

Appendix B

Conceptual Bridge Hydraulics Analysis

Introduction

This memorandum documents the data and assumptions used to evaluate the conceptual bridge hydraulics to further determine a preliminary size for the conceptual bridge crossings of the waterway.

Alternative 1 – the Northern Alignment begins east of the First Coast Expressway and continues east adjacent to and south of an existing unpaved road and terminates at Cheswick Oak Avenue. This alignment crosses the Double Branch waterway immediately south of the confluence of the North Prong Double Branch and South Prong Double Branch. There is an existing eighty-foot (80') long bridge and a cross drain along the unpaved road. Downstream, there is also a cross drain under Blanding Blvd.

Alternate 2 – Southern Alignment begins east of the First Coast Expressway and continues southeast through the Clay County Board of County Commissioners property between the Cameron Oak Phase 1 and Phase 3 subdivisions. The alignment continues east, crossing perpendicular to the Double Branch waterway and terminating at Cheswick Oak Avenue south of the Alternative 1 termination location.

Alternative 3 – Branan Field Adjustment is primarily the same as Alternative 1 passing through the Double Branch floodplain at the same location, but then curves to the southeast to terminate perpendicular to Blanding Blvd

Hydraulic Analysis

Hydraulic analyses for the existing and proposed conditions were performed utilizing the HEC-RAS (version 6.0) computer program. HEC-RAS was developed by the U.S. Army Corps of Engineers (USACE) and is used to model the hydraulics of water flow through a channel.

The methodology spelled out in the HEC-RAS User's Manual was used to enter cross-sections into the model upstream and downstream of the bridge. The latest LiDAR information was obtained from NOAA to create an existing surface within the project area. Since this a preliminary analysis, no survey data was utilized during this exercise.

The project is located within FEMA FIRMs 12019C0065E & 12019C0070E (eff. date 3/17/2014) and all alignment alternatives pass through a designated FEMA floodway. Boundary conditions were set for the model using information obtained from the latest FEMA FIS study 12019CV001A & 12019CV002A (eff. date 03/17/2014) for the area with the upstream flow and tailwater conditions being taken from the Double Branch. Summary upstream and downstream boundary conditions can be found in *Table 1.0*.

Water Body Name	Location	Flow Conditions (cfs)			Tailwater Location Conditions (ft) (NAVD 88)		
		50-year	100-year	500-year	50-year	100-year	500-year
Double Branch	Upstream near mouth of North and South Prong Branch	1410	1700	2450	-		
	Upstream near Blanding Blvd	-			17.33	18.00	18.79

Table 1.0 Summary of Boundary Conditions

Parameters that must be entered in HEC-RAS include the Manning's n (roughness) coefficients, reach length, ineffective flow areas, and contraction and expansion coefficients. A discussion of each parameter is included below.

- The Manning's n for the overbanks and the channel were selected based on the aerial analysis of the area with 0.05 used for the overbanks and 0.03 used for the channel bed.
- The reach length for the channel and the overbanks is the distance between the cross sections for the center, left and right over bank. The cross sections were geo-referenced, the left and right overbanks identified, and distance measured accordingly.
- The expansion and contraction coefficients were set to 0.3 and 0.5 thru the proposed bridge and for the downstream and upstream model cross sections.

- River stations were assigned beginning with lowest Id number at the downstream boundary condition and extending to highest Id number at the upstream boundary condition.

The existing model was constructed with these parameters and boundary conditions in place and proposed models for each alternative was created with a proposed bridge inserted along each alignment option. Refer to Figure 1 and Figure 2 for the existing and proposed HEC-RAS model domains for each alignment.

