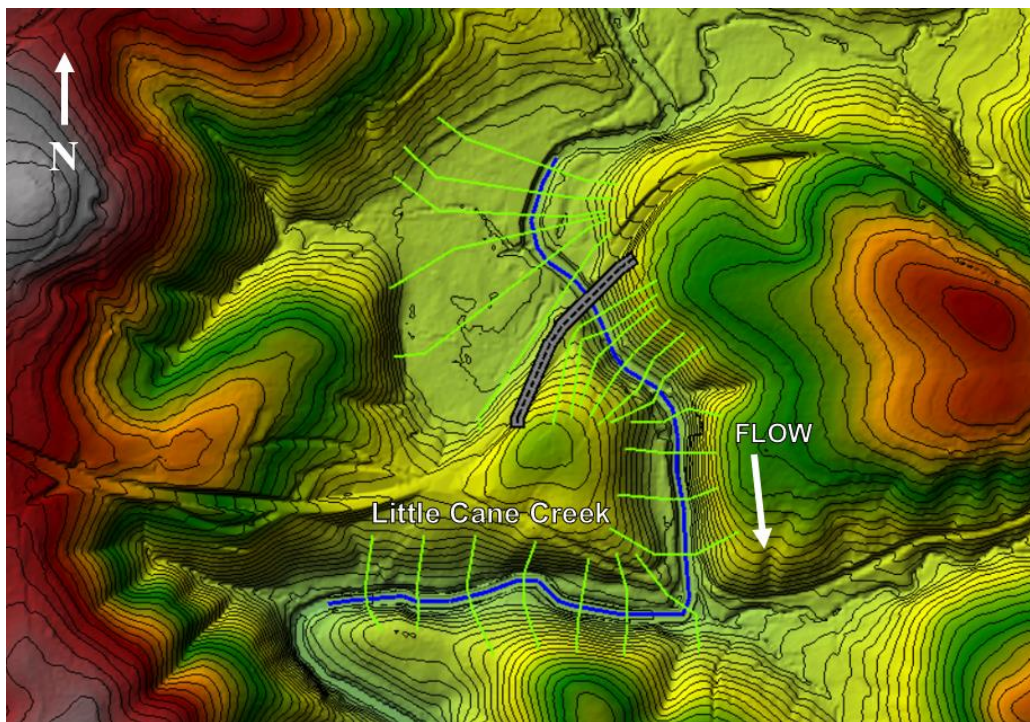


Figure 1: Little Cane Creek model layout (S-37-133)

A sensitivity analysis was completed on the unrestricted conditions model to verify the extents of the model. The analysis was performed by revising the downstream boundary conditions +/- 3 ft and comparing the resulting water surface elevations near the bridge location (RS 2049). The results of the sensitivity analysis are shown below.

Table 2: Sensitivity analysis

100-Year (1% AEP) Water Surface Elevations – Sensitivity Analysis			
RS	Unrestricted WSE (ft)	+3-ft WSE (ft)	-3-ft WSE (ft)
2485	851.93	851.93	851.93
2409	851.98	851.98	851.98
2344	851.70	851.70	851.70
2295	851.87	851.87	851.87
2203	851.68	851.68	851.68
2111	851.99	851.99	851.99
1984	850.90	850.90	850.90
1937	850.61	850.61	850.61
1895	850.66	850.66	850.66
1825	850.50	850.50	850.50
1756	847.98	847.98	847.98
1703	847.94	847.93	847.94
1616	847.76	847.76	847.76
1510	846.12	846.12	846.12
1378	845.37	845.36	845.37
1221	843.49	843.51	843.49
1069	844.00	844.02	844.00
889	842.32	842.40	842.32
753	841.09	841.70	841.09
568	840.33	841.36	840.35
404	839.45	841.01	839.51
257	838.62	840.75	838.78
109	837.53	840.53	*836.71

*Flow depth defaulted to critical depth

The sensitivity analysis indicates that the model has sufficient downstream length to negate any effects of fluctuations in the downstream boundary condition to the water surface elevations at the project site.

