RM of Mossey River - Fork River Crossing Replacement   File: 5655.00

TAC Questions and Responses

1. **Culvert type: the executive summary mentions open bottom culverts for the new crossing; the project summary (p. 2.1) mentions arched CMPs. Since a cross section of the installation is not shown in the drawings, can you clarify if the proposed culverts have an open bottom?**

Response:

The proposed will be arched so that a natural bottom will develop along the bottom of the culvert.

2. **Culvert invert elevation: the project summary (p. 2.2) mentions an invert elevation of 295.35 m and a streambed elevation of 295.50 m, for an embedded amount of 0.15 m. In the mitigation measures discussed on page 5.7, embedding 0.3 m or 10% of the vertical height of the pipe, whichever is greater, is mentioned. Can you confirm the invert elevation with respect to the bed elevation?**

Response:

The culverts have an invert elevation of 294.35 m, a streambed elevation of 294.50 m (I'm assuming the 295.XX was a typo) with a 0.15 m embedment.

3. **Culvert horizontal spacing: what is the horizontal distance between adjacent culverts? How does this compare with the stream crossing guidelines?**

Response:

The culverts will be spaced 500 mm from metal to metal. UNIES' analysis (modified one-dimensional open channel flow hydraulics) does not explicitly consider a pipe spacing, only the conduit cross sectional flow area and number of conduits in order to estimate entrance, exit, and frictional energy losses and the resulting headlosses, water depths and velocities in the conduits and over the top of the road. For minimum obstruction to the discharges under lower flow conditions, it would be desirable to minimize the pipe spacing, subject to construction requirements.

4. **Concerning the phases of the project (Section 2.1.3, p. 2.2), it is not clear that each of the two phases will require a separate cofferdam to isolate the work area involved, while leaving the other side open for flow and fish passage. Can you confirm that this is the case?**

Response:

Correct, a cofferdam will be used during each phase of construction to isolate the construction from the stream.

5. **Concerning fish passage and the application of the stream crossing guidelines, the anticipated average flow velocity (Section 2.1.5, p. 2.2) is 1.64 m/s, but DFO reports an average velocity (presumably an average maximum velocity) of 1.0 m/s, which is lower than the anticipated velocity. Can you clarify? Has any analysis been done of the amount of time maximum fish passage velocities could be exceeded? What happens during extraordinary events such as the event that damaged the existing structure? Is fish passage possible through or over the structure?**

Response:

Stantec has surveyed cross sections A, B, and C upstream, and D, E, F, G and H downstream of the crossing. Varying cross sectional geometry at the various cross sections within the group surveyed means that, for any particular river discharge, in simplest form, the average or mean velocity in the stream theoretically speeds up and slows down as the water advances downstream through the contracting and expanding cross sections. In reality, the flow in the river is not simply one-dimensional; its velocity varies across the channel both in rate and direction, creating both quieter and more rapid areas of flow.

At the Fork River low-level crossing in question, the channel hydraulics are further complicated by the very high skew of the roadway in relation to the general direction of flow. Flows traversing the roadway via the culverts do so more or less in parallel with the general direction of flow. In contrast, any portion of the flow which passes over the roadway, or weir, tends to curve toward the left, to exit at an angle closer to right angles with the road. The accumulated widening of the channel now seen at the left bank just downstream of the crossing may be largely attributable to the more direct attack angles for the flows that have been imparted to them during their passage over the top of the roadway. The flows tend additionally to be a little quieter near the right bank as a result, and the right side upstream of the crossing has tended to catch a little more of the stream's bed load and debris over time.

For the 3dQ10 one-dimensional test discharge estimated at 16 cubic metres per second, the theoretical mean velocities at the open channel cross sections ranged typically between 0.78 m/s, at one of the upstream sections located about 40 metres upstream of the roadway centreline, to 1.20 m/s at one of the downstream sections located about 65 metres downstream of the roadway centreline (UNIES report, Table 2). At the other typical cross sections upstream and downstream, the theoretical mean velocities varied within that range. Cross sections at two other locations were considered to be unrepresentative of actual general channel conditions near the crossing and yielded estimated flow conditions outside this range, one appearing to be unrealistically constricting and the other too large. Ignoring the non-linearity of flow conditions, one could estimate that the range of geometries therefore would yield a theoretical average velocity in the open channel near the site of around 1.0 m/s at the adopted 3dQ10 discharge. One would expect faster flows nearer the middle and slower flows nearer the banks.

At the 3dQ10 discharge of 16 cu m/s, it is estimated that 10.2 cu m/s would be passing through the ten proposed culverts and 5.8 cu m/s would be going over the road. It is expected that the effective widening of the flow section at the road (due to the high degree of skew and shallow approach gradient of the road) would result in areas of very low overflow velocity along the sides and limited contribution to the total discharge, together with an active area toward the middle, above the culverts. As this differs from uniform flow conditions, quantities cannot be estimated precisely. However, with an assumed active overflow flow area about 28 metres in width at the upstream side and 40 metres at the downstream side, with ineffective flow areas assumed further out from the stream centre line, average velocity in the culverts under these conditions is estimated at 1.64 m/s. Average velocity above the active part of the road at the upstream edge with this conceptualization of flow conditions is estimated to be about 0.74 m/s from an average flow depth of 0.28 m and flow width of 28 m, while at the downstream edge it is 1.11 m/s from a flow depth of 0.13 m and the 40 metre flow width. These estimates must be considered range only, due to the expected unresolvable difference between simple theory and actual field conditions.

The existing structure is overtopped often for short periods due to the combination of a flashy stream and low roadway/weir height (~ 1 metre). At the time of the site inspection in late 2011, the structure was still in position and a functional stream crossing for motor traffic. However, the hardened surface was well worn and cracked. The main loss in hydraulic performance of the structure has been the plugging of the culverts by an accumulation of stream bed material delivered at higher discharges. The significant reduction in culvert capacity has increased the number of times that the roadway has overtopped. Whether the inner dimensions of any of the existing conduits had been reduced by collapsing could not be ascertained. The proposed replacement conduits are of significantly greater flow area in order to facilitate their maintenance and allow a greater proportion of the flow to pass beneath the roadway surface, thus reducing the frequency of road closure.

Fish passage is possible both over the roadway and through the culverts, as exemplified in Table 2 of the report for various discharges. It is expected that overflow velocities lower than the cross-sectional average would be experienced adjacent to the shorelines and provide alternative opportunity for fish bypass outside of the main flow areas when conduit and overflow velocities may be high. Because the proposed replacement roadway would remain quite low, frequency of overtopping would remain relatively high, although less than for the existing structure (with the obstructing stream bed materials assumed to be removed). At higher, although less frequently experienced flow conditions, the obstructive effect of the submerged structure diminishes to minor, while overflow velocities within the same range as experienced in the unaltered channel at various points upstream and downstream would prevail. As noted in the report (page 13 and Figure 9), the lengths of time when discharges remain above about 13 cu m/s at the site have been about three or four days for the largest rainfall floods on the record and slightly longer for spring runoff conditions.