Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

E/82/042

January 11th, 1982

Halfmoon Developments
P.O. Box 769
Sechelt, B.C.
V0N 3A0

ATTENTION: Mr. Len van Egmont

Re: Geotechnical Appraisal for Proposed Subdivision
Halfmoon Bay, Sechelt, British Columbia

Dear Sir:

Following a request by Mr. Peter Gordon, of P.M. Gordon Surveys Ltd., the above mentioned site was inspected by Mr. D.F. Wood of Golder Associates on Wednesday and Thursday, December 2nd and 3rd, 1981. Staff of P.M. Gordon Surveys Ltd. were present during the inspection to assist in on-site location.

This letter describes the conditions encountered during the visit and discusses the geotechnical implications of the appraisal. It is our understanding that this geotechnical study forms part of your application for preliminary layout approval for the subdivision to the Sunshine Coast Regional District.

1.0 INTRODUCTION

The parcel of land owned by Halfmoon Bay Developments covers an area of predominantly rock exposure near Halfmoon Bay. Part of the property has already been developed and it is proposed that the remainder be subdivided for fully serviced residential building lots. A number of eroded rock terraces, rock bluffs, and rock scarps are to be found on the property, and it is these features which need to be addressed in the successful development of the subdivision.

Following discussions with yourself, it has been agreed that this report should present preliminary geotechnical findings and make general statements as to the impact of such findings. Site specific (on a lot by lot basis) geotechnical requirements will depend on the final lot layout and access road development.

2.0 SITE INVESTIGATION

The property inspected is identified by the following legal description:

Remainder of DL 2394
Group 1
N.W.D.

It is located adjacent to the shoreline of Halfmoon Bay on the Sechelt Peninsula, B.C., about 15 km north of Sechelt. Access is provided by paved road from the Sunshine Coast Highway via Brooks Road and Truman Road west of Halfmoon Bay.

The investigation on site was made with reference to the existing survey plan supplied by Mr. P.M. Gordon, and the survey hubs installed across the property. Many of the proposed access roads are in some stage of development and these were also used for on-site location.

The area has been extensively logged a number of times and selective undercover clearance has been undertaken in some parts of the proposed subdivision. It is felt, however, that no undue ground disturbance has been effected which would worsen the stability of existing slopes or bluffs.

The attached drawing, Figure 1, is taken from the subdivision plan of P.M. Gordon Survey Ltd. and should be referred to for details of site location. Appendix I includes all photographs taken during the visit and their locations are also shown in Figure 1.

2.1 Geology and Geomorphology

The exposed bedrock, seen on the majority of the proposed subdivision, consists of a faintly weathered, massive, grey, medium to coarse grained, very strong to extremely strong granite. It comprises a series of rounded rock terraces formed by erosion during the last glacial period. These structures are subject to stress relief jointing following glacial retreat, and the occurrence of blocky ground is due almost entirely to this jointing.

There is little accumulation of granular soils anywhere on the property and the vegetation is typically shallow rooting pines, firs and underbrush.

The overall slope angle on the land varies to a maximum of about 30 degrees, although local rock bluffs are up to 5 m high and at angles to 60 degrees.

3.0 GEOTECHNICAL CONSIDERATIONS

The comments presented below address the geotechnical implications of the proposed subdivision based on the conditions encountered during the site visit, dated December 2nd and 3rd, 1981. Access road

development is currently under way with some rock blasting. It was apparent that individual lot access in some areas had not yet been established and some of the recommendations contained in this letter may be affected by any changes in rock conditions subsequent to the development of main access roads or individual lot access, see Section 3.1.

There are three main geotechnical conditions to be found on the property, and these are defined in detail below.

(a) Massive Intact

The majority of the proposed subdivision comprises land with very little overburden or soils covering intact, massive granitic rock. The landforms are generally rounded, glacially eroded rock terraces with surfaces clear of rock debris. Vegetation varies across the property, including fir, cedar, and pine to 2 ft. diameter trunks, arbutus, salal, juniper, ferns, and mosses.

Overall slope angles in excess of 25 degrees were not observed on any portion of the property, although rock bluffs to 5 m in height may be found locally with slope angles to 60 degrees.

Where the underlying rock is of the type described above, no further geotechnical consideration would be required for development of the property, provided that suitable foundation engineering be employed as noted below.

(b) Loose Surface

In a few areas on the proposed subdivision the ground comprises intact rock of a competent nature with about 10 per cent cover of loose, surface blocks. These blocks have been derived by local degradation of the rock mass, usually by the breaking up of slabs of rock generated by stress relief jointing. This jointing was caused by the removal of ice pressure during the last glacial retreat; it was this same glaciation which caused the erosional landforms described in (a) above.

Loose surface rock must not be used for the location of any load bearing foundations. In certain areas the presence of loose surface rock does not eliminate the possibility of locating a residential structure provided that suitable rock improvement techniques are developed. Such techniques are detailed in Section 3.1 below.

