US 278
CORRIDOR IMPROVEMENTS
Casting a Light on the Community's Transportation Future

Appendix I

SCDOT Bridge Replacement Scoping Trip Risk Assessment Form

Floodplains Checklist

2-D Hydraulic Analysis

June 2021

BRIDGE REPLACEMENT SCOPING TRIP RISK ASSESSMENT FORM

COUNTY: Beaufort DATE: 04/28/2020

ROAD #: US-278 STREAM CROSSING: Mackey Creek

Purpose & Need for the Project:

Refer to the Environmental Assessment for project details

I. FEMA Acknowledgement

Is this project located in a regulated FEMA Floodway? ☐ Yes ☒ No

Panel Number: 4500250115 D Effective Date: 09/29/1986 (See Attached)

II. FEMA Floodmap Investigation

FEMA Flood Profile Sheet Number N/A illustrates the existing 100 year flood:

- ☑ Passes under the existing low chord elevation.
- ☐ Is in contact with the existing low chord elevation.
- ☐ Overtops the existing bridge finished grade elevation.

III. No Rise/CLOMR Preliminary Determination

☑ Preliminary assessment indicates this project may be constructed to meet the "No-Rise" requirements. A detailed hydraulic analysis will be performed to verify this assessment.

Justification: No Significant impacts are anticipated due to longer bridge length, however the base flood elevations in tidal zone are governed by storm surge.

☐ Preliminary assessmnet indicates this project may require a CLOMR/LOMR. Impacts will be determined by a detailed hydraulic analysis.

Justification:

BRIDGE REPLACEMENT SCOPING TRIP RISK ASSESSMENT FORM

IV. Preliminary Bridge Assessment

A. Locate Existing Plans

a. Bridge Plans ☑ Yes ☐ No File No. 7.418 Sheet No. 7 (See Attached)

b. Road Plans ☑ Yes ☐ No File No. 7.418 Sheet No. 4-6 (See Attached)

B. Historical Highwater Data

a. USGS Gage ☐ Yes ☑ No Gage No. _____ Results: 1945 Hurricane

b. SCDOT/USGS Documented Highwater Elevations

☑ Yes ☐ No Results: 1945 Hurricane High Water - Elev. 9

c. Existing Plans ☑ Yes ☐ No See Above

V. Field Review

A. Existing Bridge

Length: 2231 ft. Width: 39 ft. Max. span Length: 70' ft.

Alignment: ☑ Tangent ☐ Curved

Bridge Skewed: ☐ Yes ☑ No Angle: _____

End Abutment Type: Spill Through

Riprap on End Fills: ☑ Yes ☐ No Condition: Fair

Superstructure Type: 11 Prestressed Beam / W Beam (Main)

Substructure Type: 18" Square Prestressed Concrete Piles

Utilities Present: ☑ Yes ☐ No

Describe: Overhead Power line along the Northeast side of the bridge

Debris Accumulation on Bridge: Percent Blocked Horizontally: 0 %

Percent Blocked Vertically: 0 %

Hydraulic Problems: ☐ Yes ☑ No

Describe:

V. Field Review (cont.)

B. Hydraulic Features

a. Scour Present: ☐ Yes ☑ No Location: _____

b. Distance from F.G. to Normal Water Elevation: 15.82 ft.
c. Distance from Low Steel to Normal Water Elev.: 12.82 ft.
d. Distance from F.G. to High Water Elevation: 3.22 ft.
e. Distance from Low Steel to High Water Elev.: 0.22 ft.

f. Channel Banks Stable: ☑ Yes ☐ No
Describe:

g. Soil Type: Bohicket Association (Bk), Capers association (CE)

h. Exposed Rock: ☐ Yes ☑ No Location: _____

i. Give Description and Location of any structures or other property that could be damaged due to additional backwater.

The base flood elevations in tidal zone are governed by storm surge.

