Memo

Date:	Friday, September 09, 2016
Project:	Dalton Highway H&H MP 0-9 (#025-5-1-055, P1)
To:	Lauren Little and Andrew Wells, Alaska DOT&PF - NR
From:	Jon Zufelt and Jacques Annandale - HDR
Subject:	**General Project Recommendations**

Objective

The purpose of this memorandum is to recommend what type of drainage structures should be constructed in order to mitigate the operations, maintenance, and damage for the Dalton Highway realignment from mile posts 0 to 9.These general project recommendations are based on a review of the project data received from the Alaska DOT&PF, analysis of the proposed new alignment (O5), the proposed road prism cross sections, and observations made during the winter and summer field investigations. The memorandum first discusses general issues followed by the structures at the specific crossing locations.

Scour issues

Scour is specifically addressed at the watercourse crossings along the proposed O5 alignment in the Summary Hydraulics Report as per the Alaska Highway Preconstruction Manual. This would include not only contraction scour at the crossing itself but also scour of the bed (e.g., within fish passage culverts) and inlet and outlet scour for the culverts. Other scour could occur in the roadside ditches (general drainage) locally and between cross highway drainage structures. It is envisioned that any special scour protection for the drainage ditches would be finalized with the determination of the final location and invert elevation of the cross highway drainage culverts in coordination with Alaska DOT&PF engineers.

Areas of aufeis and mitigation alternatives

During the field observations of March 20-21, 2016, aufeis was present at many locations south of the O2 and O5 alignments, primarily from 125+00 to 170+00 and from 260+00 to 270+00. These deposits were actively growing (visibly wet) along the O2 alignment and they extended to the north toward the O5 alignment in areas where the ground slope was relatively flat and vegetation indicated at least seasonal flooding (wetlands). In the O5 alignment areas where the ground elevation increases, aufeis was not observed. The O5 alignment generally hugs the base of the hill on the north side of the West Branch of the Tolovana Valley. Other than small wetland areas directly south of the alignment in a couple of locations, there did not appear to be any significant seeps or groundwater drainages coming off of the hill which might contribute to aufeis formation. During the August 17-18, 2016 field visit, it was noted that the footing along the alignment was difficult due to excessive hummocking of the ground surface between

125+00 to 150+00. This type of ground is indicative of permafrost or highly frost susceptible materials.

Where the existing ground slope is flat on the south side of the road prism, such as in Figure 1 below for the section at 155+00, there exists potential for aufeis development, especially where cross drainage structures may be required for local drainage. The location in this figure also corresponds to the low point of the north side ditch along this section of the O5 alignment, where cross drainage structures would typically be located. Options for mitigation of aufeis formation include insulated subdrains below any culverts, thaw pipes in the culverts, and minimizing winter flow at the cross drainage structures.

