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Montana Department of Transportation

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Memorandum

To: Tyrel Murfitt, P.E.
Road Design Area Engineer - Butte District

From: Nick Jaynes, P.E.
Geotechnical Engineer - Butte District

Date: April 27, 2018

Subject: NH 11-1(84)50
Livingston-South
CN 8790000
Geotechnical Engineering Alignment Report (Activity 464) **SUPPLEMENTAL**

Please replace Section 3.2.2 of the March 8, 2018 Geotechnical Engineering Alignment Report (Activity 464) with the following:

3.2.2 Station 45+00 to Station 64+50

3.2.2.1 Special Borrow Placement for Subgrade Support (Station 45+00 to Station 53+00)

To mitigate for the presence of near surface very loose silty sand and provide the required subgrade structural support, we recommend that between Station 45+00 and Station 53+00 the top 2 feet of subgrade below the typical section (measured at the left edge of the surfacing section) consist of properly compacted special borrow in accordance with Section 203. Prior to placement of special borrow, the top 8 inches of subgrade will be recompacted in accordance with Section 203 and separation geotextile will be placed at the bottom of the excavation. The excavation will match the surfacing grade for 28 feet and then bench into the existing embankment toe. A special provision for special borrow has been uploaded to DMS and a sketch of the special borrow placement at Station 47+50 is shown in Figure 7a below to assist in preparing details for the final plans.

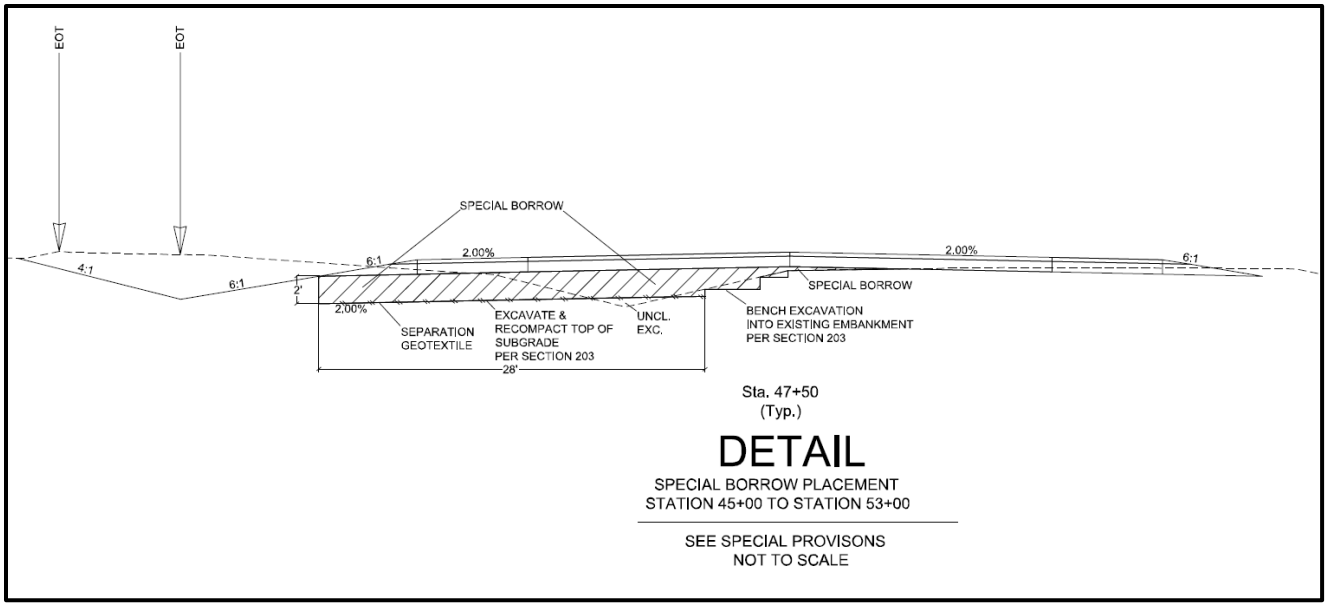

Figure 7a. Special Borrow Placement for Subgrade Support. Station 45+00 to Station 53+00.

3.2.2.2 Special Borrow Placement for Liquefaction (Station 53+00 to Station 64+50)

Liquefaction analyses were performed for five cross sections between Station 47+50 and Station 60+00 using the SPLiq Liquefaction Analysis Tool (Franke et al. 2016) and checked using Liquefy Pro 5.0 liquefaction software. The subsurface stratigraphy and site parameters were obtained from nearby borings and with an assumed groundwater table of 5 feet bgs. The results of these analyses are summarized in Table 1 below:

Table 1. Embankment Liquefaction Analysis Results.

