



## **Memo**

Project: SCDOT CLRB Package 21

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Subject: Preliminary Hydraulic Analysis

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Route: Road S-42-31 (Cannons Campground Rd.) Bridge over Peters Creek (Asset ID 4212)

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Date: Friday, February 14, 2025

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To: SCDOT

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McCormick Taylor is providing preliminary hydrologic and hydraulic assessment of the Peters Creek Bridge Replacement along Road S-42-31 (Cannons Campground Rd.) in Spartanburg County, South Carolina. Cannons Campground Road in the vicinity of Peters Creek is designated as a Secondary Route and provides access to residential and rural areas. The Flood Insurance Study (FIS) for Spartanburg County and Flood Insurance Rate Map (FIRM) Panel No. 45083C0257D (attached) indicates the project is located in a Special Flood Hazard Area Zone AE without an established floodway.

### **Model Setup:**

A HEC-RAS model provided by the SCDOT was used for the existing conditions and unrestricted conditions of Peters Creek. The model extends approximately 16,000 feet downstream and approximately 11,000 feet upstream of the bridge. The main channel roughness was assumed to be  $n=0.045$ . Values for Manning's roughness in the floodplain from the existing FEMA model were used.

The USGS Rural and Urban regression equations using the StreamStats web application was used to estimate flow rates for a drainage area of 6.53 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.

**Table 1: Comparison of flows**

Design Event (% AEP)	FEMA Effective (cfs)	SCS Unit Hydrograph (cfs)	USGS StreamStats
2 YR (50% AEP)	-	659	502
10 YR (10% AEP)	-	1492	1160
25 YR (4% AEP)	-	2115	1560
50 YR (2% AEP)	-	2597	1910
100 YR (1% AEP)	1751	3153	2240
500 YR (0.2% AEP)	-	-	3050

The USGS flows were used for the analysis.

