9. DESIGN AND CONSTRUCTION RECOMMENDATIONS

9.1 General

Based on the results of the supplementary field program and the slope stability assessment/analysis, the main geotechnical concern identified at the proposed Beatton River crossing is the presence of landslide terrain. The stability assessment/analysis demonstrated that the northeast approach is in a stable and inactive condition at present; similarly, the southwest approach is inactive.

From a geotechnical perspective, there is a higher risk associated with pipelining across inactive slide terrain. While the slide features appear to be old and inactive, past experience confirms that such old slide terrain is more sensitive to development, particularly where adverse terrain modifications are involved, such as removal of toe support or surcharging old slide blocks, etc., and surface/subsurface drainage is impeded. Consequently, pipelining across this terrain will require special construction practices to reduce the potential for its reactivation. Specifically, this would entail minimizing the terrain disturbance as much as possible and maintaining or improving the local surface drainage and subsurface drainage.

In addition, there are a number of geotechnical construction planning and specific pipeline installation techniques which should be considered for conventional trenching. These installation techniques apply to construction on steep slopes, and control of surface runoff, erosion and seepage.

Recommendations for design and construction are presented below.

9.2 Construction Options

9.2.1 Northeast Approach

Provident is considering to construct the northeast approach slope by conventional trenching or horizontal directional drilling. The supplementary program has identified that the Beatton River is incised into the floor of a lower paleovalley drainage system. Fluvial gravel is identified to form the floor of the drainage system, above bedrock, some 40 to 60 m above the present-day valley bottom. Thick gravelly colluvium is noted by the geophysical survey to blanket the steep lower portion of the valley wall.

In consideration of directionally drilling the northeast approach slope, it is likely that the alignment would be constructed as an intersect. Thick alluvium containing a high water table at the toe of the slope would be cased off. Similarly, the thick deposit of gravel underlying the slope may also need to be cased off or drilled and/or grouted from a drill rig set up on the upland. Logistics for drill fluid handling may require withdrawal from the Beatton River and hauling to the upland. A disposal plan and permitting for mud disposal should also be considered.

In consideration of the logistics required for HDD construction and the probable risk associated with completing a successful drill, it is recommended that the northeast approach be constructed by means of conventional trenching. Methodologies for construction planning are presented in Section 9.2.4

9.2.2 Southwest Approach

Conventional trenching is planned for the southwest approach slope. The supplementary program has indicated that inactive landslide terrain will be crossed. Consequently special pipeline installation techniques, as outlined in Section 9.2.4, should be adhered too.

9.2.3 Uplands Areas

No major geohazards have been identified; conventional trenching is proposed.

Drainage and erosion controls comprising trench breakers and diversion berms, and subdrains may be required at intervening slope breaks, such as the transition from the upland at the valley crests. These measures should be implemented by environmental or geotechnical specialists.

All disturbed areas should be remediated and seeded as soon as possible following construction.

9.2.4 Approach Slopes

The following construction methodologies, and drainage and erosion controls are recommended to minimize terrain disturbances:

- Access to the route alignment using the existing network of trails and roads;
- Clearing should be limited to narrow right of way segments, where only the trees are cut and stumps are left in place;
- Minimize grading within narrow right of way segments;
- Limit construction equipment access to narrow right of way segments to trackhoes winched down the right of way for stripping and excavation of the ditchline only, so long pipeline segments can be pulled-in ("stove-piped") into the trench to reduce equipment access and terrain disturbance;
- Steep slopes may require a higher quality backfill, such as gravel or blast rock, to be placed under engineering supervision back into the trench
- Trench breakers, diversion berms, subdrains and silt fence drainage control measures should be implemented by environmental and geotechnical specialists;

- Surface erosion should be minimized with the installation of geosynthetic matting and appropriate vegetation in the location of steeper slope segments and where highly erodible soil conditions are encountered; and

- Routine construction cleanup initiatives should be implemented on regular spring and fall schedules.

10. CLOSURE

Montane Geotechnical Inc. (MGI) and Rangeland Conservation Services Ltd. (RCS) are pleased to provide the Provident Energy Inc. with this supplementary geotechnical evaluation of the terrain conditions traversed by the proposed pipeline on the northeast valley approach and slope stability assessments for the proposed Beatton River valley route alignment.

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We appreciate the opportunity to be of continued service. Should you have any questions or require additional information, please contact our office at your convenience.

Yours truly,

MONTANE GEOTECHNICAL INC. **RANGELAND CONSERVATION SERVICE LTD.**

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