Hydrology Report

Introduction

The Biddeford Snake River Bridge is a low-lying water crossing; which carries Route 208 over Snake River in Biddeford, Maine. Based on MaineDOT studies, it drains a small watershed area of 0.19 square miles. During tidal periods and storm surges due to hurricanes and northeasters, the flow is southerly from Wood Island Harbor into the Biddeford Pool passing through the bridge opening. The bridge is exposed to tides and coastal flooding in a low-lying area. The hydrology for this site has three components: tidal, storm surge, and riverine flows and are discussed below.

Tidal Data

The determination of the tidal water elevations are based on article 2.3.6 of the Bridge Design Guide (BDG) of the MaineDOT. The data used in the computation is published by the National Oceanic and Atmospheric Administration (NOAA). The administration keeps accurate and up to date records of tidal elevations at four reference stations in Maine; Namely Eastport, Bar Harbor, Portland, and Wells. Wells is the closest station to the bridge location and so its station data will be used in calculating tidal data for this project site.

Wells Reference Station Data:

Length of series: 19 years
Time Period : January 1983 – December 2001
Tidal Epoch : 1983 – 2001

Tidal elevations are given from a Station Datum, which is unique to this station and not based on a fixed datum. NAVD adjustment is 19.76 (Station Datum – 19.76 = NAVD88)

Tidal Level	**Tidal Elevations (Station Datum)**	**Tidal Elevations (NAVD)**
Highest Observed Water Level (04/16/07)	27.91	8.15
Mean Higher High Water (MHHW)	24.32	4.56
Mean High water (MHW)	23.89	4.13
Mean Sea level (MSL)	19.53	-0.23
Mean Tide Level (MTL)	19.50	-0.26
Mean Low Water (MLW)	15.11	-4.65
Mean Lower Low Water (MLLW)	14.77	-4.99
Lowest observed water Level (03/21/07)	12.02	-7.74

2012 Highest predicted Tide = El 7.67 (12.66’ above MLLW)

Biddeford Subordinate Station Data:

Mean Range = 9.06 ft
Spring range =9.94 ft
Mean Tide Level (MTL) = 4.79 ft

The Tidal Levels at Biddeford are computed as follows:

Mean High Water (MHW) = $MTL_{(Wells)}$ + Mean Range/2 = -0.260 + (9.06/2) = 4.27 ft

Mean Low Water (MLW) = $MTL_{(Wells)}$ – Mean Range/2 = -0.260 – (9.06/2) = - 4.79 ft

Mean Lower Low water (MLLW) = $MTL_{(Wells)}$ – MTL = -0.260 – 4.79 = -5.05 ft

Mean Higher High Water (MHHW) = MLLW + Spring Range = -5.05 + 9.94 = 4.89 ft

2011 highest predicted $tide_{(Biddeford)}$ = 2011 highest $tide_{(Wells)}$ x ratio of height differences at high water (R)

R is obtained from Table 2 of the Tide Tables book under Biddeford = 0.96

2012 highest $tide_{(Biddeford)}$ = 12.66 ft x 0.96 = 12.15 ft (datum is MLLW)

2012 predicted high $tide_{(Biddeford)}$ = MLLW + 2012 highest $tide_{(Biddeford)}$
= -5.05 ft + 12.15 ft = 7.10 ft

In summary, the calculated tidal elevations for Biddeford are as follows:

Type of Tidal Flow	**Elevation (NAVD 88)**
Mean High Water (MHW)	4.27
Mean Low Water (MLW)	-4.79
Mean Lower Low Water(MLLW)	-5.05
Mean Higher High Water(MHHW)	4.89
2012 predicted high tide	7.10

Storm Surge Flooding

FEMA has conducted studies on the probability of flooding in the Biddeford shoreline region for flood insurance purposes. It has issued flood maps for the 100 and 500 year flood events with peak stage elevations of 9.0 ft (NGVD) for the 100 year flood event for the entire shoreline within Biddeford. It indicated that the source of the flooding

within the shoreline is the Atlantic Ocean. The following is a summary of elevations for the flood events per FEMA:

Type of flow	**Stage (NGVD)**	**Stage (NAVD)**
Ordinary High Water (Q10)	8.10	7.38
Design Discharge (Q50)	8.70	7.98
Check Discharge (Q100)	9.00	8.28
Scour Discharge (Q500)	9.60	8.88

Note: a -0.722' datum shift was applied to convert to NAVD 88

Riverine Flow

MaineDOT hydrology section has performed its own hydrological study for the bridge waterway by conducting peak flow river flow calculations by 1999 Hodgkins, USGS regression equations. They have thus reported flows as follows:

Type of flow	**Recurrence Int.**	**Flow (cfs)**
Ordinary High Water	Q1.1	1.6
Discharge flow	Q10	6.7
Discharge flow	Q25	8.8
Design Discharge	Q50	10.3
Check Discharge	Q100	12.1
Scour Discharge	Q500	16.4

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HYDRAULIC REPORT

Existing Bridge

Snake River Bridge (#3910) is located in Biddeford on Route 208 over Snake River. The bridge was built in 1947. The existing bridge is 32' span steel superstructure on pile supported integral abutments. The steel stringers are in poor condition with heavy rusting throughout and extreme section loss on the exterior stringers. Snake River empties into Biddeford Pool immediately downstream of the bridge. The drainage basin is 0.19 sq. miles.

Hydraulic Analysis

Due to the minimal drainage basin size and the site being directly adjacent to Biddeford Pool and at sea level, tidal flows far exceed riverine flows. An HY8 analysis would be of little value due its inability to deal with tidal flows.

Two site visits were conducted, one on April 5, 2012 and a second on May 21, 2012. The first visit occurred at high tide and the second at low. At both times, the tidal action was slack under the bridge indicating that no lag was being created by the structure and therefore it was adequately sized to handle the tidal flows between Biddeford Pool and the Snake River Basin. Additionally, because no lag was being created, as long as the hydraulic opening of any new structure was equal to or larger than existing, no change in upstream tide elevations would occur.

Because riverine flows are such a small portion of the hydraulic characteristics, it was determined that a complex hydraulic analysis wouldn't be necessary. As the structure, by observation, was adequately sized to handle tidal flows, all that would be necessary would be to replicate the existing opening with each alternative.

Lastly, none of the alternatives will be sized to address storm surge flooding. Because the Q_{100} floodplain is so wide-spread, it would be unfeasible to raise all the adjacent approaches up high enough to prevent overtopping. Furthermore, if this bridge were raised to prevent overtopping, its functionality would still be limited by the fact that many of the outlaying areas served by this bridge would also be under water.

Proposed Bridge

Snake River Bridge (#3910) in Biddeford is scoped for Bridge Replacement in the 2012-2013 Workplan.

Alternative 1: Rehabilitate Existing Bridge: This option will have no effect on hydraulics.

Alternative 2a: Replace Bridge with 44' Span precast concrete superstructure on integral abutments: Abutments would be built behind existing abutments, keeping intact the slope in front of the abutments to preserve flow characteristics. The new hydraulic opening would be 187 SF. Although this is 29% larger than existing, all the additional opening area is above MHHW, having no effect on flow characteristics and is merely the result of setting back the abutments for constructability and a slight increase in freeboard.

Alternative 2b: Accelerated bridge replacement with 44' Span precast concrete superstructure on integral abutments: Hydraulically, this alternative is identical to Alternative 2a.

Alternative 3: Replace Bridge with 22' Span x 9' Rise Precast Concrete Box Culvert. When buried 2', the rise would be identical to the existing 7' height. The 22' span was selected to provide a total area close to the existing 145 SF opening. The new hydraulic opening would be 154 SF.

Conclusion

Upon completion of the hydraulic analysis, all alternatives will be adequate to handle both tidal and riverine flows and will not adversely affect fish passage. Therefore final selection of structure type will be made based on other factors such as life cycle, construction methods and maintenance of traffic. Please refer to the Summary of Preliminary Design for further information.

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