Design Criteria:

Burns Mill Rd. is classified as a secondary route. Secondary route crossings should be designed based on the 25-year design event as indicated in the *SCDOT Requirements for Hydraulic Design Studies*. Based on the Flood Insurance Study (FIS) for Fairfield County and Flood Insurance Rate Map (FIRM) Panel No. 45073C0195D the project is located in a Special Flood Hazard Area Zone AE without floodways. The bridge will therefore be designed based on the following criteria:

1. The minimum low chord elevation shall be the 25-year (4% AEP) water surface elevation plus 2-ft of freeboard.
2. The 100-year (1% AEP) should not overtop, while maintaining free-surface flow.
3. The backwater for the 100-year (1% AEP) design event is one (1) foot or less when compared to the unrestricted or natural conditions.
4. The proposed bridge should not create more backwater than the existing bridge.

It is preferred by the SCDOT that all structures and roadway components meet the requirements for a finding of “No Impact”. The S-133 bridge over Little Cane Creek is located within a FEMA Flood Zone AE without floodways. Thus there can be no increase in the 1% AEP flood profile at published and unpublished cross sections.

Existing Bridge Analysis:

The existing bridge consists of four (4) 30 ft spans for a total bridge length of 120 ft. The bridge has a breadth of 28 ft and a deck thickness of 1.8 ft, supported by timber piers. Ineffective flows upstream and downstream of the proposed bridge were set based on assumed 1.5:1 expansion and 1:1 contraction ratio.

The existing roadway profile was extracted from surveys provided by SCDOT. Based on the project surveys and existing bridge plans, the existing bridge low chord was estimated as 855.83.

Preliminary Bridge Analysis:

A three-span bridge with total length 200 ft is proposed consisting of a 100-ft central box beam span across the main channel and a cored slab span on each side (40 ft and 60 ft). The preliminary bridge considered has a total width of 36 ft and the low chord was set to an elevation of 866.73. The Road S-37-133 crossing is located at RS 2049.

Ineffective flows upstream and downstream of the proposed bridge were set based on assumed 1.5:1 expansion and 1:1 contraction ratios and sloping abutments were added.

Table 3 shows the resulting water surface elevations in the project area for the existing and preliminary bridge for the 25-year (4% AEP) event.

The resulting water surface elevation upstream of the bridge was used to check the required minimum bridge low chord elevation for the preliminary bridge vs the existing low chord elevation.

Existing low chord (855.83) > Existing WSE (850.44) + 2.0 ft F.B.

Proposed low chord (866.73) > Proposed WSE (850.33) + 2.0 ft F.B.

In addition to the freeboard requirement, the *SCDOT Requirements for Hydraulic Design Studies*, states that the proposed bridge must not be subject to pressurized flow for the 100-year design event and produce less than 1' of backwater over natural (unrestricted) conditions. The resulting water surface elevations along the stream are presented in Table 4.

Table 3: 25-year design event water surface elevations

25-Year (4% AEP) Design Event			
RS	Existing 120' Bridge WSE (ft)	Preliminary 200' Bridge WSE (ft)	Difference (ft)
2485	850.65	850.55	-0.10
2409	850.68	850.58	-0.10
2344	850.50	850.39	-0.11
2295	850.58	850.47	-0.11
2203	850.44	850.33	-0.11
2111	850.44	850.33	-0.11
2049	Road S-37-133		
1984	849.05	849.05	0.00
1937	848.82	848.82	0.00
1895	848.85	848.85	0.00
1825	848.72	848.72	0.00
1756	846.57	846.57	0.00
1703	846.21	846.21	0.00
1616	846.01	846.01	0.00
1510	844.66	844.66	0.00
1378	843.88	843.88	0.00
1221	842.43	842.43	0.00
1069	842.34	842.34	0.00
889	840.94	840.94	0.00
753	839.88	839.88	0.00
568	838.98	838.98	0.00
404	838.00	838.00	0.00
257	837.23	837.23	0.00
109	836.20	836.20	0.00