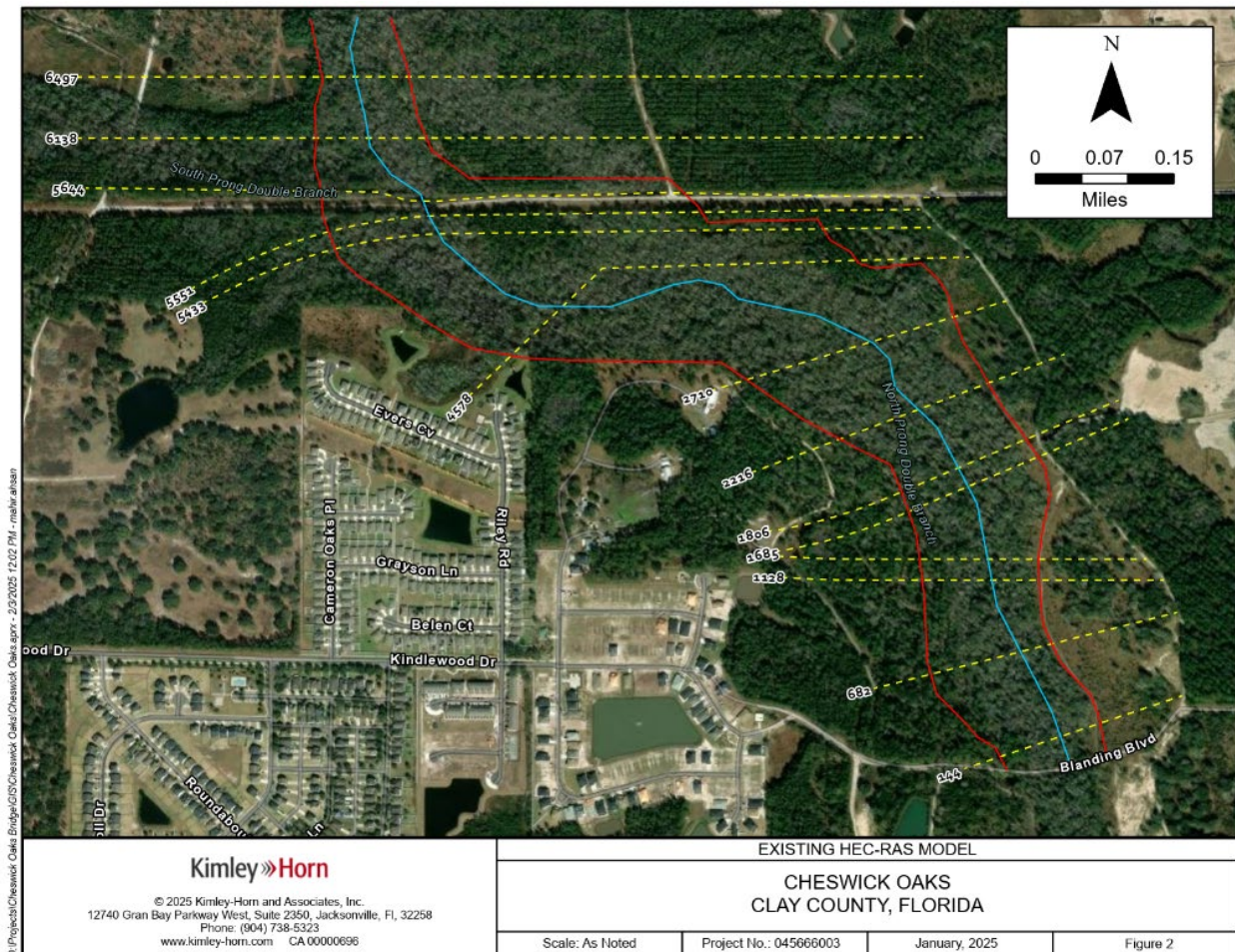


Figure 1. Existing HEC-RAS Model

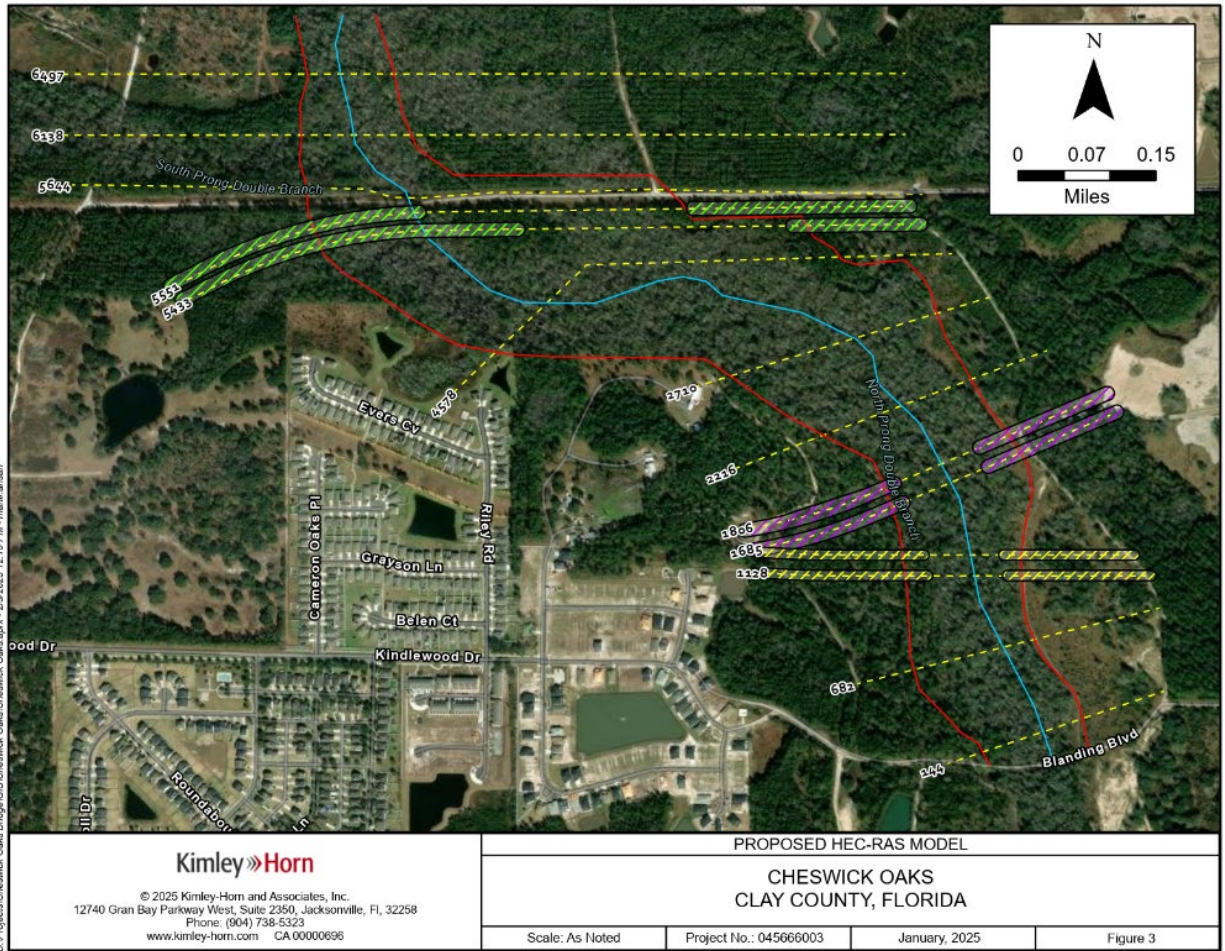


Figure 2. Proposed HEC-RAS Model

The existing and proposed water surface elevations comparison upstream and downstream of the bridge for the 50-year, 100-year, and 500-year storm events from the HEC-RAS models using the steady flow conditions analysis are shown in *Table 2.0 & 3.0*.



River Station	50-year WSEL		Δ	100-year WSEL		Δ	500-year WSEL		Δ
	Existing	Proposed		Existing	Proposed		Existing	Proposed	
6497	27.35	27.35	0	27.46	27.47	0.01	27.68	27.7	0.02
6138	26.68	26.65	-0.03	26.79	26.76	-0.03	27.07	26.98	-0.09
5644	25.55	25.64	0.09	25.67	25.76	0.09	25.93	26.02	0.09
5551	24.93	25.35	0.42	25	25.46	0.46	25.18	25.69	0.51
5492	Proposed Alignment 1 & 3 Bridge Crossings								
5433	24.36	24.36	0	24.46	24.46	0	24.7	24.7	0
4578	23.31	23.31	0	23.41	23.41	0	23.65	23.65	0
2710	21.25	21.25	0	21.37	21.37	0	21.67	21.67	0
2216	20.69	20.69	0	20.83	20.83	0	21.13	21.13	0
1806	19.96	19.96	0	20.08	20.08	0	20.33	20.33	0
1685	19.64	19.64	0	19.74	19.74	0	19.97	19.97	0
1251	18.41	18.41	0	18.56	18.56	0	19.11	19.11	0
1128	17.91	17.91	0	18.26	18.26	0	18.96	18.96	0
682	17.47	17.47	0	18.08	18.08	0	18.85	18.85	0
144	17.33	17.33	0	18	18	0	18.79	18.79	0