C. Existing Roadway Geometry

a. Can the existing roadway be closed for an On-Alignment Bridge Replacement
☑ Yes ☐ No
Describe:

In theory it could be closed and replaced on-alignment by staging traffic to one side. However, the reasonable alternatives utilize a replacement on new alignment.

If "yes", does the existing vertical and horizontal curves meet the proposed design speed criteria?

Yes

If "No", will the proposed bridge be:
☐ Staged Constructed
☑ Replaced on New Alignment

VI. Field Review (cont.)

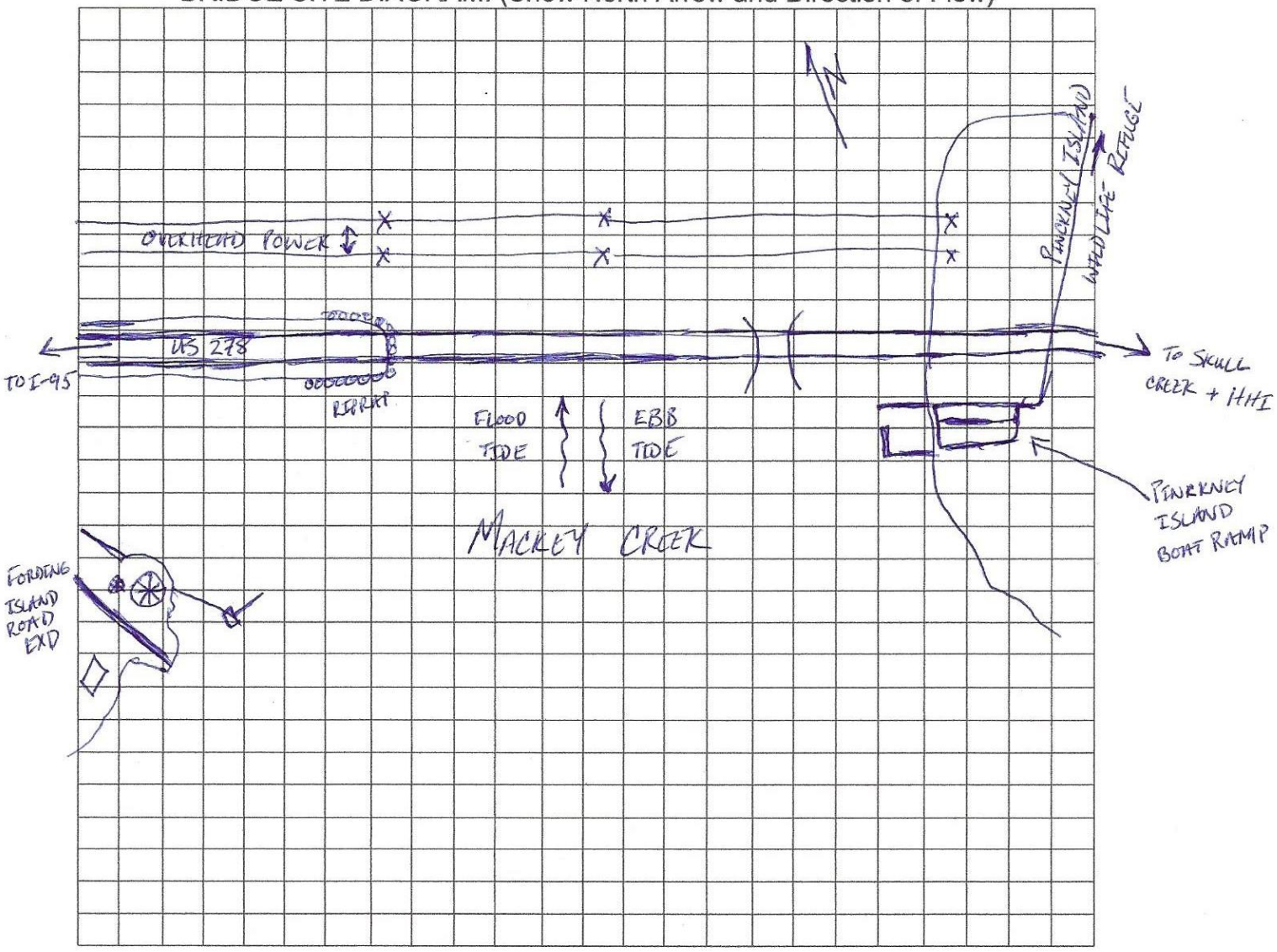
A. Proposed Bridge Recommendation:

Length: TBD ft. Width: 39 ft. Elevation: TBD ft.

