

HYDROLOGY, HYDRAULICS, AND SCOUR REPORT

**Belfast, Perkins Bridge, # 5143, PIN 016685.00
Preliminary Design Report, Hydraulic and Scour
Analysis**

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For: **SEA Consultants, Inc. and Maine Department of Transportation**

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Introduction:

This report provides hydrologic and hydraulic design information for preliminary design of the proposed arch bridge in Belfast, where Herrick Road crosses the Little River. According to information furnished by SEA, and according to MDOT plans, the existing bridge is a 28' span, just downstream of a dam. It is proposed to replace this bridge with a 50' span arch with a rise of 18'.

Review of Existing Data:

Existing data related to this bridge included:

- MDOT file information: Plans included two detail sheets from the design for the bridge completed in 1921. An existing bridge profile was provided by SEA.
- FEMA Flood Maps and FIS report: FEMA did not provide detailed flood mapping of this reach of river, and no flood elevations had been computed by FEMA.
- Air photos:
- Topographic Maps
- Historical Flood Information: No historical flood information was identified for this location.

Hydrologic Analysis:

Flow data for design floods was developed by MDOT. The following table summarizes peak flow data as calculated by MDOT. A copy of the calculations is included in the appendix. The drainage area is 12.78 square miles, with a wetlands percentage of 5.6%. This stream has two reservoirs, one of which is upstream of the project site. The flow formula used by MDOT does not include a reservoir routing component. The reservoir storage likely impacts flows to some extent, but this would reduce high flows, so flows computed without reservoir routing would be conservative (higher).

Frequency, yrs	Flow, cfs
1.1-year	242
10-year	1056
25-year	1375
50-year	1630
100-year	1903
500-year	2592

Hydraulic Analysis:

Flow characteristics for existing and proposed bridges were analyzed using model HECRAS. Since the dam is upstream of the project, the dam does not cause backwater at the bridge.

Stream cross sections from project survey, bridge plans and project plans were be used to develop the hydraulic model. Flood elevations for design of bridge elevations and flow velocities for scour analyses were analyzed for the bridge using model HECRAS. Goals of the hydraulic analysis included providing adequate clearance for passage of design flows (typically 2' for minor structures, 4' for major bridges), and calculation of projected scour depths for

foundation design. In addition, pre- and post- condition flood elevations were determined and compared to assure that flood levels are not raised by the new bridge. Analysis with and without the dam for proposed conditions was also included. The following table summarizes model results. Detailed HECRAS input and out put is included in the appendix.

Location Frequency	Elevation, feet		Velocity, fps	
	Existing	Proposed	Existing	Proposed
Downstream of Bridge (312)				
1.1-yr	39.7	39.7	2.4	2.4
10-yr	42.6	42.6	4.4	4.4
25-yr	43.3	43.3	4.9	4.9
50-yr	43.9	43.9	5.2	5.2
100-yr	44.3	44.4	5.5	5.5
500-yr	45.6	45.6	6.2	6.2
In Bridge Section				
1.1-yr	39.8	39.8	2.1	1.1
10-yr	42.6	42.8	5.9	2.8
25-yr	43.3	43.6	7.2	3.3
50-yr	43.8	44.2	7.9	3.7
100-yr	44.3	44.8	8.7	4.1
500-yr	45.5	46.1	10.5	4.9
Upstream of Bridge (385)				
1.1-yr	39.8	39.8	2.4	2.4
10-yr	43.0	42.8	4.4	4.5
25-yr	32.9	43.6	4.8	5.0
50-yr	44.6	44.2	5.0	5.4
100-yr	45.3	44.7	5.3	5.7
500-yr	46.9	46.1	5.6	6.4
At base of dam				
1.1-yr		39.9		1.1
10-yr		43.1		2.3
25-yr		44.0		2.7
50-yr		44.6		2.9
100-yr		45.2		3.1
500-yr		46.6		3.6

Bridge Clearance:

The existing bridge has a low chord of approximately 53'. The proposed arch will have a similar peak elevation. This provides the following clearances:

Condition	Flood Elevation	Low Chord	Clearance
Existing			
50-yr	44.6	53.0'	8.4'
100-yr	45.3	53.0'	7.7'
Proposed			
50-yr	44.2	53.0'	8.8'
100-yr	44.7	53.0'	8.3'



Effect of Dam:

Although it is unknown whether the dam is likely to remain in place for the life of the bridge, the HECRAS model was run for proposed conditions with and without the dam in place. The primary effect of removing the dam would be the loss of storage and hence a potential increase in rate of flow. However, the hydrology model used by MDOT did not account for routing of flood flows through the reservoir, and thus likely provides conservative flows as computed. The hydraulic model was run with and without the dam. The model does not show a change in flow regime if the dam is removed. The model is somewhat limited in its ability to model complex flow, but it was run using a “mixed” flow calculation where the potential for both sub- and super-critical flows are considered. With this type of modeling, HECRAS does not predict any significant differences in flow velocities. The model does not predict a hydraulic jump near the bridge. Channel contours indicate that this type of flow occurs within about 20’ of the base of the dam.

Scour Computations:

The current design for the project is to either found abutments on bedrock, or provide a concrete seal, so potential scour was not computed.

Summary of Findings:

1. The proposed arch bridge is expected to lower flood levels by approximately 0.4' for the 50-year flood and 0.6' for the 100-year flood.
2. Bridge clearance is more than adequate to provide at least 4' during a 50-year event and at least 2' during a 100-year event.
3. Removing the dam is not expected to have significant impact on flow velocities or volumes.
4. Scour was not computed because abutments are to be founded on bedrock or a concrete seal will be utilized to protect the foundation.

Appendix:

- MDOT Hydrologic Calculations
- HECRAS section locations
- HECRAS section plots
- HECRAS output for existing and proposed conditions