Table 4: 100-year water surface elevations and backwater comparison

100-Year (1% AEP) Design Event					
RS	Natural WSE (ft)	Existing 120' Bridge WSE (ft)	Existing Backwater (ft)	Preliminary 200' Bridge WSE (ft)	Preliminary Backwater (ft)
2485	851.93	852.56	+0.63	852.29	+0.36
2409	851.98	852.61	+0.63	852.34	+0.36
2344	851.70	852.44	+0.74	852.14	+0.44
2295	851.87	852.58	+0.71	852.29	+0.32
2203	851.68	852.56	+0.88	852.11	+0.43
2111	851.99	852.60	+0.61	852.24	+0.25
1937	Road S-37-133				
1895	850.90	850.96	+0.06	850.96	+0.06
1825	850.61	850.61	+0.00	850.61	+0.00
1756	850.66	850.66	+0.00	850.66	+0.00
1703	850.50	850.50	+0.00	850.50	+0.00
1616	847.98	847.98	+0.00	847.98	+0.00
1510	847.94	847.94	+0.00	847.94	+0.00
1378	847.76	847.76	+0.00	847.76	+0.00
1221	846.12	846.12	+0.00	846.12	+0.00
1069	845.37	845.37	+0.00	845.37	+0.00
889	843.49	843.49	+0.00	843.49	+0.00
753	844.00	844.00	+0.00	844.00	+0.00
568	842.32	842.32	+0.00	842.32	+0.00
404	841.09	841.09	+0.00	841.09	+0.00
257	840.33	840.33	+0.00	840.33	+0.00
109	839.45	839.45	+0.00	839.45	+0.00

The existing and proposed 100-year backwater along with the low chord criteria checks are summarized in Table 6. Although the backwater is higher at cross sections upstream of RS 2111, the backwater criteria is still met as no cross sections upstream of the bridge experience backwater that exceeds 1 ft for the 1% AEP design event. To ensure the preliminary bridge meets a FEMA “No Impact” finding, the water surface elevations for the FEMA 1% AEP storm event are summarized in Table 5.

Table 5: FEMA 100-year design event water surface elevations

FEMA 100-Year (1% AEP) Design Event			
RS	Existing 120' Bridge WSE (ft)	Preliminary 200' Bridge WSE (ft)	Difference (ft)
2485	851.70	851.44	-0.26
2409	851.74	851.48	-0.26
2344	851.55	851.27	-0.28
2295	851.66	851.37	-0.29
2203	851.53	851.24	-0.29
2111	851.60	851.32	-0.28
2049	Road S-37-133		
1984	850.07	850.07	0.00
1937	849.77	849.77	0.00
1895	849.81	849.81	0.00
1825	849.67	849.67	0.00
1756	847.30	847.30	0.00
1703	847.12	847.12	0.00
1616	846.94	846.94	0.00
1510	845.43	845.43	0.00
1378	844.66	844.66	0.00
1221	843.01	843.01	0.00
1069	843.22	843.22	0.00
889	841.68	841.68	0.00
753	840.52	840.52	0.00
568	839.70	839.70	0.00
404	838.76	838.76	0.00
257	837.97	837.97	0.00
109	836.91	836.91	0.00

Table 6: Design criteria summary

Design Criteria Summary							
Prelim. Bridge (4% AEP) WSE (ft)	Minimum Required Freeboard (ft)	Prelim. Bridge Min. Low Chord (ft)	Existing Low Chord Elevation (ft)	Prelim. Bridge (1% AEP) WSE (ft)	Prelim Bridge (1% AEP) Backwater (ft)	Existing (1% AEP) Backwater (ft)	500-Year (0.2% AEP) WSE Check (ft)
850.33	2.0	866.73	855.83	852.14	+0.44	+0.88	854.37

The preliminary bridge configuration meets SCDOT design criteria for freeboard based and the requirement of 1 ft maximum increase in water surface elevations when compared to natural (unrestricted) conditions. The results of the preliminary bridge analysis support the finding of “No-Impact” in accordance with the SCDOT Requirements for Hydraulic Design Studies and HDB 2019-4. There is no increase in the 1% AEP flood profile in the proposed conditions compared to existing. The preliminary bridge low chord elevation is controlled by the roadway grade and structure depth.

Design Considerations:

Scour protection should be provided on both abutments. Additionally, scour potential due to flow contraction as well as local scour at internal bents should be evaluated and included with the final design.