Span Arangement: TBD

Notes: Proposed Geometry To Be Determined through final Design

BRIDGE SITE DIAGRAM: (Show North Arrow and Direction of Flow)



Performed By: Clayon H. McCathern

Title: Water Resources Engineer

BRIDGE REPLACEMENT SCOPING TRIP RISK ASSESSMENT FORM

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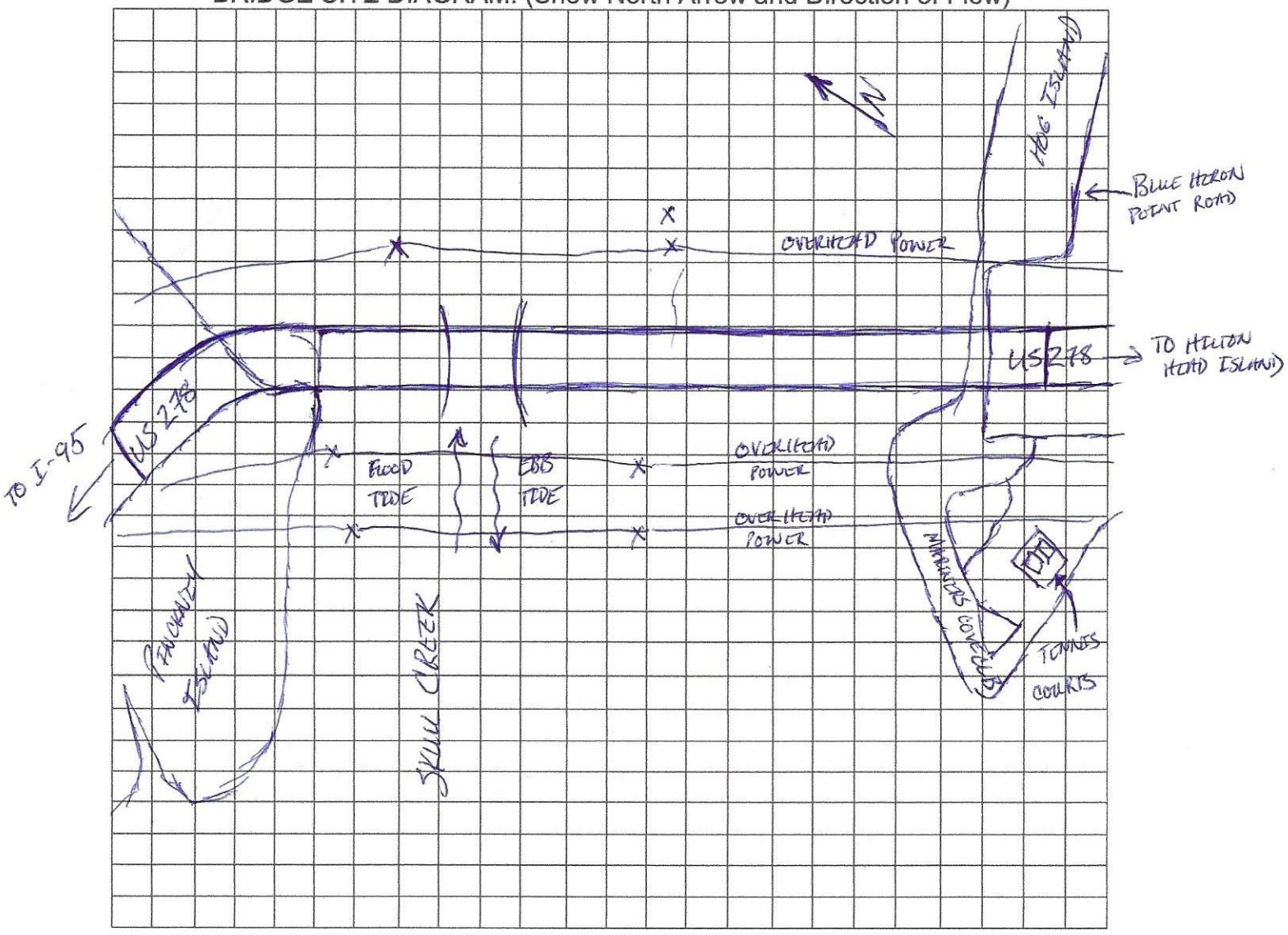

