HYDROLOGY REPORT

Fish Bridge – Winslow, Kennebec, BR #0509

General Information and Scope

This study is prepared to provide hydrologic information from water resources agencies on the Fish Bridge in Winslow, which carries Garland Road over Pattee Pond Brook. The information will be used in the hydraulic evaluation of the existing culvert opening and proposed bridge opening. The existing 40 ft. long culvert excluding the 15' downstream apron, has a rectangular hydraulic opening of 20 ft. span and 7.33 ft. rise. The culvert walls, slabs, wingwalls, and the downstream apron are all cast in place concrete. The flow direction is from east to west and has confluence with Sebasticook River, which flows North-South and joins with Kennebec River several miles downstream.

Flow rates were computed using 1999 USGS regression equations by Hodgkins, based on 25.1 sq. miles of drainage area and 5 sq. miles of wetlands or 20%. The flows were computed based on the standard site regression equations

Below is a summary of the design flows:

SUMMARY

Drainage Area	25.1	mi^2
Q1.1	209.9	ft^3/s
Q2	385.3	ft^3/s
Q5	562.6	ft^3/s
Q10	687.9	ft^3/s
Q25	851.7	ft^3/s
Q50	976.2	ft^3/s
Q100	1110.3	ft^3/s
Q500	1427.0	ft^3/s

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PRELIMINARY HYDRAULIC REPORT

Winslow, Fish Bridge #0509

Existing Bridge Analysis

HEC-RAS Model Description:

A hydraulic analysis using a HEC-RAS model was performed using MicroStation cross section data to analyze the existing and proposed bridge configurations. The cross sections closest to the bridge were placed just outside the upstream and downstream embankments. Additional cross sections were placed to capture the channel topography and bathymetry upstream and downstream. To fully contain the flow in the flood plain, the upstream cross sections were extended out of the channel boundaries and into the adjacent flood plain to the highest elevations present on the survey plan. The bridge itself is located over Pattee Pond Brook which has downstream confluence with the Sebasticook River main channel. The flow in the Pattee Pond Brook is east-west, and it is north-south in the Sebasticook river main channel, which joins with the Kennebec River a few miles miles downstream.

Boundary conditions and flow stages:

The tailwater and downstream boundary conditions are very important in the analysis. Since the bridge is on a tributary close to the confluence with another stream, the conditions of flow at the main channel greatly affects that at the tributary. At low flow conditions in the main channel, the water surface elevation at the bridge is controlled by the incoming flow from watershed contributing to the tributary. This represents the design condition and results in highest velocities and scour effects at the bridge. As the water level rises in the river channel, it starts to affect the flow and stage in the tributary. At high flows and high flow stages in the main channel, the water flows into the tributary from the main channel as backwater. This represents the check condition and defines the highest possible stage and bottom chord elevation at the bridge. Using FEMA FIS's information studies performed for the Sebasticook main river, values of flows and corresponding stages were obtained. The modeling completed for this project utilizes a joint probability analysis as outlined in the VTrans Hydraulic Manual to account for the coincident recurrence intervals of the flood events on Pattee Pond Brook and the Sebasticook River. Table 6-6 from the VTrans Hydraulic Manual is below:

Table 6-6. Joint Probability Analysis

Area Ratio $A_R = A_M/A_T$	Frequencies for Coincidental Occurrence							
	10% AEP Design		4% AEP Design		2% AEP Design		1% AEP Design	
	Main Stream	Tributary	Main Stream	Tributary	Main Stream	Tributary	Main Stream	Tributary
$A_R \geq 10{,}000$	50%	10%	50%	4%	50%	2%	50%	1%
	10%	50%	4%	50%	2%	50%	1%	50%
$1{,}000 \leq A_R < 10{,}000$	50%	10%	50%	4%	20%	2%	10%	1%
	10%	50%	4%	50%	2%	20%	1%	10%
$100 \leq A_R < 1{,}000$	20%	10%	20%	4%	10%	2%	4%	1%
	10%	20%	4%	20%	2%	10%	1%	4%
$10 \leq A_R < 100$	10%	10%	10%	4%	4%	2%	2%	1%
	10%	10%	4%	10%	2%	4%	1%	2%
$1 \leq A_R < 10$	10%	10%	4%	4%	2%	2%	1%	1%
	10%	10%	4%	4%	2%	2%	1%	1%

The flow rates and boundary conditions used to model this bridge site are summarized below

Reccurence Interval	Design		Check	
	Q	Downstream WS EL	Q	Downstream WS EL
1.1	210	44.1	210	44.1
2	385	45.9	385	45.9
5	563	48.9	563	48.9
10	688	51.4	688	51.4
25	852	51.4	688	54.6
50	976	54.6	852	57.1
100	1110	57.1	976	59.9
500	1427	59.9	1110	67.2

Conclusion

In reviewing the hydraulic modeling and based on the probability analysis based on the VTrans Hydraulic Manual, flow at the Pattee Pond Brook bridge is largely unaffected by the Sebasticook downstream until the 25 year event. The Sebasticook overtops during the check, Q100, event inundating the surrounding area including this bridge. It was not considered prudent to further raise the grade to clear the 100 year event especially considering the character of Garland Road

and the other low lying areas along it that would also be flooded. The proposed bridge is adequately sized for the design, Q50, event.

Stream bed channel and Habitat connectivity analysis (HCD)

The proposed channel is the same as the existing channel upstream and downstream of the bridge except directly under the bridge and within the proposed cofferdam limits. A deep cut to is to be performed just below the bridge, and an existing push bar just downstream from the bridge is to remain and to get tied to a 1% slope channel upstream. An existing upstream sediment wedge is to remain untouched as we rely on natural flow to readjust the stream channel. The existing profile of the stream does not contain any major head cuts or incisions, but it has a 2 to 3 ft drop at the downstream apron edge, which is going to be removed when the apron is taken out. It is recommended that both the upstream and downstream banks be armored to maintain channel stability and improve connectivity, as evidence of bank erosion exist with fallen trees and vegetation into the channel. The existing downstream bed itself contains natural rocks and pebbles, but some channel rock features are to be placed in certain areas upstream to improve roughness and provide streambed stability.

SUMMARY

The summary table below includes subcritical flow regime results for both the existing and the proposed bridge openings.

		Existing Structure	Recommended Structure
		20' span Concrete Frame Bridge	58' span Integral Abutments Bridge
Total Area of Waterway Opening	ft^2	146	458
Headwater elevation @ $Q_{1.1}$	ft	51.69	51.49
Headwater elevation @ Q_{10}	ft	53.01	52.97
Headwater elevation @ Q_{25}	ft	54.57	54.62
Headwater elevation @ Q_{50}	ft	57.07	57.11
Headwater elevation @ Q_{100}	ft	59.88	59.91
Headwater elevation @ Q_{500}	ft	67.22	67.22
Freeboard @ Q_{50}	ft	1.93	2.09
Freeboard @ Q_{100}	ft	-0.88	-0.71

Outlet Velocity @ $Q_{1.1}$	ft/s	5.91	5.47
Outlet Velocity @ Q_{10}	ft/s	8.16	6.37
Outlet Velocity @ Q_{25}	ft/s	7.91	6.21
Outlet Velocity @ Q_{50}	ft/s	6.43	4.45
Outlet Velocity @ Q_{100}	ft/s	4.15	2.64
Outlet Velocity @ Q_{500}	ft/s	3.54	2.21