

## HYDROLOGY REPORT

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The Merriland River originates in North Berwick and South Sanford and moves southeast. The Merriland River converges with the Branch Brook into the Little River at the head of a tidal marsh. The Little River flows into the Atlantic Ocean. The Capell Bridge is located on the lower reach of the Merriland River in Wells and is about 1.2 miles from the Atlantic Ocean. The Merriland River flows over the remnants of a dam near Skinner Mill Road (formerly Lords Road). The Little River is tidal for its entire length within the town of Wells, but the tidal flow is not likely to reach the Capell Bridge per Jacob Aman from the Wells National Estuarine Research Reserve.

Per the Wells Flood Insurance Study (FIS, 2003), Wells is subject to the periodic flooding and wave attack that accompany coastal storms. Some of the more significant storms that occurred in York County include those of November 1945, 1963, and 1968, February 1972; January and February 1978; and October 1991. In the town of Wells, the only riverine flooding occurs infrequently on a small portion of Route 1 near the Merriland River, which is where the Capell Bridge is located. According to the local residents, the Merriland River has overtopped the bridge 3 times in the past 10 years. These floods usually lasted about a day.

There were two recent major floods of record at this location, which were the Mother's Day Flood and the Patriot's Day Flood. The Mother's Day flood was in May 2006 and according to USGS Scientific Investigation Report (SIR) 2008-5047, it had a peak flow of 2,240 cubic feet per second (CFS) at the bridge location, with a downstream flood elevation of 22.2 feet and an upstream flood elevation 24.1 feet. A video which shows the water level at the bridge during this flood can be found at <https://www.youtube.com/watch?v=wcYYOKxgCXY>. The Patriot's Day Flood was in April 2007 and according to USGS SIR 2009-5102, it had a peak flow of 1,860 CFS at the bridge location, with an upstream flood elevation of 23.50 feet. The downstream flood elevation was not found. The peak flows were estimated by the United States Geological Survey (USGS) using hydraulic modeling that produced the high water elevations of these floods that were observed in the field. The flood elevations were estimated using surveyed high water marks, which can be located, marked and rated after a storm.

According to the Wells FIS, during major floods, the entire length of the Little River acts as an estuary, which is where the tide meets the stream. Water surface elevations during floods are a function of discharge, flood volume, tide levels, and wind effects. This is important for the Capell Bridge, because the Little River is downstream of the Merriland River and could affect the Merriland River elevations. Hydrology was not established for the Little River in Wells, because the peak discharges were not used in flooding analysis. There used to be a dam between the bridge and Little River on Skinner Mill Road, but it has been removed. The Little

River should not affect the hydraulics at the bridge, because it is about 4,800 feet downstream from the bridge.

Hydrology was evaluated for Capell Bridge by the Maine Department of Transportation Environmental Office – Hydrology Section. Peak flows were calculated with techniques described in the USGS Water-Resources Investigations Report 99-4008 (Hodgkins, 1999) and also in the USGS Scientific Investigations Report 2015-4059 (Lombard, 2015). After performing the existing hydraulic model runs, the peak flows initially provided were not estimating flood levels comparable to the 2006 or 2007 floods, because the headwater elevations were coming in much lower than anticipated. The team asked the Environmental Office to reevaluate the peak flows based on known overtopping from the flood in 2006. The conclusion was to scale up the peak flows calculated using the USGS regression equations to set the 2006 flood at a Q500 flood frequency event. These new flows match up well with the flows provided in the Wells FIS. The table below summarizes the peak flows calculated from the USGS Regression Equations.

<b>SUMMARY</b>		
Drainage Area	17.0	mi <sup>2</sup>
Q1.1	353.8	ft <sup>3</sup> /s
Q10	1111.6	ft <sup>3</sup> /s
Q25	1366.5	ft <sup>3</sup> /s
Q50	1558.4	ft <sup>3</sup> /s
Q100	1800	ft <sup>3</sup> /s
Q500	2240	ft <sup>3</sup> /s

Reported by: Nash, Kendra  
Date: August 11, 2017

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.