Performed By: Clayon H. McCathern

Title: Water Resources Engineer

South Carolina Department of Transportation
Location and Hydraulic Design of Encroachments on Floodplains Checklist

23 CFR 650, this regulation shall apply to all encroachments and to all actions which affect base floodplains, except for repairs made with emergency funds. Note: These studies shall be summarized in the environmental review documents prepared pursuant to 23 CFR 771.

SCDOT proposes to make improvements to a 4.11-mile section of US 278, between Bluffton and Hilton Head Island, from Moss Creek Drive to Spanish Wells Road. This project includes replacement of the eastbound Mackay Creek bridge and potential improvements to three other bridges; westbound Mackay Creek, eastbound Skull Creek and westbound Skull Creek. Improved access to Pinckney Island National Wildlife Refuge and the C.C. Haigh, Jr. boat ramp are also components of this project.

A. Narrative Describing Purpose and Need for Project
   a. Relevant Project History:
   b. General Project Description and Nature of Work (attach Location and Project Map):
   c. Major Issues and Concerns:

Refer to the Environmental Assessment for project details

B. Are there any floodplain(s) regulated by FEMA located in the project area?
   Yes☒ No☐

C. Will the placing of fill occur within a 100-year floodplain?
   Yes☒ No☐

D. Will the existing profile grade be raised within the floodplain?

Yes, However the profile will be raised on Structure on Pinckney Island with minimal changes to existing embankments.

E. If applicable, please discuss the practicability of alternatives to any longitudinal encroachments.

N/A – no longitudinal encroachments anticipated with this project.

F. Please include a discussion of the following: commensurate with the significance of the risk or environmental impact for all alternatives containing encroachments and those actions which would support base floodplain development:

a. What are the risks associated with implementation of the action?

No baseflood impacts anticipated. No significant encroachments planned.

b. What are the impacts on the natural and beneficial floodplain values?

No significant impact are anticipated due to longer bridge length, however the baseflood elevations in tidal zone are governed by storm surge.

c. What measures were used to minimize floodplain impacts associated with the action?

Utilizing the existing alignment as much as possible and a longer total bridge length.

d. Were any measures used to restore and preserve the natural and beneficial floodplain values impacted by the action?

Proposed total bridge length will reduce impacts to the waterway and floodplain. NPDES requirements will include erosion control BMPs on the construction plans for water quality.

G. Please discuss the practicability of alternatives to any significant encroachments or any support of incompatible floodplain development.

N/A, no significant encroachment anticipated

H. Were local, state, and federal water resources and floodplain management agencies consulted to determine if the proposed highway action is consistent with existing watershed and floodplain management programs and to obtain current information on development and proposed actions in the affected? Please include agency documentation.

Refer to the Environmental Assessment for project details. A copy of the complete Hydraulic Design and Risk Assessment will be provided to the Beaufort County Floodplain Manager.

