Evaluating flow conditions for alternative bridge replacement scenarios using SRH2D

Matthew Deshotel, CFM - Dewberry
Agenda

• Background
• Hydrology
• Hydraulics
• Results
Background
Project Site

Project Site

Dock Road

Waccamaw River

Juniper Creek

USGS Stream Gage
Geometries

• Post-1985 (existing conditions): As described previously

• Pre-1985:
  • Structure 3 was a 4-span bridge
  • Structure 2 was ~15ft shorter (1 less span)

• No Road

• Expand Structure 1

• Expand Structure 4

• Expand both Structure 1 & 4
What Flows to Model?

- Comparative analysis to determine how different geometries impact water surface elevations for a range of events
- Annual exceedance probability (AEP) events
  - 100-year
  - 25-year
- Flood of record – Hurricane Florence
Hydrology
Hydrograph Shape

Project Site
Juniper Creek

Waccamaw River

USGS Stream Gage

Discharge (CFS)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000

3_4_15
10_8_15
11_27_06
1_1_10
10_12_16
9_21_99
Hydrograph Peak

\[ Q_{i,S} = \frac{Q_{i,O} \times Q_{100yr}}{\max(Q_{i,O})} \]

Where,

- \( Q_{i,S} \) = the 15 minute incremental discharge when the hydrograph has been scaled to the 100 year event
- \( Q_{i,O} \) = the 15 minute incremental discharge of the observed hydrograph
- \( Q_{100yr} \) = the discharge corresponding to the 100 year event

Project Site

- Waccamaw River
  - Area: 531 Sq Miles
  - Q: 15,055 CFS
- Juniper Creek
  - Area: 550 Sq Miles
  - Q: 5,285 CFS
- USGS Stream Gage
  - Area: 693 Sq Miles
  - Q: 20,340 CFS
Flow Frequency Analysis

- USGS stream gage (02109500) located ~11 miles downstream of Dock Rd and containing 76 years (1940-2017) of annual peak flow records
- Bulletin 17C
- Regional skew & MSE
- PILFs
Regression

\[ Q_{100} = 380(DA)^{0.594} \]

• Gage corrected
Hydrograph Peaks

Observed discharge hydrographs at gage

Hydrographs scaled to 100yr AEP at gage

Flow Frequency Analysis

Peak discharges calculated at project site (USGS Regression)

Peak discharges gage corrected at project site

Hydrographs at project site

Gage  Project Site  Juniper Creek

Juniper Creek  Upper Waccamaw  Gage

Hydrograph Peaks

Observed discharge hydrographs at gage

Hydrographs scaled to 100yr AEP at gage

Flow Frequency Analysis

Peak discharges calculated at project site (USGS Regression)

Peak discharges gage corrected at project site

Hydrographs at project site

Gage  Project Site  Juniper Creek

Juniper Creek  Upper Waccamaw  Gage
Comparison of Simulated and Observed Hydrographs at Dock Road Under Existing Conditions
Hydraulics
Modeling software

Variable Mesh

Velocity

Froude’s Number
Results
Decrease in Inundation

Existing Conditions → Pre-1985

Existing Conditions → No Road
Particle Trace – 25-year AEP

Pre-1985

Post-1985
Functional Surface - Hurricane Florence

Pre-1985

Post-1985
## Comaprisson

<table>
<thead>
<tr>
<th>Address</th>
<th>Water Surface Elevations (ft NAVD88)</th>
<th>WSE Increase (ft) Pre-1985 → Post-1985</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100-Year</td>
<td>25-Year</td>
</tr>
<tr>
<td></td>
<td>Pre-198</td>
<td>Post-1985</td>
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<tr>
<td>Structure 4</td>
<td>36.44</td>
<td>36.52</td>
</tr>
<tr>
<td>Structure 3</td>
<td>36.31</td>
<td>36.44</td>
</tr>
<tr>
<td>Structure 2</td>
<td>36.22</td>
<td>36.29</td>
</tr>
<tr>
<td>Structure 1</td>
<td>36.4</td>
<td>36.49</td>
</tr>
</tbody>
</table>
Thank you!
Questions?

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