Hydrology

Barrell Bridge carries Beech Ridge Rd. over the Dolly Gordon Brook in the town of York, Maine. Dolly Gordon Brook is located within the tidal controlled areas of the York River drainage basin, which is located entirely within the State of Maine. Dolly Gordon Brook is almost entirely controlled by tidal flow, resulting in low stream flow rates for the brook. These low stream flow rates were considered to have no effect on the structure and were not used in the design process. Dolly Gordon Brook has a calculated drainage area of 3.50 mi^2.

A summary of the calculated flow rates for Dolly Gordon Brook is shown below:

SUMMARY		
Drainage Area	3.5	mi^2
Q1.1	36.9	ft^3/s
Q10	130.4	ft^3/s
Q25	170.9	ft^3/s
Q50	191.7	ft^3/s
Q100	224.5	ft^3/s
Q500	290.8	ft^3/s

Tidal information was obtained through two sources:

- Flood Insurance Studies (FIS) for the town of York issued in 2002
- Tidal data available through the National Oceanic and Atmospheric Administration (NOAA) website

The tidal datums on the NOAA website are based on data collected at a benchmark station in Portland, Maine and referenced to the 1983-2001 tidal epoch. These elevations have been adjusted to NAVD of 1988 and to the nearest substation to the project which is Fort Point in York Harbor, using calculations for determining subordinate station elevations from the Bridge Design Guide (BDG), and correction factors provided by NOAA. A 0.6 foot rise in sea level was calculated for the York River, based on an average of the equivalent sea level rise at two NOAA stations located in Portland ME and Seavy Island ME. The equivalent sea level rise at each station was based on monthly mean sea level data collected from 1912 to 2015 and 1926 to 2001, respectively.

Below are two tables showing the adjusted elevations for the Fort Point, York Harbor subordinate station; the first table reports the current tidal datums and the second reports the adjusted tidal datums for a projected 0.6 foot rise in sea level. If the sea level were to rise more

than 1 foot, the proposed structure would have enough hydraulic capacity to handle up to a 3-4 foot increase in water elevations, for more information see the hydraulics section below.

Table 1: Current Tide Datums

Mean Higher High Water (MHHW)	=	4.36 ft
Mean High Water (MHW)	=	4.00 ft
Mean Low Water (MLW)	=	-4.70 ft
Mean Lower Low Water (MLLW)	=	-5.06 ft

Table 2: Future Tide Datums

Mean Higher High Water (MHHW)	=	4.96 ft
Mean High Water (MHW)	=	4.60 ft
Mean Low Water (MLW)	=	-4.10 ft
Mean Lower Low Water (MLLW)	=	-4.46 ft

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

The data provided by FIS and the NOAA website were very similar. The FIS estimates the 50 year coastal flood Stillwater elevation for Dolly Gordon Brook as 8.8 feet. The NOAA tidal data for Highest Observed Water Level (HOWL) at the aforementioned subordinate station is 8.426 feet after adjustment from the reference station.

Hydraulics

A detailed hydraulic analysis of the existing and proposed structures was not performed for this project due to the low stream flows of Dolly Gordon Brook and the determination that the existing structure is not a tidal restriction. Dolly Gordon Brook is tidal controlled with low stream flow, which would not produce any applicable results from a steady flow HEC-RAS model. The Departments Environmental Office performed a tidal evaluation at Barrell bridge between the dates of July 8th and September 5th, 2016. During this period, data loggers measured the tidal elevations upstream and downstream of the existing structure to determine if a restriction occurred. The conclusion from the tidal evaluation is that there is no tidal restriction for the existing structure, see Appendix F for more information.

The flooding of Dolly Gordon Brook is controlled by the flow of the York River, due to their confluence. When the York River experiences high flows due to runoff, high ocean tides, etc. it directly affects the water surface elevations of Dolly Gordon Brook, as it is within the flood plain of the York River. As a result, the still water elevations defined in the FIS report for the entire shoreline within the Town of York, which includes the York River, were used to

represent the flood water surface elevations shown in the FIS Flood Profile for Dolly Gordon Brook, see the summary table below for the water surface elevations and Appendix F for more information. These elevations are higher than the predicted tidal data as they are based off of significant riverine flow in the York River, converging with the tidal effects of the Atlantic Ocean.

The higher elevations defined in the FIS report would be difficult to size the proposed hydraulic opening for based on existing site conditions, as the existing bridge is located in a vertical sag curve, and the roadway forming a causeway through the Dolly Gordon Brook wetland area. Any increase to the finished grade elevation of the roadway will have a significant impact to the surrounding wetland area, as the existing roadway slopes are steeper than current standards and any reconstructed slopes will have a much larger footprint due to more gradual slopes. The finished grade of the roadway was raised enough to provide the minimum of a 0.5% grade across the new structure for drainage, which results in roughly a 1 foot increase on the western approach, and 7 inches on the eastern approach at the bridge. In order to minimize the impacts to Dolly Gordon Brook and the surrounding wetlands, the proposed bridge span length was increased to 75 feet, which pulls the toes of slopes away from the brook. This span increase results in a significant increase to the hydraulic opening of the proposed structure vs. the existing (548 SF vs 290 SF). The elevation of the low point of the bottom chord for the proposed structure is roughly 8.48 feet, meaning that a projected Q50 flood of the York River (elev. 8.8 feet) would not pass under the structure. The proposed superstructure consists of concrete beams, so water contact with the superstructure during flood events should not result in accelerated degradation as it would for a steel superstructure. The low point of the finished grade of the bridge is roughly elevation 12.5 feet, meaning that the projected Q500 flood of the York River (elev. 9.8 feet) would not overtop the proposed structure. Furthermore, at the preliminary public meeting for the project, local residents that have lived near the existing structure for 38 years reported that they have never seen the water touch the bottom chord of the existing structure (elev. 8.1 feet) during any flood events over that time frame, see Appendix F for more information. Based on this information the hydraulic opening of the proposed structure was deemed appropriate, due to its ability to pass the water elevations determined from the tidal analysis, see Appendix A for more information.

The proposed structure has 3.48 feet of vertical clearance for the future tidal datums defined above, which includes 0.6 feet of sea level rise, and is defined as the distance from the lowest elevation of the bottom chord of the superstructure to the future MHW elevation, and provides close to 6 inches of additional clearance than the existing structure. If the sea level rise were to be 1 foot over the next 100 years, the vertical clearance would be 3.15 feet. Sea level rise can be difficult to predict based on ever changing environmental factors. The hydraulic capacity of the proposed Barrell Bridge would support upwards of a 3-4 foot sea level rise. This

amount of sea level rise would result in a similar water surface elevation to the existing Q50 water elevation for the York River, which can pass under the proposed structure, as shown on the plans. The flood water surface elevations of the York river are shown in the table below.

SUMMARY

		York River Stillwater Elevations
Headwater elevation @ Q_{10}	ft	8.2
Headwater elevation @ Q_{50}	ft	8.8
Headwater elevation @ Q_{100}	ft	9.2
Headwater elevation @ Q_{500}	ft	9.8

Reported by: Eaton, Devan C
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