4/23/2021

SCDOT Hydraulic Engineer Date

US278 CORRIDOR IMPROVEMENTS PHASE 1: FROM MOSS CREEK DRIVE TO SQUIRE POPE ROAD IN HILTON HEAD BEAUFORT COUNTY, SC

PRELIMINARY

JUNE 8, 2021

Prepared by:
CDM SMITH
Project No. 225988

Prepared for:
SCDOT

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1.0 INTRODUCTION

SCDOT proposes to make improvements to a 4.11-mile section of US 278, between Bluffton and Hilton Head Island, from Moss Creek Drive to Spanish Wells Road. This project includes replacement of the eastbound Mackay Creek bridge and potential improvements to three other bridges: westbound Mackay Creek, eastbound Skull Creek and westbound Skull Creek. Improved access to Pinckney Island National Wildlife Refuge and the C.C. Haigh, Jr. boat ramp are also components of this project. This report covers the drainage design for the US-278 corridor improvement project, Phase 1 including Hog Island.

Figure 1: Aerial Bridge Layout

1.1 PROJECT DESCRIPTION

The proposed US-278 bridges over Mackay Creek, Skull Creek and Hog island are a combination of various span lengths and beam types. The total length of the proposed project is 4.15 miles with 2.96 miles of roadway and 1.38 miles or bridge structure length.

A total of 44 bents (not including the end bents) will be located between the banks of the Mackay Creek and Skull Creek and their overbanks. A combination of columns, drilled shafts, and footings will be used in the overbanks and within and around the existing channels. The proposed Hog island bridge is a multi-span, flat slab bridge totaling 300' in length.

1.2 Scope of Services

The scope of services for this study included 2-D hydraulic analyses of the proposed US-278 bridge replacement and Hog Island bridge replacement configuration to predict hydraulic impacts on the existing Mackay and Skull Creek flow regimes. Also, the flow distribution between the bridge over Mackay Creek, Skull Creek, and the existing culvert to Hog Island is very complicated and determining stagnation points would be very difficult and inaccurate. Therefore, it was determined that a 1-D HEC-RAS analysis would be insufficient to accurately model the bridge replacement configuration.

The 2-D analysis was completed with the Surface Water Modeling System (SMS) interface using the Sedimentation and River Hydraulics (SRH-2D) solution algorithm. As part of the design services, 2-D hydraulic modeling of the 2-year (50% probability), 50-year (2% probability), 100-year (1% probability), and 500-year (0.2% probability) storms was completed. The approach velocities and depths obtained from the 2-D 100-year and 500-year models will be used to conduct scour analyses at the partially bents located within the river and the overbanks.

1.3 Project Datums

The 2-D SMS/SRH-2D hydraulic model are based on the South Carolina State Plane (FIPS 3900) Coordinate System, North American Datum of 1983 (NAD83). The vertical coordinate system for both models is the North American Vertical Datum of 1988 (NAVD88), although it is important to note that the information printed in the old bridge plans could be shown in NGVD29 or an older vertical datum.

2.0 BRIDGE HYDRAULIC DESIGN CRITERIA

2.1 DESIGN CRITERIA

Design Item	Criteria/Used	Reference
Hydraulic Design: Bridge		
Hydraulic Opening	Primary:50 yr, Secondary: 25 yr FEMA Requirements if applicable	SCDOT
Freeboard – Bridge Low Chord	2 ft (min) above Design Storm Pass 100 yr in free flow	SCDOT
Backwater	Less Than 1 ft above Natural Condition (non-FEMA)	SCDOT
Bent Skew	Align with high flow if > 5 deg. Attack angle	SCDOT
Scour Analysis	100-yr w/500-yr check	SCDOT/HEC18
Abutment Type	Spillthrough 2:1 Min	SCDOT
Endfill Limit	Min 10 ft from Bank & Projection Outside Channel	SCDOT
Abutment Protection	Riprap 2’ Below Ground & 2ft Above Design High Water	SCDOT
Bridge Deck Drainage	Std. Scupper where possible	SCDOT/OCRM

3.0 DATA COLLECTION

3.1 GENERAL

The hydraulic data necessary to create the SMS/SRH-2D model was collected from NOAA, StreamStats, field observation, and survey. The velocity and water surface elevation to calibrate the model was provided by a sub-contract with WEC.

