

August 17, 2009

PML Ref.: 09HF047
REVISED Report: 1

Mr. Mark Mueller, B.E.S.
McCormick Rankin Corporation
2655 North Sheridan Way
Suite 300
Mississauga, Ontario
L5K 2P8

Dear Mr. Mueller

**Slope Stability Evaluation
Grand River Bridge at Cayuga
GWP 3501-01-00, Site 9-43
Highway 3, District 31
Cayuga, Ontario**

This letter provides foundation engineering comments and recommendations regarding the stability of the embankment fill slopes that parallel the alignment of Highway 3 on the west side of the Grand River in Cayuga. The study was conducted for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation (MTO).

Refer to the Foundation Report prepared during the Feasibility Study for the Rehabilitation or Replacement of the Highway 3 Bridge over the Grand River at Cayuga (Geocres No. 30L13-18, PML Ref.: 04HF058A) for additional information concerning the existing bridge and adjacent land use.

Drawing Review

It is noted from the Cross Sections provided by email dated June 30, 2009 that the west approach embankment is about 4.0 to 5.5 m high (increasing from west to east), the design calls for placement of 100 to 300 mm of fill on the slope west of Station 9+870 and about 1.0 m near the west bridge abutment (Station 9+870 to 9+890) to enable widening of the roadway. It is noteworthy that the design does not call for increasing the embankment height except in the area within 20 m of the abutment where the road grade will be raised by less than 500 mm.

It is also noted that the design calls for no significant change to the overall inclination of the embankment slope transverse to the embankment between Station 9+810 to 9+850; between Station 9+850 and 9+890 the overall slope inclination will be increased by up to 0.3 horizontal to 1.0 vertical (0.3H:1.0V) (about 14%) from 2.4H:1V to 2.1H:1V.

The contours on the plan provided indicate the embankment at the west abutment is about 6.5 m higher than the ground surface in the Grand River adjacent to the east side of the abutment. The overall inclination of the slope transverse to the abutment (parallel to the river) is inclined at 1.6H:1V.

Site Reconnaissance Survey

A site reconnaissance survey was conducted on July 6, 2009 to examine the embankment slopes for the characteristic indicators of slope performance (tension cracks, slide scars, irregular topography, vegetation cover, distressed vegetation, seepage zones, guardrail misalignment).



No evidence of instability or seepage zones was detected. A heavy vegetation cover of grass, weeds and small shrubs exist on the slope.

The side slopes of the Grand River (parallel to the Grand River, perpendicular to the bridge approach embankments) remote from the abutment are about 2 m high, heavily vegetated and inclined at 35 to 50° (1.4H:1.0V to 0.8H:1.0V) to the horizontal. The inclination of the river bank slopes are governed by erosion.

Review of MTO Slope Maintenance Records

We understand there have been no maintenance concerns regarding the performance and/or stability of the approach embankments at the bridge.

Subsurface Conditions

Boreholes were not drilled at the abutments or along the alignment of the approach embankments during the field investigation conducted for the Preliminary Design Report (Geocres 30L13-18). The subsurface conditions revealed in boreholes drilled during foundation investigations conducted by Peto MacCallum Ltd. (PML) for eight other projects in the vicinity of the bridge indicate the soil below the embankments is likely to comprise stiff to very stiff silty clay and/or stiff to very stiff layered silt and clay at or slightly below the Plastic Limit. Stiff to very stiff silty clay was observed in the sideslopes of the Grand River.

There is no record of the composition of the fill used to construct the approach embankments. Cognizant of the age of the bridge (constructed in 1924) and the observed/reported performance of the fill slopes, we believe it is reasonable to assume that silty clay from the area was used to construct the approach embankments.

Engineering Discussion

The approach embankments to the Grand River Bridge on Highway 3 in Cayuga were constructed about 85 years ago. The most significant change to the inclination of the embankment slope west of the bridge called for in the design is in the vicinity of the west abutment where the embankment is about 5.5 m high; the overall average inclination of the slope on the south side of the embankment is currently about 2.4H:1V, the slope inclination on the north side of the embankment is flatter.

The design calls for increasing the inclination of the south embankment slope to 2.1H:1V and the north slope to 2.3H:1V. It is considered therefore, that the future performance of the south slope is critical from a foundation engineering perspective.

Engineering analysis conducted to assess the impact of steepening the slope inclination using reasonable geotechnical parameters for the stiff silty clay fill and the native soil likely to exist on site ($c' = 5 \text{ kPa}$; $\phi' = 27.5^\circ$; $\gamma_r = 20 \text{ kN/m}^3$; pore pressure ratio of 0.3) indicate the factor of safety against failure of the existing slope inclined at 2.4H:1V is about 1.6 and increasing the inclination to 2.1H:1V will result in an approximate 5% decrease in the computed factor of safety to about 1.5.



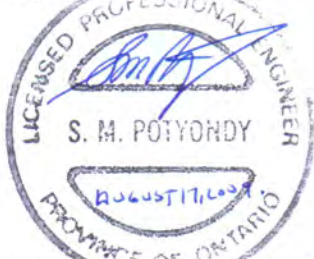
Cognizant of the satisfactory performance of the embankment slopes indicated by MTO records, visual examination of the slopes on July 6, 2009, and engineering analysis conducted to assess the impact of steepening the slope, it is our opinion that the proposed construction will not adversely impact the future performance of the approach embankment slopes. It is assumed that the slope grading work will be conducted in accordance with OPSD 208.010 (existing slope to be stripped; bench height and width to be 600 mm). In addition, the permeability of the fill placed to steepen the slope should be higher than the existing embankment fill.

These comments are specific to the slopes that parallel the approach embankments to the bridge; measures to prevent erosion of the river bank and maintain the stability of the slope at the abutment transverse to the approach fill embankment should be considered during detail design.

We trust these brief comments are sufficient and look forward to any questions you may have.

Sincerely

Peto MacCallum Ltd.



Susan M. Potyondy, P.Eng.
Senior Geotechnical Engineer
Manager, Geotechnical Services
Hamilton



Dennis W. Kerr, MEng., P.Eng.
Chief Foundation Engineer

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Distribution:

4 cc: McCormick Rankin Corporation (+ email)
1 cc: PML Hamilton
1 cc: PML Toronto