Loose surface rock is generally located at the toe of a rock terrace or in a gully between adjacent rounded terraces. Such areas are not considered to impose problems from a geotechnical standpoint provided that their development conforms to acceptable specifications.

(c) Broken Ground

In about 5 per cent of the proposed subdivision the landform is comprised almost exclusively of loose rock blocks up to 5 cu.m in size.

The ground is so broken that the underlying intact, massive rock is not evident. With the current configuration of slope angle (25 to 30 degrees) and rock mass conditions, it is recommended that no foundations be placed on this broken ground.

Selected building sites, lot access roads and the like may be successfully developed only following engineered slope improvement techniques as detailed in Section 3.1.

Figure 1 shows the breakdown of the above geotechnical types by area on the proposed subdivision.

3.1 Building Placement

The following section deals specifically with the location of structures to ensure that safe building foundation may be developed adjacent to rock bluffs and slope debris. A copy of the relevant section of the Sunshine Coast Regional District Building Code (section 2.4, subsections 2.4.1, 2.4.2, and 2.4.3) has been consulted to clarify the set backs required for building placement relative to flood levels, natural boundaries of the sea, and lot boundaries. The following comments relate directly to building placement and foundation preparation required for geotechnical reasons.

(a) Massive, intact rock
On the majority of the proposed subdivison, where smooth, rounded rock surface is exposed, no geotechnically required set back need be enforced.

(b) Loose surface rock
In areas, shown in Figure 1, where loose surface rock was encountered during the site inspection, the following guidelines for building placement and foundation preparation should be used:

(i) All loose surface rock should be removed and the area treated as in (a) above, or

(ii) Loose surface rock should be reduced in size by crushing, then compacted to create the equivalent of fill compacted to 25 cm lifts. This may then be used for building foundations, where approved by an engineer, or

(iii) Except where an individual rock terrace itself is unstable, see (d) below, a residential structure may be built on engineered dowell foundations, for example, and designed to span over loose surface rock in a gully, or to cantilever over loose surface rock at the toe of a terrace. Such designs should be approved by an engineer, and examples are shown in Figure 2.

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(c) Broken ground

Broken ground should not be used for building foundations unless specific slope improvement techniques are used. These include:

(i) Complete removal of loose, surficial blocks of rock to expose massive intact and stable ground. This may then be used for structures with engineered dowell foundations, for example.

(ii) Crushing and compacting loose, surficial blocks of rock to create the equivalent of fill compacted in 25 cm lifts. This may then be used for engineered strip footings, for example.

It should be noted that broken ground slope treatment may also be necessary up-slope of any proposed building in order to protect the structure from slope degradation in the future.

(d) Unstable rock terraces

In a few locations, shown on Figure 1, the nature of the exposed rock on the eroded terraces is such that a 3 m set back will be required from the crest of the slope, outside which engineered foundations may be considered for residential structures. The adverse conditions comprise discontinuities, cracks and loose slabs of rock, and such areas should be avoided or improved using techniques mentioned in (b) or (c) above.

It is felt that hazard-free residential structures may be located in all areas of the proposed subdivision, provided that suitable engineered foundations are designed for the area of broken ground described above. Thus the layout of the property lines will be controlled more by building code constraints than by geotechnical hazard.

4.0 CONCLUSIONS

This report presents preliminary geotechnical findings for layout approval of the proposed subdivision. Of the area inspected, only a small portion is considered to be, in its current condition, unsuitable for building. However, this part of the subdivision, to the northeast of the property, may be improved and developed provided that care is taken during slope improvement to ensure that the present marginal stability is not exacerbated.

It is recommended that this area should not be built upon without engineered foundations.

We hope that this information is sufficient for your present needs, should you require any clarification, please do not hesitate to call.

Yours very truly,

GOLDER ASSOCIATES

D.C. Wyllie, P. Eng.

