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76-052

April 2, 1976

Mr. Louis H. Potvin
Heather Jean Properties Ltd.
Box 220
Pemberton, British Columbia

Subject: Proposed Development on the Northeast Shore of Lillooet Lake above the Forestry Road

Dear Sir:

Further to discussions concerning your proposed development with Mr. G. Miller of Miller Engineering Surveys Ltd., and yourself, and the subsequent visit to the site by myself on March 16, 1976, described in the following are our general findings and recommendations.

We understand that we are to be concerned with geotechnical problems related to residential development above the main forestry road only.

Shown in Figure 1 are Photos 1 to 21 which indicate some of the salient features of the site. The triangular-shaped property in question is located on a relatively well developed, moderately sloping alluvial fan. As indicated in Photo 1 in Figure 1, the north side of the property is parallel and close to the north extent of the general fan limits. The east side of the property is parallel to the east side of the fan, but a considerable distance from it. The distance from the forestry road to the top of the property is about 1,600 feet and from the top of the property to the mouth of the tributary valley another 600 feet. The topography of the area and the related potential surface water flow lines are given in Figure 2.

1. Earlier Study

In an earlier letter report dated January 5, 1973, concerning the area in the southeast corner of the property between the main forestry road and the lake front, we were asked to comment on the possibility of hazardous rockfalls or landslides occurring in the area. We indicated "that the possibility of your proposed property development below the road being jeopardized by either massive deep-seated landslides or rockfalls resulting from normal static loads is remote".

2. Engineering Geology of the Site

i) Geological History

The precipitation catchment area of the tributary valley is relatively small as indicated in Photo 1, the plan area being less than 5 times larger than the area of the fan. A direct relationship has been found to exist between the size and slope of alluvial fans and the size and nature of the drainage basins from which the alluvial fan material originates. It appears that large deep tributary valleys have wide fans of gently inclined slopes, whereas small shallow valleys produce small fans with steeply inclined slopes. This particular site appears to approximate more the latter conditions.

The tributary valley (see Photo 1) from which the alluvial fan originates was essentially formed preglacially and/or inter-glacially by stream erosion and has been modified by glacial action during the different stages of ice advance. The existing fan itself appears to have commenced development during late glacial times, probably when a large quantity of ice was still present.

The materials that make up the alluvial fan originates from glacial depositional sources and from debris from mechanical mass wasting of the bedrock walls of the tributary valley. The former consists of an assortment of erratics, glacial drift and/or glacial outwash materials. The latter consists of talus, scree, slide debris and other slope forming materials that find their way into the bottom of the tributary valley.

During the glacial waning period erosional processes in the tributary valley act rapidly. In early post-glacial times the valley slopes are essentially bare of vegetation and the geomorphic process is extremely dynamic until the forest cover and other weathering and erosion retarding agents become effective. Once the growth of vegetation becomes established in the valley, the various forms of mass wasting such as mudflows, debris flows, rock slides, frost action and general sloughing, although still active, are considerably reduced. Glacial debris, because of the ease of erosion and relatively limited supply of this material, quickly dissipates in the more susceptible areas. More protected localities and areas with extremely deep and/or tougher less erodable deposits eventually sustain abundant vegetation.

Evidence in other localities, such as the Fraser Canyon, Bonaparte, Thompson and Similkameen Valleys, indicate that the alluvial fans were almost completely formed some 7000 years ago. This is due to the fact that the supply of immediately available glacial materials in the valleys is virtually exhausted and that vegetation (see Photo 1) has significantly retarded mass wasting processes in the tributary valley in more recent years.

The amount of material which is transported to the fan during the post-glacial times probably decreases in a somewhat exponential manner. Hence, within a relatively short period the bulk of the aggradational process which takes place in early post-glacial times is completed, and the fan geometry relative to aggradation essentially becomes static. Thus, the geomorphic process eventually changes from one of aggradation (building up of a surface by deposition) to one of degradation (lowering of the land surface by erosion). During the degradational process fan dissection by the tributary stream develops. The alluvial fan at the property is presently being dissected by the downcutting action of the parent tributary stream, which is the basic degradational erosion process acting on the site at present.