Table 2.0 Summary of Alignment Option 1 & 3 Results

Alignment 2									
River Station	50-year WSEL		Δ	100-year WSEL		Δ	500-year WSEL		Δ
	Existing	Proposed		Existing	Proposed		Existing	Proposed	
6497	27.35	27.35	0	27.46	27.46	0	27.68	27.68	0
6138	26.68	26.68	0	26.79	26.79	0	27.07	27.07	0
5644	25.55	25.55	0	25.67	25.67	0	25.93	25.93	0
5551	24.93	24.93	0	25.00	25.00	0	25.18	25.18	0
5433	24.36	24.36	0	24.46	24.46	0	24.70	24.70	0
4578	23.31	23.31	0	23.41	23.41	0	23.65	23.64	-0.01
2710	21.25	21.25	0	21.37	21.38	0.01	21.67	21.68	0.01
2216	20.69	20.7	0.01	20.83	20.85	0.02	21.13	21.19	0.06
1806	19.96	20.02	0.06	20.08	20.15	0.07	20.33	20.44	0.11
1745.5	Proposed Alignment 2 Bridge Crossing								
1685	19.64	19.69	0.05	19.74	19.79	0.05	19.97	20.01	0.04
1251	18.41	18.41	0	18.56	18.56	0	19.11	19.11	0
1128	17.91	17.91	0	18.26	18.26	0	18.96	18.96	0
682	17.47	17.47	0	18.08	18.08	0	18.85	18.85	0
144	17.33	17.33	0	18.00	18.00	0	18.79	18.79	0

Table 3.0 Summary of Alignment Option 2 Results

Cheswick Oak Ave Bridge Alternatives

The following summarizes the proposed bridge lengths and elevations for planning purposes.

Design Storm: 50-year/100-year

	Alignments 1	Alignment 2	Alignment 3
Design High Water (50/100)(ft)	25.35/25.46	20.02/20.15	18.52/18.68
Vertical Clearance (ft)	2.0	2.0	2.0
Bridge Length (ft)	1,200	450	400
Structure Depth (ft)	4.5	4.5	4.5
Roadway Cross Slope	0.42	0.42	0.42
Roadway Elevation (PGL)	32.27/32.38	26.94/27.07	25.44/25.60

Notes:

- For spans of 110'-115', the structure depth would be 54.5" or 4.5'
- Beam (45") + 8.5" deck + 1" bearing pad = 54.5"
- Roadway Cross Slope: EOP to PGL = (21ft)(0.02 ft/ft) = 0.42 ft (Does not include shoulder on the bridge)

Based on information provided in the FDOT Design Manual. A unit cost of \$200 per square foot is proposed.

New Construction (2023 Cost Per Square Foot)		
Bridge Type	Low	High
Short Span Bridges ¹		
CIP Reinforced Concrete Flat Slab	\$140	\$320
Florida Slab Beam (FSB) with CIP Topping	\$180	\$300
Medium Span Bridges ¹		
Florida-I Beam (FIB) with CIP Deck; FIB36 thru FIB84	\$110	\$200
Florida-I Beam (FIB) with CIP Deck; FIB96	\$190	\$270
AASHTO Type II Beam with CIP Deck	\$110	\$230
Steel I-Girder with CIP Deck; Simple Span ²	\$200	\$320
Steel I-Girder with CIP Deck; Continuous Span ²	\$210	\$330
Steel Box Girder with CIP Deck; Span Range from 150-feet to 280-feet (add 15% for horizontal curvature) ²	\$220	\$340
Segmental Concrete Box Girders; Cantilever Construction	Insufficient Data	
Movable Bridge; Bascule Spans and Piers	Insufficient Data	
Demolition Cost		
Typical	\$45	\$90
Bascule	Insufficient Data	
Project Type	Low	High
Widening (Construction Only)	\$165	\$240
Widening Removal Work	\$115	\$215

¹ Increase the cost by 20% for phased construction.

² Cost range based on limited data due to use of non-conventional contracts.

FDOT Design Manual, Section 260.8.1

Drainage:

The minimum vertical clearance between the design flood stage and the low member of a bridge is 2 feet. This clearance is necessary to allow the majority of debris to pass without causing damage to the structure. This requirement does not apply to culverts and bridge culverts.

Navigation:

Provide the following minimum vertical clearance for navigational purposes:

- (1) 6 feet above the Mean High Water for tidewater bays and streams
- (2) 6 feet above the Normal High Water for freshwater rivers, streams, non-regulated/controlled canals, and lakes
- (3) 6 feet above the control elevation for regulated/controlled lakes and canals