## HYDRAULIC REPORT

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Hydraulic analysis of the existing and proposed bridges was performed using the HEC-RAS 4.1.0 software. A 480 foot length of the Merriland River that intersects Capell Bridge was modeled with 5 cross sections upstream and 7 cross sections downstream.

The HEC-RAS models were based on the following assumptions:

- One-directional steady flow
- Manning's numbers:
  - Channel: 0.045
  - Overbanks: 0.07
- Default expansion and contraction values, which are 0.3 and 0.1 respectively
- Ineffective flow areas:
  - Existing bridge: the upstream follows the direction of the wingwalls. The downstream follows a 2:1 slope from the bridge abutments.
  - Proposed bridge: Both the upstream and downstream flow use a 2:1 slope from the bridge abutments.
  - Downstream of the bridge, the curve in the stream does not include any ineffective flow area.
- Obstructions were blocked out on the downstream cross-sections to represent the location of buildings in the campground area.
- Reach boundary conditions: normal depth with a downstream slope of 0.00603 ft/ft
- Bridge cross sections:
  - Existing bridge: used upstream and downstream cross sections with existing bridge profile.
  - Proposed bridge: used proposed stream cross sections with proposed bridge profile.
- Existing Bridge Geometry:
  - 27' single span with mass abutments
  - Upstream low chord elevation: 20.9'
  - Downstream low chord elevation: 19.6'
  - Superstructure depth: 3'-2" = 2'-4.4" tee beams + 9.6" wearing surface
- Proposed Bridge Geometry
  - 40.2' bridge opening at Q1.1 elevation
  - 70' single span with 1.75:1 abutment slopes
  - Upstream low chord elevation: 19.6'
  - Downstream low chord elevation: 19.3'

- Superstructure depth:  $4'-0.25'' = 3'-4''$  NEXT beams + 3.25'' wearing surface + 5'' crown

The flows estimated by the Department's discharges and the May 2006 flood discharge were used to analyze the bridge's hydraulics. The 2006 flood had an elevation of 24.1 feet downstream of the railroad bridge, which is upstream of the Capell Bridge. The HEC-RAS model estimates an upstream water elevation of 22.7 feet upstream of the existing bridge, which approximately matches the actual flood elevation; therefore, the HEC-RAS model is reasonably correct for the flow representation.

A minimum freeboard depth of 2 feet at Q50 is recommended for "other riverine bridges" per BDG 2.3.10.2. The existing bridge has an estimated freeboard of 1.4 feet at the Q50. The proposed bridge has an estimated freeboard of 2.2 feet at the Q50; therefore, the proposed bridge meets hydraulic recommendations. The BDG also recommends a 1 foot freeboard at Q100 under the same section, which is also met by proposed bridge. Water surface elevations and discharge velocities are reported below for the existing and proposed bridges.

**SUMMARY**

		Existing Structure	Recommended Structure
		28' Span Concrete T-beam	70' Span NEXT Beam
Total Area of Waterway Opening	ft <sup>2</sup>		
Headwater elevation @ Q <sub>1.1</sub>	ft	15.5	14.6
Headwater elevation @ Q <sub>10</sub>	ft	18.6	17.4
Headwater elevation @ Q <sub>25</sub>	ft	19.5	18.2
Headwater elevation @ Q <sub>50</sub>	ft	20.1	18.8
Headwater elevation @ Q <sub>100</sub>	ft	20.9	19.4
Headwater elevation @ Q <sub>500</sub> *	ft	22.1	20.3
Freeboard @ Q <sub>50</sub>	ft	1.4	2.2
Freeboard @ Q <sub>100</sub>	ft	0.7	1.5
<b>*May 2006 Peak Discharge</b>			
Outlet Velocity @ Q <sub>1.1</sub>	ft/s	1.5	1.5
Outlet Velocity @ Q <sub>10</sub>	ft/s	3.1	2.9
Outlet Velocity @ Q <sub>25</sub>	ft/s	3.5	3.2
Outlet Velocity @ Q <sub>50</sub>	ft/s	3.8	3.4
Outlet Velocity @ Q <sub>100</sub>	ft/s	4.1	3.7
Outlet Velocity @ Q <sub>500</sub>	ft/s	4.7	4.2

Reported by: Nash, Kendra  
Date: August 21, 2017

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.