David F. Wood

D.F. Wood

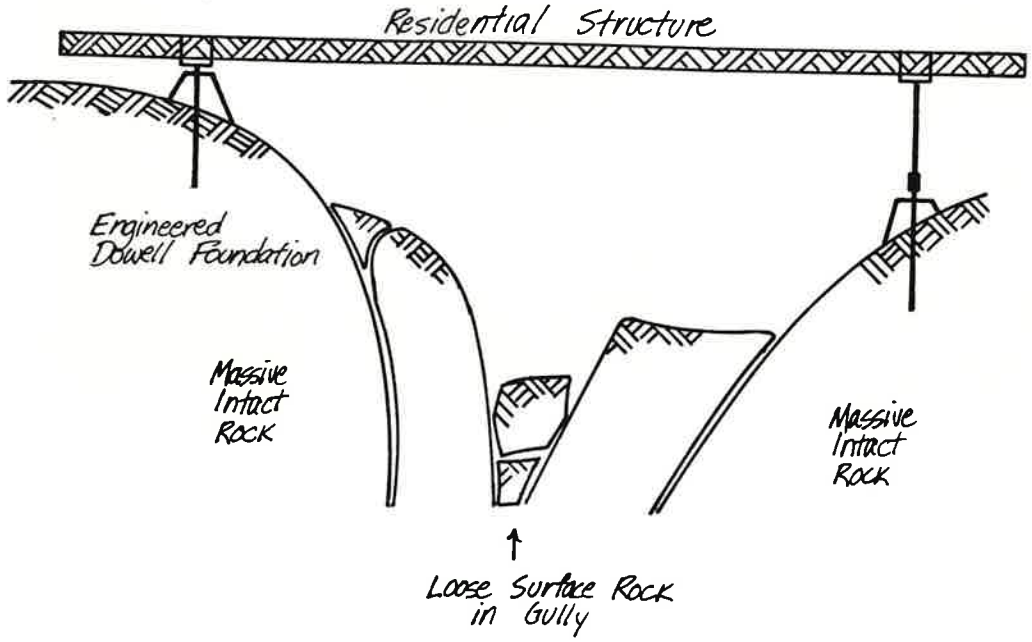
DCW/DFW/bjh
812-1596

Att.

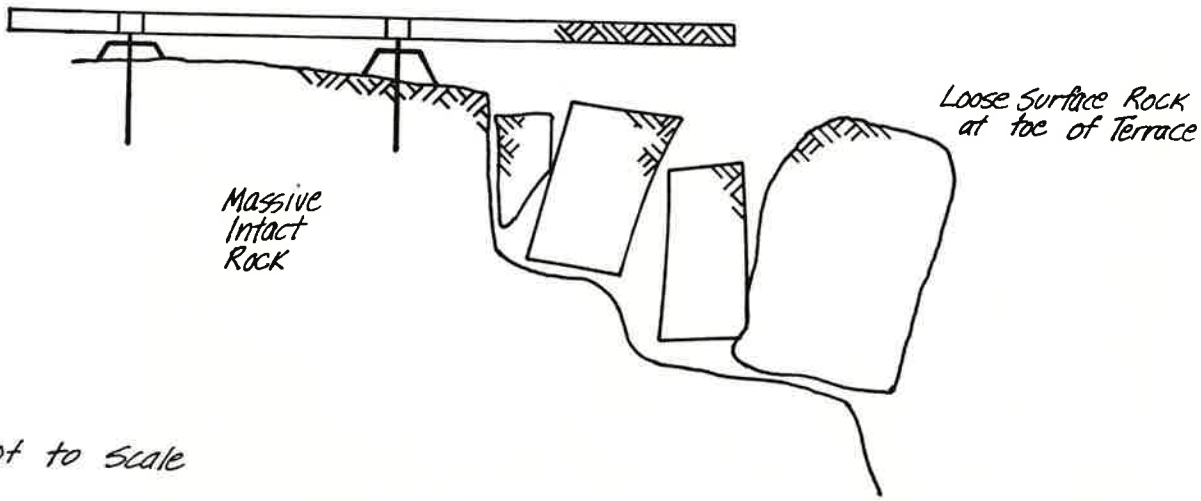
EXAMPLES OF ENGINEERED FOUNDATIONS

Figure 2

a) Loose Surface in Gully.



b) Loose Surface at Toe of Terrace.



Not to Scale

Typical foundations only.
Actual designs should be approved by an engineer.

PROJECT NO. 812-1596 DRAWN TAE REVIEWED DGJ DATE Jan. 1982

APPENDIX I

SITE PHOTOGRAPHS

Photograph 1

Irregular blocky ground below fill

Photograph 2

Rounded, glacially eroded shoreline, locally broken

Photograph 3

Very blocky shoreline, within Regional District set back

Photograph 4

Clean, eroded shoreline

Photograph 5

Rounded bluffs with broken gully between

Photograph 6

Fill and blasted rock below access road

Photograph 7

Broken ground at toe of slope

Photograph 8

Marginally stable block (broken by tree roots) within Regional Distric set back

Photograph 9

Loose surface rock at toe of terrace

Photograph 10

Minor loose surface rock on terrace

Photograph 11

Overall view of stable rock mass

Photograph 12

Individual lot access development

Photograph 13

View of cleared stable rock terraces

Photograph 14

General view of rounded rock terraces, with some local loose surface rock

Photograph 15

Stable, smooth, glacially eroded terrace

Photograph 16

Flat, clean rock outcrop

Photograph 17

Dense salal over rock outcrop

Photograph 18

Loose surface rock from stress relief jointing

Photograph 19

Flat lying, shallow terraces, some loose surface

Photograph 20

Uniform, clean, smooth slope

Photograph 21

Broken ground on 25 degree slope

Photograph 22

Loose, surface rock below terrace

Photograph 23

Broken ground, heavily overgrown

Photograph 24

Broken ground, photograph along back line of property

Photograph 25

Rounded, clean rock terraces

Photograph 26

Clean, eroded rock terrace to Square Bay

Photograph 27

Flat surface at crest of terrace

Photograph 28

Smooth, clean eroded terrace

Photograph 29

Shallow hollow with some loose surface

Photograph 30

Hummocky ground, stable with some loose surface

Photograph 31

Blocky ground with loose surface below smooth terrace