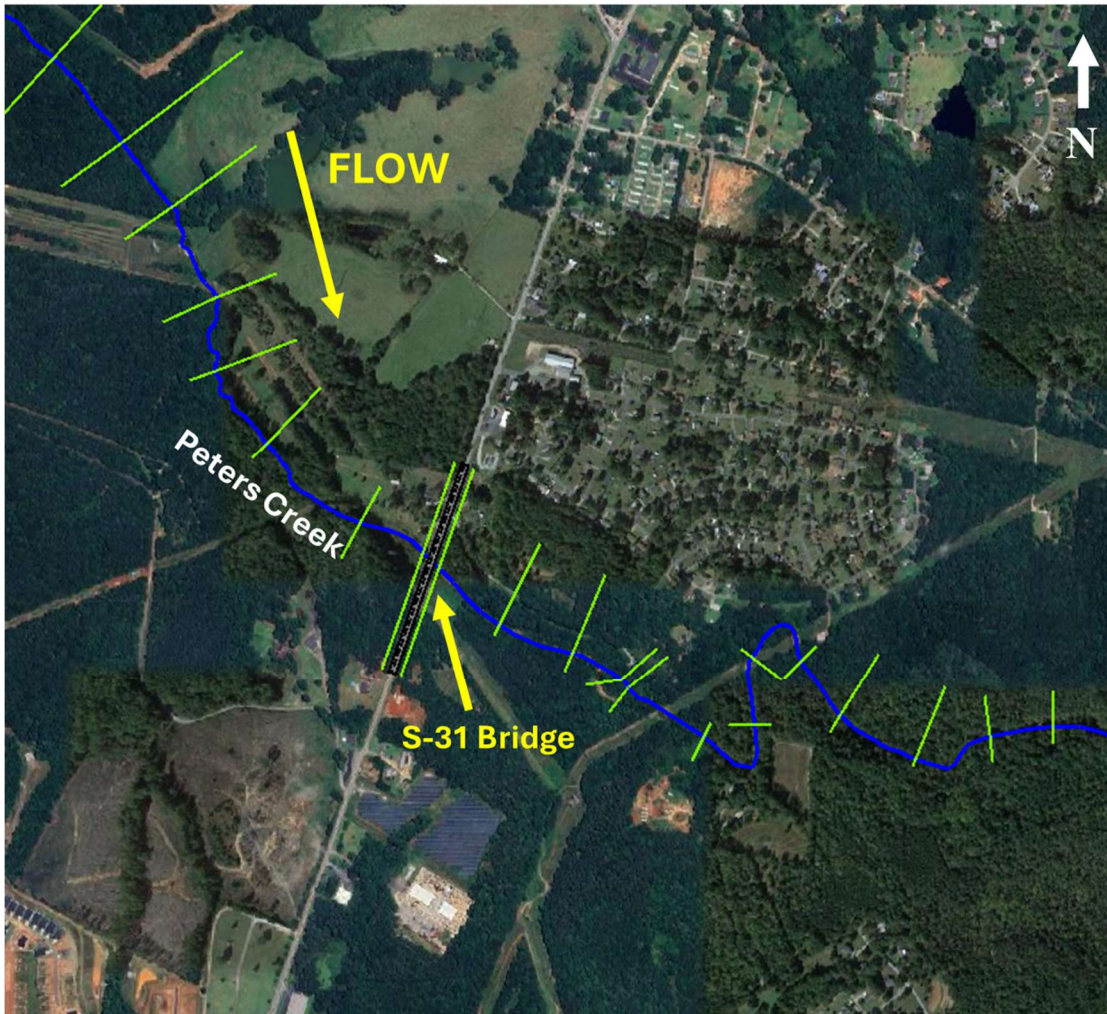


Figure 1: Peters Creek model layout (S-42-31)

**Design Criteria:**

Cannons Campground 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. 45083C0257D the project is located in a Special Flood Hazard Area Zone AE. 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.
5. Since the proposed bridge low chord elevation is less than the existing bridge low chord elevation, the bridge should convey the 500-year (0.2% AEP) design event while maintaining free surface flow.

It is preferred by the SCDOT that all structures and roadway components meet the requirements for a finding of "No Impact". The S-31 bridge over Peters 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 eight (8) 15 ft spans and a 30 ft main channel span for a total bridge length of 150 ft. The bridge had a breadth of 40.6 ft and a deck thickness of 2.6 ft, supported by 1 ft diameter 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 714.16.

**Preliminary Bridge Analysis:**

A triple span bridge consisting of 3.75 ft deep AASHTO Type III prestressed concrete beams was considered for preliminary analysis. The preliminary bridge consists of a 70 ft mid-span with 50 ft spans on either side for a total length of 170 ft. The low chord was set to an elevation of 712.53. The Road S-42-31 crossing is located at RS 15757.

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

Table 2 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 (WSE) 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 minimum low chord (714.16) > Existing WSE (693.68) + 2.0 ft F.B.

Proposed minimum low chord (712.53) > Proposed WSE (693.60) + 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 3.

Table 4 lists the FEMA 100-year (1% AEP) water surface elevations for existing and proposed conditions. To support a finding of no-impact, the WSE must not increase in proposed conditions.

The existing and proposed 100-year backwater, low chord criteria, and 500-year WSE checks are summarized in Table 5.

Table 2: 25-year design event water surface elevations

25-Year (4% AEP) Design Event			
RS	Existing 150' Bridge WSE (ft)	Preliminary 170' Bridge WSE (ft)	Difference (ft)
21226	709.40	709.40	0.00
20785	706.14	706.14	0.00
20115	703.46	703.46	0.00
19422	702.35	702.35	0.00
18907	699.72	699.72	0.00
18218	698.69	698.69	0.00
17703	697.79	697.79	0.00
17088	696.66	696.65	-0.01
16277	693.96	693.89	-0.07
15832	693.68	693.60	-0.08
15757	Road S-42-31		
15687	693.48	693.48	0.00
15160	693.07	693.07	0.00
14660	692.34	692.34	0.00
14296	691.42	691.42	0.00
14269	Unknown Dam		
14231	673.81	673.81	0.00
13653	670.35	670.35	0.00
12993	666.20	666.20	0.00
12557	663.52	663.52	0.00
11974	657.03	657.03	0.00
11548	653.87	653.87	0.00