4.0 Modeling Methodology

4.1 Introduction

The SMS/SRH-2D model was constructed in version 13.0.1 for this analysis. The velocity vector results from the SMS/SRH-2D model output will be used to perform the scour estimations. Model Domain is shown below.

Figure 2: Model Domain

4.2 2-D Hydraulic Modeling (SMS / SRH-2D)

The original 2D model was received from SCDOT. The roadway embankment was not included in the original model and a separate mesh was created to encompass these modifications. The two meshes were then merged to incorporate the roadway embankment to accurately model the existing scenario. The SMS/SRH-2D model was constructed to reflect the area of obstruction caused by the bridge piers and deck during each analyzed storm event for the proposed and existing structures. A separate SMS/SRH-2D model was generated for each storm simulation, including the 2-yr (50%), 50-yr (2%), 100-yr (1%), and 500-yr (0.2%) storms. US-278 bridge replacement and Hog Island bridge replacement were included in the same SMS/SRH-2D model to accurately reflect their flow distribution and tailwater condition.

The mesh for the model included the bridge over Mackay Creek, the bridge over Skull Creek, and the Hog Island flow area. The bridges and piers were modeled within SMS as obstruction coverages. The materials were determined from aerial imagery within SMS and Google Earth. The mesh was created utilizing LiDAR from NOAA Atlas Viewer, and the surveyed channels were then “stamped” into the mesh to accurately reflect channel bed and water surface elevations. For the natural model, all structures and roadway embankment for US-278 were removed. The boundary conditions were created from StreamStats and WEC tidal data.

A total of four SMS / SRH-2D models were created to analyze the 2-yr, 50-yr, 100-yr, and 500-yr storms. The flow obstructions caused by the bridge structure decks and piers in each flow scenario were input into each model. The various column, shaft, and footing widths will be modeled within SMS as well as the various span lengths for Mackay Creek, Skull Creek, and Hog Island.

4.3 Predicted Impacts

As expected, the calculated pier approach flow depths and velocities increased with storm magnitude. As part of preparation work for the simulation, a mesh was developed for each of the three scenarios: natural, existing, and proposed. The mesh consists of over 6,000 elements at which velocity, water surface, and water depth can be extracted a well as discharge values utilizing the data calculator within SMS. The mesh nodes are denser in the areas surrounding the bridges and the channel. The surveyed channels for Mackay Creek and Skull Creek were “stamped” into the meshes, and all structures along with the roadway embankments for both were removed for the natural model.

4.4 Model Calibration

The SMS/SRH-2D model and the 1-D HEC-RAS model were calibrated using WEC velocity and water surface elevation data taken over the course of 6 months. The datum used is in NAVD88.

Table 1: US 278 & Hog Island Hydrology Data

US 278 Hydrology Data Tidal					
Mackay Creek:		**Skull Creek:**		**Marsh (Hog Island):**	
MHHT	3.71	MHHT	3.71	MHHT	3.71
MLLT	-4.07	MLLT	-4.07	MLLT	-4.07
10 yr Tidal Surge Ht	--	10 yr Tidal Surge Ht	--	10 yr Tidal Surge Ht	--
100 yr SW Height (ft)	4.56	100 yr HW Elev (ft)	5.21	100 yr HW Elev (ft)	4.86
500 yr SW Height (ft)	4.65	500 yr SW Height (ft)	5.36	500 yr SW Height (ft)	4.89
100 yr Tidal Surge V	7.41	100 yr Tidal Surge V	4.23	100 yr Tidal Surge V	1.42
500 yr Tidal Surge V	6.27	500 yr Tidal Surge V	4.36	500 yr Tidal Surge V	1.31
*MP=monitor point					
**used most conservative values between MP, ML, and observation arcs					

5.0 REFERENCES AND DATA SOURCES

1. Aquaveo, *SMS User Manual (v13.0) The Surface Water Modeling System*, November 2019.

US Department of the Interior Bureau of Reclamation Technical Service Center, SRH-2D version 2: Theory and User's Manual, November 2008.