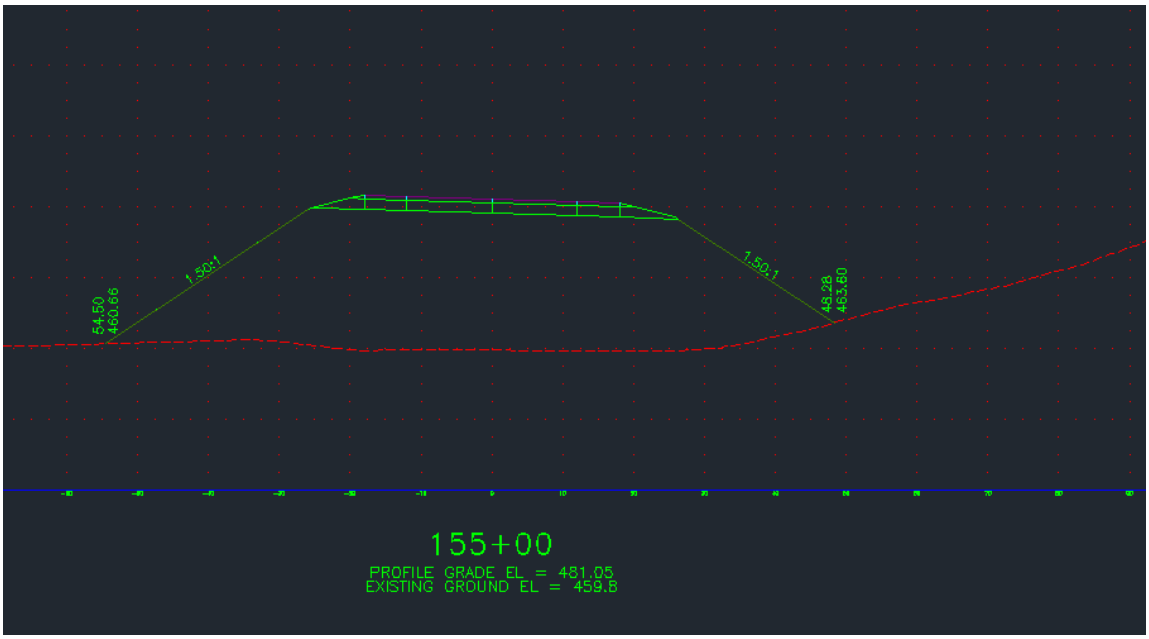

Figure 1 Representative road prism section along O5 alignment

In addition to the aufeis along the proposed alignments, there is extensive aufeis that develops both upstream and downstream of the Elliott Highway at Rosebud Creek which is addressed below.

Special ditch treatments

In addition to the ditch treatments for protection from local scour, there are a few areas where the road prism will be cut into the hillslope and additional measures should be considered. For example, Figure 2 shows the road prism at station 306+00 where both sides show a significant cut (entrenched road section). The width of the ditches should be sufficient to catch rock or soil slides in the case of cut slope failures. Sections with significant entrenchment may also result in snow drifting, particularly in the ditches.