Table 3: 100-year water surface elevations and backwater comparison

100-Year (1% AEP) Design Event					
RS	Natural WSE (ft)	Existing 150' Bridge WSE (ft)	Existing Backwater (ft)	Preliminary 170' Bridge WSE (ft)	Preliminary Backwater (ft)
21226	710.93	710.93	+0.00	710.93	+0.00
20785	707.22	707.22	+0.00	707.22	+0.00
20115	704.24	704.24	+0.00	704.24	+0.00
19422	702.96	702.96	+0.00	702.96	+0.00
18907	701.27	701.27	+0.00	701.27	+0.00
18218	700.10	700.10	+0.00	700.10	+0.00
17703	699.26	699.27	+0.01	699.26	+0.00
17088	698.14	698.16	+0.02	698.15	+0.01
16277	695.07	695.32	+0.25	695.21	+0.14
15832	694.73	694.89	+0.16	694.77	+0.04
15757	Road S-42-31				
15687	694.63	694.59	-0.04	694.59	-0.04
15160	694.18	694.11	-0.07	694.11	-0.07
14660	693.32	693.20	-0.12	693.20	-0.12
14296	688.09	691.77	+3.68	691.77	+3.68
14269	Unknown Dam				
14231	675.50	675.50	+0.00	675.50	+0.00
13653	671.87	671.87	+0.00	671.87	+0.00
12993	667.65	667.65	+0.00	667.65	+0.00
12557	665.00	665.00	+0.00	665.00	+0.00
11974	658.33	658.33	+0.00	658.33	+0.00
11548	655.58	655.58	+0.00	655.58	+0.00

Table 4: FEMA 100-year water surface elevations comparison

FEMA 100-Year (1% AEP) Design Event				
RS	Natural WSE (ft)	Existing 150' Bridge WSE (ft)	Preliminary 170' Bridge WSE (ft)	Difference (ft)
21226	710.93	709.92	709.92	0.00
20785	707.22	706.64	706.64	0.00
20115	704.24	703.92	703.92	0.00
19422	702.96	703.18	703.18	0.00
18907	701.27	700.01	700.01	0.00
18218	700.10	698.90	698.90	0.00
17703	699.26	697.99	697.99	0.00
17088	698.14	696.86	696.86	0.00
16277	695.07	694.37	694.29	-0.08
15832	694.73	694.04	693.95	-0.09
15757	Road S-42-31			
15687	694.63	693.82	693.82	0.00
15160	694.18	693.38	693.38	0.00
14660	693.32	692.59	692.59	0.00
14296	688.09	691.52	691.52	0.00
14269	Unknown Dam			
14231	675.50	674.31	674.31	0.00
13653	671.87	670.82	670.82	0.00
12993	667.65	666.64	666.64	0.00
12557	665.00	663.97	663.97	0.00
11974	658.33	657.41	657.41	0.00
11548	655.58	654.41	654.41	0.00

Table 5: 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)
693.60	2.0	712.53	714.16	694.77	+0.14	+0.25	695.92

The preliminary bridge configuration meets SCDOT design criteria for freeboard 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. The preliminary bridge low chord elevation is controlled by the roadway grade and structure depth.

**Design Considerations:**

The bridge is located within a FEMA Special Flood Hazard Area (SFHA) Zone AE without established floodway. Additional analysis may be warranted to establish the regulatory floodway boundaries. Assessment of potential scour at the abutments and interior bent are necessary. Additionally, there are residential properties located upstream of the bridge crossing to the northwest. Care should be taken in design to avoid adverse flood impacts to the nearby properties.