Proposed Embankment Cross Section	Boring Number(s)	Min. Factor of Safety	Critical Soil Layer Depth	Expected Ground Surface Settlement (in)	Expected Lateral Spread (in)
47+50*	8790-8	1.3	5'-8.3'	<1	0.7
52+00*	8790-9	11.7	5'-8'	<1	0.4
56+00	8790-10	0.90	4.1'-8.1'	1.2	1.1
58+00	8790-11	0.50	11.1'-16.1'	2.8	1.5
60+00	8790-12	0.60	4'-8.9'	4.5	1.8

* Cetin (2004, 2009) method used instead of Idriss & Boulanger (2008, 2012).

As shown above, the highest probability of liquefaction occurs between approximate Station range 56+00 to 60+00 near the location of the proposed retaining wall. At these locations, the factor of safety against liquefaction triggering ranges from 0.5 to 0.9 (probability of 72 to 99 percent), with most of the liquefaction occurring within the very loose, wet, silty sand encountered near the ground surface. The cumulative ground surface displacement due to liquefaction in this segment of the alignment is estimated to range from 1.2 to 4.5 inches and lateral spread is expected to be about 1 to 2 inches.

To mitigate some of the anticipated settlement, we recommend that between Station 53+00 and Station 64+50 the top 3 feet of subgrade below the typical section (measured at the left edge of the surfacing section) be excavated, the top 8 inches of subgrade be recompacted to MT 230 (modified proctor) in accordance with the special provisions and separation geotextile be placed at the bottom of the

excavation. Higher compaction effort in this segment of the alignment is recommended to provide increased density to the underlying very loose sand and help reduce liquefaction potential.

New embankments in this segment of the alignment should be constructed with special borrow in accordance with Section 203. The excavation will match the surfacing grade for 28 feet and then bench into the existing embankment toe. Special provisions for compaction of subgrade and placement of special borrow have been uploaded to DMS and a sketch of the excavation and geotextile placement at Station 56+00 is shown in Figure 7b below to assist in preparing details for the final plans.

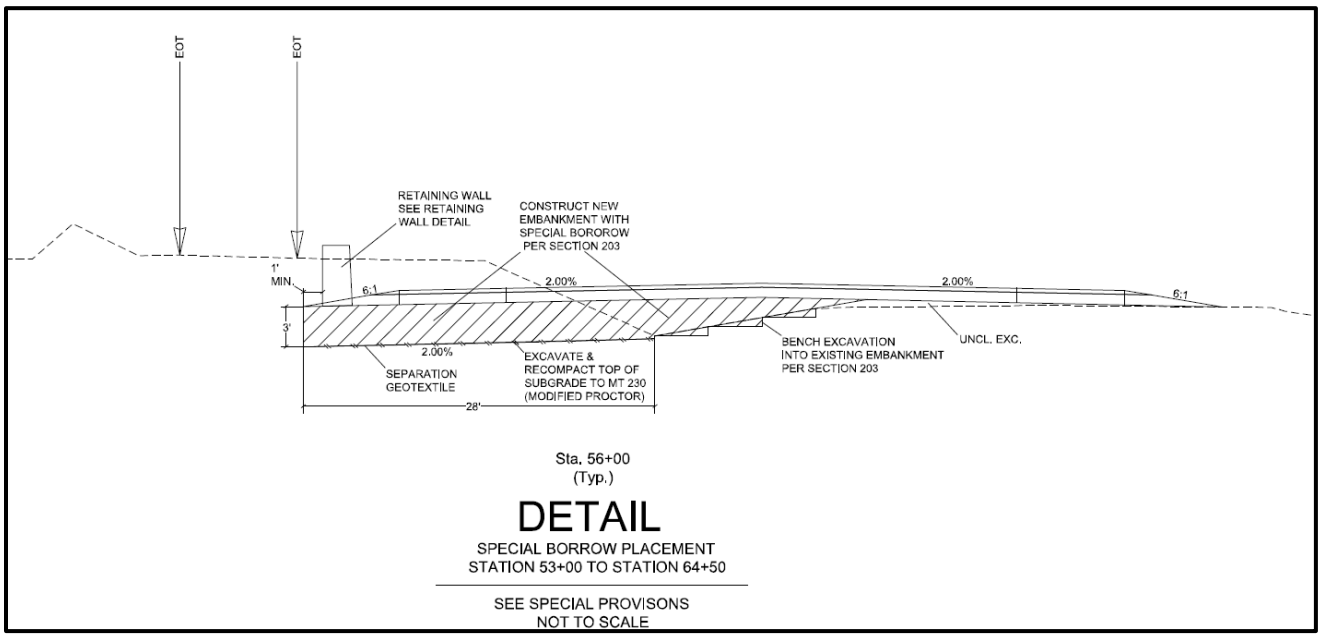

Figure 7b. Special Borrow Placement for Liquefaction. Station 53+00 to Station 64+50.

As shown above, the retaining wall will be constructed on top of the compacted special borrow section. The retaining wall will be addressed with a separate detail and special provision, which will be provided in an Activity 468 report.

Please let us know if you have any questions or need clarification.

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