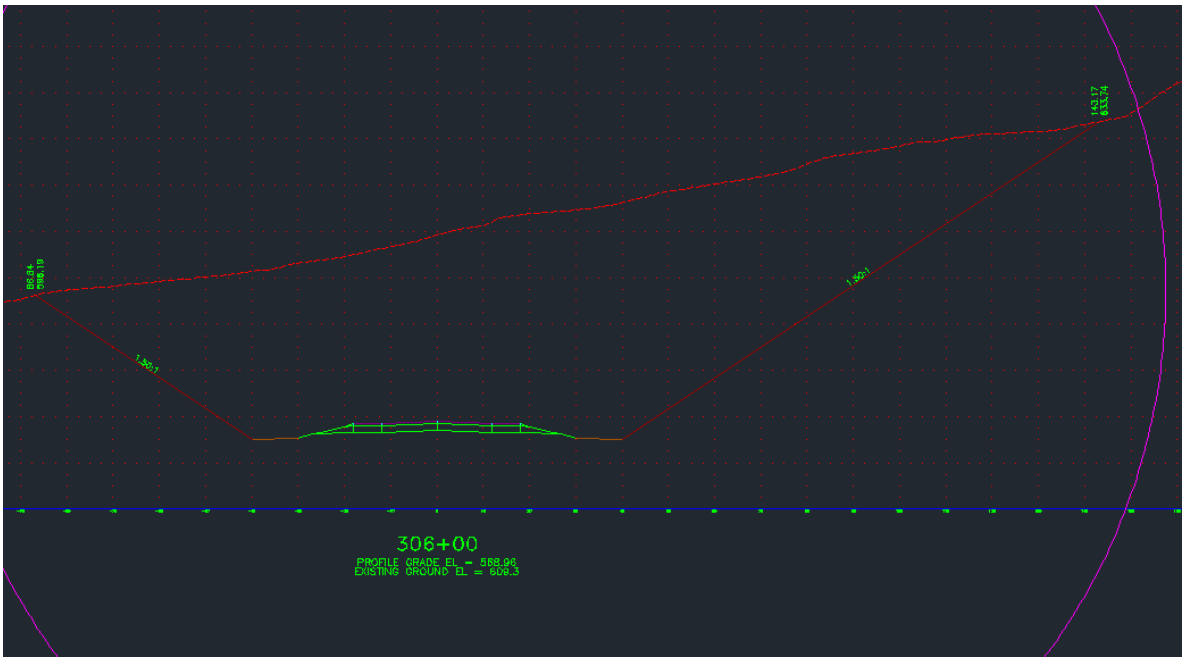

Figure 2 STA 306+00 Significant Entrenchment Section

Snow drifting

Snow drifting does not appear to be a problem for most of the proposed route. There were some local areas along the alignment observed during March 20-21, 2016 where snow had drifted into a snow machine track and other small depressions but these were generally in areas with little vegetation to block the wind. Wind direction was prominent from west to east and this direction would correspond to little accumulation along the east/west alignment (approximately 80+00 to 335+00). The cross wind locations where drifting would be more prevalent do not expose much wind shadow area where snow would accumulate. Areas that may accumulate snow include 78+00 to 80+00 and 338+00 to 347+00.

Rosebud Creek Culvert

The existing Rosebud Creek culvert is plagued by aufeis with thick accumulations developing at both the upstream and downstream sides. The crossing consists of 30 feet of cover over a 60 inch CMP with a slight skew angle (approximately 10 degrees as shown in Figure 3) with a 24 inch CMP located directly above it as shown in Figure 4. The roadway has settled adjacent to the culvert crossing most likely due to permafrost thawing. Both culverts have damage at their inlet and outlet. The first and last 6 feet of the 60 inch culvert has been disconnected at the inlet and outlet and the remaining end sections are both bent upwards (Figures 3 and 4). The inlet is slightly perched and the outlet has a scour hole. The damage is likely due to buoyancy forces from ice. The 24 inch culvert above has a slightly squashed inlet. Figure 5 shows the aufeis conditions at the inlet and outlet on March 21, 2016. Aufeis fills the channel and floodplains both upstream and downstream of the Elliott Highway at this location.

Figure 3 (Left) Aerial View of Rosebud Creek; (Right) Rosebud Creek Inlet

Figure 4 (Left) Rosebud Creek Outlet from above; (Right) Rosebud Creek Culvert Outlet from downstream

Figure 5 (Left) Rosebud Overflow Culvert Inlet; (Right) Rosebud Overflow Culvert Outlet

Alaska DOT&PF have indicated that options include either 1) leaving the existing Elliott Highway embankment in place and replacing/extending the Rosebud Creek culvert (resulting in a total length of 300 feet) or 2) removing the existing Elliott Highway embankment following construction of the new alignment.

For the first option, the new alignment will not be as high (not as much cover) for the extended culvert and the existing culvert would need to be repaired or replaced. Aufeis would continue to be a problem at both the inlet and outlet of an extended culvert. It is recommended that during the construction of the new alignment, the existing Rosebud culvert should be replaced with an equivalent or larger culvert that extends through the proposed embankment. In addition, the 24 inch overflow culvert should be replaced with a minimum 36 inch culvert during the repair and construction of the Rosebud crossing. Thaw systems should be constructed through both culverts.

The second option of removal of the existing embankment would provide an opportunity to remove the existing the culvert crossing (inlet and outlet damage), provide for some mitigation credits by remediation of the upstream channel, and construct a new shorter 60 inch or greater culvert, a new shorter 36 inch aufeis overflow culvert, and thaw pipe systems.

West Fork of the Tolovana Tributaries #1 and #2

The proposed alignment crosses the West Fork of Tolovana Tributary #1 approximately 8,000 ft. southwest of the existing highway crossing at STA 205+00. The highway-creek crossing is close to the confluence of the Tolovana and the Tributary and is generally in the floodplain valley of the Tolovana. The West Fork Tolovana Tributary #1 meanders in and out of the proposed alignment downstream of the crossing from STA 192+00 to 205+00. At the crossing location (205+00), the tributary conditions on August 17, 2016 were approximately 6 to 10 feet wide, 1 foot deep, an approximate flow velocity of 0.75 fps, a gravel-sand creek substrate, and crossing the alignment at a significant skew. These conditions can be seen in Figure 6.

