



December 11, 2018

Reference No. 088877

Mr. Allan Leuschen  
Senior Environmental Protection Officer  
Authorizations – South  
Environmental Protection Division  
Ministry of Environment  
2080 Labieux Road  
Nanaimo, British Columbia V9T 6J9

Dear Mr. Leuschen:

**Re: Amendment to the Technical Response to ENV Review (Auth. No.:Pr-10807)  
Task 7 – Additional Bedrock Characterization  
Upland Landfill  
Upland Excavating, Campbell River, British Columbia**

As discussed, we have made amendments to the Task 7 - Additional Bedrock Characterization letter report. Task 7 forms part of the March 7, 2018 work plan prepared and submitted to the BC Ministry of the Environment and Climate Change Strategy (ENV). The work plan identified the scope and schedule for completing eight tasks in response to ENV's February 1, 2018 letter requesting additional information. The work for Task 7 was completed during the months of July, August and September 2018 and the initial Task 7 letter report submitted to ENV on October 1, 2018. An amended Task 7 letter report is attached to this letter.

Task 7 included conducting additional bedrock characterization work along the bedrock ridge separating Rico Lake and the Upland Excavating Ltd. sand and gravel extraction pit (Pit). The additional bedrock characterization was carried out to further characterize the bedrock ridge and the hydraulic connectivity of Rico Lake to the sand and gravel aquifer beneath the Pit.

The characterization work included advancing boreholes and test pits, installing monitoring wells, completing single well response tests, and conducting an electrical resistivity (ER) geophysical survey along three transects on top of the bedrock ridge. The Task 7 letter report was submitted to Patrick Consulting Inc.(PCI) for technical peer review on October 4, 2018. From the results of the PCI peer review, two additional hydrogeologic cross-sections through the bedrock ridge were developed by GHD and were provided to ENV and PCI on November 6, 2018. The characterization work further confirms Rico Lake is located upgradient of the sand and gravel aquifer beneath the Pit with steep groundwater gradients present across the ridge and the downgradient Pit.

Subsequently, GHD learned through discussions with ENV that the locations of test pits and boreholes may be incorrectly shown on the geophysical cross-sections (Figure 6.1 to 6.3) included in the Task 7 report. GHD reviewed the geophysical cross-sections and concurs that the location of certain test pits and boreholes were inadvertently placed in a north to south orientation rather than the correct south to north orientation on these figures. The inadvertent placement of the test pits and boreholes only occurred on the geophysical cross-sections and not on the hydrogeologic cross-sections.



Figures 6.1 to 6.3 show the results of the ER survey and the placement of the test pits and boreholes on these cross-sections does not affect the range or location of the resistivity readings illustrated.

### *Amendments*

The amendments made to the Task 7 letter report include both corrections and improvements. The amendments include, in order of page number:

- Figures 6.1 to 6.3 – The test pits and boreholes illustrated on the geophysical cross-sections have been placed in the south to north orientation.
- Figure 7.1A and 7.1B – The changes made to Figure 6.1 to Figure 6.3 are reflected on Figure 7.1A and 7.1B.
- Pg. 7, Section 6 – The section was augmented to acknowledge that additional factors were considered regarding the location of the interpreted bedrock surface on the electrical resistivity survey transects.
- Pg. 8, Section 6 – The second paragraph on pg. 8 has been inserted to describe how bedrock elevations are arrived at from the additional investigations and surveys.
- Pg. 10, Section 7.1 – The first and sixth paragraphs on pg. 10 have been modified to reflect the changes in the interpreted bedrock surface elevations and bedrock contours.

### *Amended Conclusions*

From the amendments made to the Task 7 letter report described above, the conclusions have been amended to better describe the geologic and hydrogeologic characterization of bedrock ridge and Rico Lake's connectivity with the sand and gravel aquifer, as follows:

- Bedrock is present between Rico Lake and the Pit. The top of bedrock to the southeast and east of Rico Lake occur at elevations above the Rico Lake water level.
- Fracturing is apparent within the upper bedrock unit including evidence of weathering and secondary mineralization. The size and permeability of the shallow bedrock fractures are highly variable.
- Evidence of a sand and gravel filled trough or scour channel within the bedrock exists to the northeast of Rico Lake. The base of the trough is below the Rico Lake water level.
- As shown on Figure 7.1A, the topography of the bedrock surface is highly variable. East and northeast of Rico Lake the inclined bedrock surface dips steeply toward the centre of the scour channel. Underlying the Pit, the bedrock surface appears to dip steeply from west to east.
- Groundwater flow eastward from Rico Lake towards the Pit occurs through the shallow sand and gravel aquifer and fractured bedrock. The groundwater contours shown on Figure 5.1 illustrates the hydraulic connection between Rico Lake and the Pit.
- The hydraulic conductivity of the shallow overburden aquifer and the fractured bedrock west of the Pit are lower than the sand and gravel aquifer beneath the Pit.



- An upward vertical gradient exists between the shallow bedrock and the overburden aquifers within the western portion of the Site.
- The predominant groundwater flow direction in the sand and gravel aquifer beneath the Pit is southeast from Mclvor Lake across the Site.
- Groundwater migrating from the eastern shore of Rico Lake flows east within the Quinsam River Watershed. As a result, the groundwater divide is located further west than initially interpreted. The watershed divide is now interpreted to be located along the eastern shore of Rico Lake.

The corrections and amendments described above more clearly define the presence of the sand and gravel filled trough northeast of Rico Lake, which in turn further confirms the easterly groundwater flow from Rico Lake.

Although the incorrect placement of test pits and boreholes on the geophysical cross-sections is regrettable, it does not substantially alter the hydrogeologic characterization of the bedrock ridge.

Should you have any questions on the amendments made to the Task 7 letter report, please do not hesitate to contact us.

Sincerely,

GHD

A handwritten signature in black ink, appearing to read 'Gregory D. Ferraro'.

Gregory D. Ferraro, P.Eng.

GF/cs/22

Encl.

cc: Terry Stuart – Upland Excavating Ltd.  
Brian Fagan – Upland Excavating Ltd.

A handwritten signature in blue ink, appearing to read 'Joe Rothfischer'.

Joe Rothfischer, M.Eng., P.Eng.