The headwaters of the stream in the upper reaches of the tributary valley appear , for a large part, to have worn down the drainage areas which feed the fan. Hence, both the loads and gradient of the stream have been considerably reduced. When this occurs, the stream flowing across the fan usually starts to cut down through the alluvium and debris material as is evident at present. Thus, a crude interlacing network of braided channels now exists in the middle of the fan area. As explained further on in this report, some of these channels are completely dry and appear to have become isolated from the main stream system many years ago.

ii) Bedrock Terrain Conditions

Massive sound granodiorite, quartz-diorite and related rocks form the bedrock in the steep mountain slopes, and accordingly the tributary valley, immediately upslope of the fan. Helicopter inspection of the area in 1972 indicates that small tension cracks, occurring along pre-existing joint planes, are present at the crest of the mountain slope. This is not an uncommon feature in steep, glaciated terrain and should not be cause for alarm. Cirque and cirque-like features are evident in both the head and sides of the tributary valley (see Photo 1). Except for one shallow, tabular slide occurring on the southeast wall of this valley, however, obvious scars and other evidence of major slides are not apparent. Recent avalanche scars are evident in the valley (see Photo 1) and a few deep snow-filled avalanche slide chutes were observed during my recent visit (see Photo 4).

As indicated in Photo 3, the frontal slopes of the mountain on both sides of the tributary valley consists of high talus slopes which are, for the greatest part, heavily timbered. Large blocks are evident at the base of the slope, but broken or even scarred trees due to rockfalls are not evident in the lower reaches of the slope. Large trees are dispersed throughout the blocks and in some instances, as indicated in Photo 21, trees are growing on the blocks themselves. Because of the vegetal cover, general topographic setting and other evidence relating to potential rockfall, the probability of rockfalls reaching the proposed development area is small.

iii) Overburden Terrain and Creek Channel Conditions

In the lower reaches of the area in the vicinity of the forestry road the overburden material forming the fan is generally extremely coarse alluvium, consisting of coarse gravel, cobbles and boulders. Most of the material in the lower reaches are round to subround due to stream abrasive action. East of the location where the creek crosses the road, there are deep, well developed deposits of cobbles and boulders (see Photos 17 and 18).

Occasional large subrounded to subangular blocks, which have undergone only minor abrasive action, are evident in the lower reaches of the fan area near the forestry road, etc. It is unlikely that these blocks rolled to their present location under existing conditions for reasons which are explained earlier. These blocks appear to be erratics which have been dropped by the ice during recession of the glacial ice. Or they were tranpsorted to their present location during early post-glacial times when mud flows, debris flows and considerably more surface water from the melting ice tended to carry the large blocks long distances from the tributary valley. Evidence of such blocks are shown in Photos 12 and 20.

In the upper reaches of the creek the overburden material exposed along the creek is much finer, highly mixed and unsorted. In the first 300 feet to 400 feet of the creek, where the creek is well entrenched and exposures are good, the overburden material appears to have originated from debris flows and/or mud flows. Photographs starting at the mouth of the tributary valley and heading down the creek towards the forestry road are shown consecutively from the top to the bottom of the creek in Photos 5 to 15.

As indicated in Photo 6 (in the upper part of the creek) and Photo 9 (about half way down the creek), the creek in some sections of the fan is well entrenched. However, in some sections of the creek, large boulders have either blocked the creek (see Photo 8) or are constricting the creek (see Photo 10). The significance of the boulders blocking the channel in Photo 8 is readily apparent in that the creek channel immediately upstream is virtually non-existant (see Photo 7).

In the area between the forestry road and some 200 feet to 300 feet immediately above the forestry road the creek channel is poorly developed and almost non existent in places. Furthermore, several isolated channels exist in close proximity, resulting in a condition analogous to a braided stream channel. The geometry of the creek bed in this area is shown in Photos 12 to 15. Two culverts which are presently used to carry the creek flow under the forestry road can be seen in Photo 15. These culverts are both poorly protected and appear to be too small. During my recent visit to the site, creek flows were not reaching the road, but appear to be going underground in the coarser alluvium, thus dissipating some 200 feet to 300 feet upslope of the forestry road. As indicated in Photos 2 and 3 and Figure 2, several isolated old creek channels exist, some of which occur a considerable distance from the present creek channel.