During the August 17-18, 2016 summer field visit it was identified that the West Fork Tolovana Tributary #2 flows into Tributary #1 approximately 100 yards upstream of the Tributary #1 O5 alignment crossing and therefore will be considered as part of the Tributary #1 basin.

Figure 6 West Fork Tolovana Tributary #1 Alignment Crossing

Because the Tolovana Tributary #1 crossing intersects and then meanders back and forth across the O5 alignment, there is a range of locations to place the crossing. It is recommended that the culvert crossing be southeast of the RS2477 Trail intersection with the O5 alignment (approx. STA 205+00). With this alternative the highway embankment would help protect the trail from erosion and flooding. Because of the creek and highway alignment orientation, the crossing will need standard culvert inlet and outlet erosion protection and some additional riprap embankment protection upstream and downstream to help guide the creek towards and out of the culvert crossing. The extents of the additional embankment riprap protection will be determined during the design of the crossing. There may be a need to provide channel improvements downstream of the crossing to direct the flow away from the highway embankment and toward the West Fork of the Tolovana River.

Lost Creek Tributary #2

Lost Creek Tributary #2 has been identified by ADF&G as potential fish habitat. The channel is well defined and slightly incised (3-4 feet from top of bank to the ice surface and OHW), has a confined floodplain, and is a step-pool stream containing some larger rocks and large woody debris. The crossing should be well suited to a large open bottom arch pipe or buried culvert with stream simulation to maintain bed conditions while providing adequate flood capacity. The stream crossing is approximately 45 degrees skew to the road alignment. The skew increases culvert length and constructions costs; however, changing the highway alignment to reduce the skew and culvert crossing costs may increase road construction costs and contradict road design guidance. Therefore, it is recommended that the highway alignment be maintained as proposed. Figure 7 depicts the crossing location in summer and winter conditions.

Figure 7 (Left) Lost Creek Tributary #2 August 18, 2016; (Right) Lost Creek Tributary #2 March 21, 2016

Unamed Culvert at MP 8.0

At MP 8.0 there are no highway alignment changes proposed, but some road rehabilitation work will be performed. At this particular crossing there is a small drainage basin with a cross drainage culvert under approximately 30 feet of cover. The culvert is not conveying the local drainage as indicated by the large pool at the inlet, and no perceivable flow from the outlet (Figures 8 and 9). It is assumed that the water is draining through the embankment via percolation and groundwater. The cause of the blockage could either be sediment and debris blocking flow, or a pipe collapse. Inspection looking up the culvert outlet did not verify either of these conditions.

Figure 8 Culvert at MP 8.0 Inlet

Figure 9 Culvert at MP 8.0 Outlet

It is recommended that the inlet pool be drained to allow for more adequate investigation. If the pipe has not collapsed the construction contractor could clear the debris, repair the culvert if needed, and reinstate drainage conveyance. If the pipe has collapsed, ADOT&PF should explore replacing the pipe using trenchless excavation approaches to avoid a significant earthwork costs and temporary highway closure. Ultimately a feasibility and cost study comparing open trench excavation and trenchless excavation would determine the appropriate method for replacing a structurally failed culvert. The current size of the culvert would provide adequate capacity if not blocked. Since it is less than 48 inches, it will not be addressed in the H&H design.

