

MEMORANDUM

To: Greg Hill, Senior Director, Kinder Morgan Canada (KMC)
Cc: James Ji, Senior Geotechnical Specialist, Golder Associates Ltd. (Golder)
From: Ron Byres, Senior Project Manager, Moffatt & Nichol (M&N)
Date: May 11, 2015
Subject: Summary of Preliminary Geotechnical Engineering
M&N Job No.: 7773

Moffatt & Nichol and Golder Associates Ltd. have been working collaboratively on the Westridge Marine Terminal engineering since late 2013. Golder's geotechnical investigations carried out to date have been specifically designed to support our preliminary engineering needs for the marine terminal structural engineering process. The nature of maritime engineering is somewhat iterative, in that potential structural solutions are used to design the field data collection program, and the results of the field program are then used to refine the design concepts. Once a preferred structural configuration is identified, the geotechnical engineering analysis is finalized and used as input to the final structural design. At this time, both the geotechnical and structural designs are preliminary in nature and will not be finalized until the detailed engineering process is well underway. Detailed engineering and design is anticipated to begin in Q3, 2015, assuming that the current overall project schedule is maintained.

Golder performed an initial hydrographic and geophysical survey of the site in March 2014, followed by a borehole and cone penetration test (CPT) investigation program in July and August 2014. The results of those investigations were described in Golder's reports dated June 26, 2014 and February 20, 2015 respectively.

Over the last several months M&N has consulted periodically with Golder Associates to obtain their preliminary geotechnical data and analysis as needed to support our ongoing preliminary structural design process. We have met with Golder several times both in person and via teleconference to discuss the project. In advance of publishing their February 20, 2015 draft report, Golder provided M&N with several emails containing the preliminary soils data and analysis pertinent to our evaluation of different potential structural alternatives. Below is a summary of the emails received by M&N:

1. Received on November 07, 2014
 - Golder developed P-Y curves at five selected test hole locations using the computer program LPile Plus (Version 6.0). P-Y curves are used to determine the response of a pile to lateral loads, such as berthing, mooring, wind, wave, and seismic forces. Golder's P-Y curves contained data for both static and cyclic loading conditions, and were created

based on the site borehole and CPT data as well as M&N's preliminary steel pipe pile size of 1219mm diameter.

2. Received on December 10, 2014
 - Golder recommended a pile spacing of 4 to 6 pile diameters to avoid group effects under lateral loading.
3. Received on December 12, 2014
 - Golder developed cyclic P-Y Curves at BH/SCPT14-12 for additional steel pipe pile sizes of 1372mm and 2134mm diameter.
4. Received on January 22, 2015;
 - Golder developed site specific ground response spectra using the computer program Shake2000. The response spectra was computed for a 1 in 2475 year design ground motion assuming 5% dampening. The response spectra are used to determine the response of the structure to seismic loads.
 - Golder developed cyclic P-Y Curves at BH/SCPT14-12 for a steel pipe pile size of 5182mm diameter.

These emails and their various attachments are appended to this memo for your reference. As noted by Golder in their January 22, 2015 email, the geotechnical analysis is still considered preliminary at this point, consistent with the level of engineering completed so far. As the design advances, additional geotechnical testing and analysis will be carried out (and, if necessary, additional field data collection) to refine these preliminary results.

The information provided to date has been used by our engineering staff to progress the preliminary design of the different marine structures to determine a suitable solution for the given soil conditions. Our current work is focused on identifying the most practical and cost effective solution(s) that will meet or exceed all applicable codes, standards and industry guidelines pertaining to the design of marine oil terminals. Although our analysis is still underway, we remain confident that we will achieve that objective.