It can be seen in Photo 2 that in the period between around 1949 and 1952 the area in question was almost completely logged. Logging accordingly has considerably aggravated the surface drainage situation. It is noteworthy, however, that no logging took place in the upper reaches of the creek in the mouth of the tributary valley or in the tributary valley itself, indicating that this area has not been disturbed and that relatively stable conditions with regard to mass wasting exist. Examination of an enlarged airphoto of this area taken in 1948, prior to logging, indicates that the isolated channels existed at that time, indicating that the isolated channels were not caused by logging. This photograph also indicates that the main creek flow in 1948 was confined to the same location that it is today; also that the isolated channels appear to be very old. Typical isolated channels are shown in Photo 16 (about 200 feet above the road) and Photo 17 (east of the existing creek bed at road level).

Except during spring thaw and torrential downpours, the main creek channel appears to be relatively dry, particularly from about 400 feet above the forestry road down to the lake. Because of the relatively youthful nature of the creek and unorganized drainage aspect, particularly in the lower reaches of the creek, surface drainage problems relating to flooding etc., may occur. Minor washouts apparently have taken place a few years ago in the vicinity of the hydro powerline tower in close proximity to the creek (the location of the tower is shown in Photo 3). It is noteworthy that additional development activities above the forestry road could aggravate the surface drainage situation unless care is given to providing proper access roads and related surface drainage facilities. Tree removal should be minimized.

iv) Recommendations

a) No building development should be carried out within an 800-foot wide corridor (as defined by the letter A in Figure 2) until proper creek training and other measures are taken to ensure that the creek channel is improved to the satisfaction of the Squamish-Pemberton Regional District. Note that this corridor is wider than 800 feet near the road to accommodate the old isolated channel.

b) Once the creek is improved to the satisfaction of the Squamish-Pemberton Regional District, following the recommendations given in d) below development would be carried out up to within 150 feet on either side of the creek (as defined by the letter B in Figure 2). Thus a permanent

300-foot wide corridor would be maintained where no permanent residential buildings would be allowed. Temporary accommodation, such as mobile homes, trailers, tents, etc., possibly could be allowed within this corridor, but only at the discretion of the Squamish-Pemberton Regional District.

c) Permission be given to proceed with development of residential buildings outside of the 800-foot wide corridor defined by the letter A as described in a) above.

d) Corrective and remedial work on the creek channel should be carried throughout the entire length of the property as well as about 400 feet above the property boundary to ensure that no flooding will occur. This work should consist of the following:

- Remove all large blocks at the crest of the channel (such as those shown in Photos 6, 11 and 12) and large blocks in the bank or bed of the creek which will tend to block the channel (such as those shown in Photos 8 and 10).

- Uniformily deepen and widen the creek channel throughout its length, thus removing large alluvial buildups which have plugged the channel (example of such a buildup is shown in Photos 7 and 8).

- Straighten (and deepen as indicated above) the channel for a distance of about 300 feet to 400 feet above the road (see Photos 12 to 15).

- Improve the conditions where the creek passes through the culverts at the forestry road (see Photo 15). A bridge should be considered to reduce problems of plugging by boulders, logs, etc.

e) Although not critical, a few isolated drainage channels which exist (see Photos 2 and 3 and Figure 2) probably could be left undisturbed (i.e. not filled in or destroyed) to provide added protection against any flooding damage. If any creek overflows did occur, they would tend to be channelled off in old channels thus minimizing damage.

f) Careful attention should be given to providing adequate drainage facilities for residential access roads and removal of trees should be minimized as much as possible. Logging in areas on or immediately above the alluvial fan should not be allowed.

Although the terms of reference for our work apply to the area above the forestry road, it should be recognized that the potential of flooding damage exists below the road as well. It is advisable therefore to complete the corrective work on the creek to minimize the possibility of damage below the road.

We hope that the above information will assist you with your proposed development program. If there are any further questions or further assistance that you require in this matter, please do not hesitate to contact us.

Yours sincerely,

PITEAU GADSBY MACLEOD LIMITED

Douglas R. Piteau, P.Eng.

DRP/nc
Encl.