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E. LIVINGSTON, P.Eng.
A. BADRY

PACIFIC HYDROLOGY CONSULTANTS LTD.

CONSULTING GROUNDWATER GEOLOGISTS

204 - 1929 WEST BROADWAY
VANCOUVER, B.C. V6J 1Z3
TELEPHONE: (604) 738-9232
FACSIMILE: (604) 738-6070

November 3, 1992

West and Associates
20609 Logan Avenue
LANGLEY, B.C. V3A 7R3

Attention: Mr. Tony West
President

Subject: **Evaluation of Hydrogeologic Conditions in Regard to Ground Disposal of Treated Effluent at Spider Lake Springs Located Northwest of Qualicum, B.C.**

Dear Sirs:

This letter is further to recent telephone discussions between Tony West of West and Associates and Ed Livingston, P. Eng., and/or Ann Badry, Hydrogeologist, both of Pacific Hydrology Consultants Ltd., concerning the disposal of treated effluent at a proposed recreational development, Spider Lake Springs, located a short distance northwest of Qualicum.

1.0 INTRODUCTION

The purpose of this letter is to report on a field reconnaissance to the Spider Lake Springs site carried out by Ed Livingston on October 30, 1992, at which time he met with and was shown around the site by the Developers, Messrs. Keith and David Hendrickson. From the aforementioned site visit to Spider Lake Springs, and from the previously mentioned telephone discussions

(West/Livingston, West/Badry), we understand that the situation concerning onsite effluent disposal is as follows:

1. The Spider Lake Springs Resort is based on the development of as many as 350 Recreational Vehicle Sites; each site will be served with electric power, piped water and a sewer connection.

2. Plans call for pumping sewage to a treatment plant, from where the treated effluent will be pumped to a disposal field. The sewage system design is based on disposal of 90 to 136 m^3/day (20,000 to 30,000 igal per day).

3. The proposed disposal field is located on a sandy ridge.

Published documents used in preparation of this letter include the following:

1. N.T.S. Map 92F/7, **Horne Lake**, of scale 1:50,000.

2. Geological Survey of Canada Memoir 318, **Surficial Geology of Horne Lake and Parksville Map-Areas Vancouver Island, British Columbia**; 1963, by J.G. Fyles, 42 pp.; and, in particular, G.S.C. Map 1111A, **Surficial Geology Horne Lake Vancouver Island British Columbia**, of scale 1:63,360, which accompanies the Memoir.

3. Geological Survey Bulletin 144, **Groundwater Resources of the Coastal Lowlands and Adjacent Islands, Nanoose Bay to Campbell River, East Coast, Vancouver Island**; by E.C. Halstead and A. Treichel, 1966, 42 pp.

2.0 TOPOGRAPHY AND GEOLOGY

The subject Spider Lake Springs Property is located in an area of very irregular topography consisting of small hills and depressions, probably best described as "kame and kettle" topography, in which the small hills are

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kames and the depressions are kettles. The most important topographic feature is an east-facing scarp located a short distance to the west of the subject Spider Lake Springs Development. The scarp of sand and gravel at the angle of repose is the eastern edge of an extensive terrace at elevation about 132 m (450 ft). There are many kettles on this terrace; the largest of the kettles is occupied by Spider Lake which has no inlet or outlet.

The area is one of thick surficial deposits; G.S.C. Map 1111A shows no rock outcrop between the mountain front and the shore of Georgia Strait, a distance of about 5.6 km (3½ mi). The Spider Lake Terrace is a raised delta deposited when the sea level was about 140 m (460 ft) higher than present sea level. The delta is probably not related to the Valley of Horne Lake but was probably deposited by a large ice marginal stream flowing southeastward between ice in Georgia Strait and the mountain front. The kettles formed when masses of ice, which were buried in the sediments of the delta, melted away and the sediments enclosing the ice collapsed. The kame and kettle area of the subject Property may represent irregular deposition of sand and gravel around melting ice in front of the advancing delta.

3.0 GROUNDWATER HYDROLOGY

The dominant hydrologic features are a series of large springs discharging from the raised delta. The springs have almost constant flow, with some of the springs forming the headwaters of creeks - for example, Kinkade Creek. Other spring discharge flows for a short distance and then goes underground in extensive swampy areas. Some of the kettles are deep enough to intersect the water table; these kettles are partly filled with black organic (peat) deposits. Since the kames are composed of sand with minor gravel, they are well drained. Thus, there is sharp local contrast between the well-drained kames and the intervening swampy areas of kettles.

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4.0 GROUND DISPOSAL OF TREATED EFFLUENT

The area selected for effluent disposal from the Spider Lake Springs Development is one of open bush cover located on a sandy kame ridge. Several test pits dug to a depth of about 3 m (10 ft) on top of the ridge are entirely in sand, with minor thin beds and lenses of small gravel. All pits were completely dry at the time of Ed Livingston's inspection of October 30, 1992. An examination of test pit exposures showed that there is a thin organic soil and some weathering of the sand to about $1\frac{1}{2}$ m (5 ft), with tree roots penetrating below the bottoms of the pits.

Insofar as effluent disposal is concerned, the only potential contaminant in treated effluent is the mobile nitrate ion which is very soluble and is not readily removed in the treatment process. Conditions for disposal of treated effluent at the site of the proposed field are nearly ideal; evidence for this statement is the following:

1. The selected area is underlain by unsaturated sand to the water table, which is 5 m (16.4 ft), or more, below surface.
2. The flow regime in motion under the area contains a large quantity of groundwater which will dilute the small amount of nitrate in the treated effluent entering the ground.
3. Water movement is generally to swampy areas above organic material; swamp vegetation will be effective in removing nitrate from the treated effluent.
4. Only a small disposal area is required. Assuming an hydraulic conductivity for the sand of 5×10^{-3} cm/sec, an area about 32 m^2 is required to permit a flow of 140 m^3/day of effluent to move down through the sand.
5. It is clear that treated effluent will travel vertically downward to the water table where it will be carried with the natural groundwater flow. Under the prevailing conditions, groundwater mounding under the field area is unlikely and no negative impacts to the groundwater regime will occur.

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We trust that this letter and meets your requirements with respect to hydrogeologic conditions concerning disposal of treated effluent at the proposed Spider Lake Springs Report Facility. However, please do not hesitate to contact us should you require clarification or additional information about any aspect of the contents of the letter.

Yours truly,

PACIFIC HYDROLOGY CONSULTANTS LTD.

E Livingston per QB

Ed Livingston, P. Eng.