Removal of the Existing Lost Creek Culverts

The existing Dalton Highway alignment culvert crossing at Lost Creek at MP 5.7 is shown in Figure 10. This section has a considerable amount of fill and crosses Lost Creek at a large skew angle. The existing crossing includes a single 60 inch CMP culvert which follows the historic creek bed plus a battery of culverts to provide flow capacity during floods. The flood capacity culverts from east to west include three 72 inch CMP culverts, two 48 inch CMP culverts, and two 36 inch CMP culverts. Figure 11 shows the view looking to the NW at the Lost Creek crossing. The large spruce trees on either side indicate the location of the historic channel. Removal of the Lost Creek culverts and adjacent roadway embankment represent an opportunity to earn mitigation credit for restoration of the historic creek bed and adjacent floodplain. Based on the summer field visit it is recommended that 285 ft. of road embankment and culverts can be removed to restore some of natural floodplain (seen in the hatched area in Figure 10). To the northwest of this area are the two 48 inch CMP culverts, one of which appears to be acting as an elevation control structure for an upstream wetlands area. A pool at

the outlet of this 48 inch culvert may serve as a water supply point (roadway maintenance) for future operations. The existing water supply point at the outlet of the 60 inch CMP would most likely be lost due to removal of this culvert and access to east side of Lost Creek.

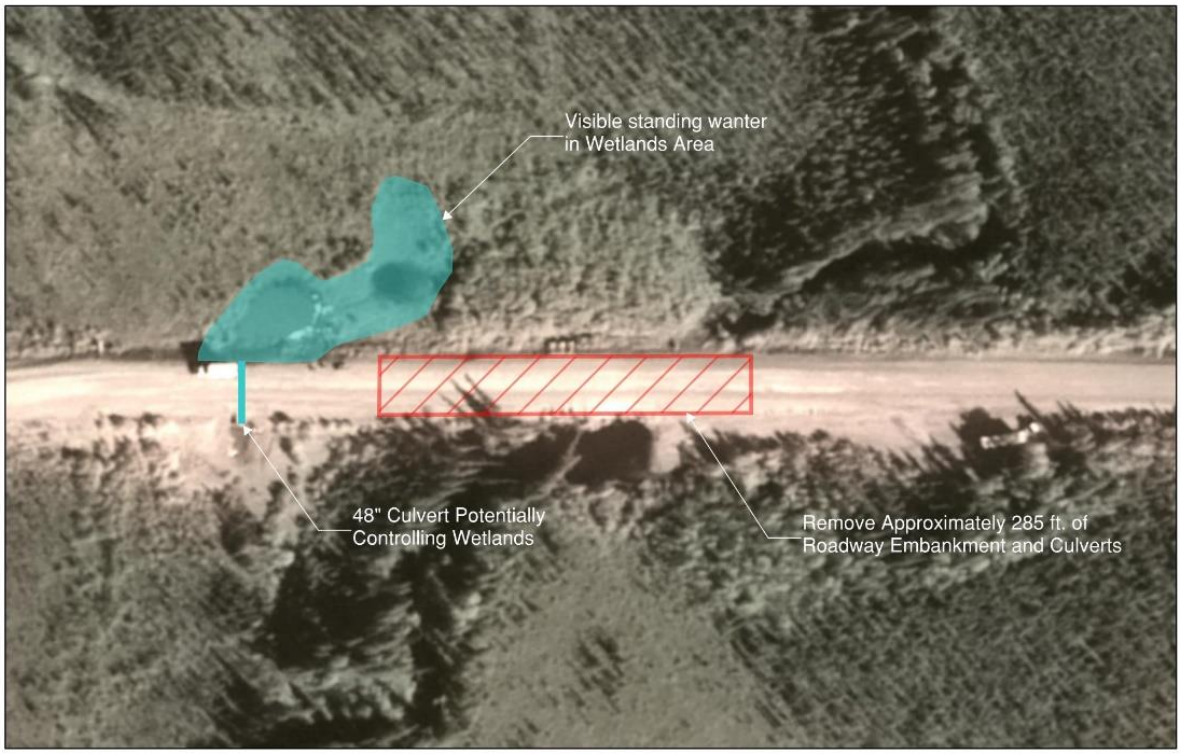

Figure 10 Proposed Road and Culvert Removal at Existing Lost Creek Crossing

Figure 11 Looking NW toward Lost Creek

Conclusion

The general H&H design recommendations discussed in this report provide the initial design concepts. The next steps include project team members meeting in order to discuss and modify these concepts, identifying the design path forward, and then providing the design and analysis details for each site in the H&H report and design drawings, respectively.