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September 8, 2009

BC Ministry of Environment
Environmental Assessment Office
PO Box 9426 STN PROV GOVT
Victoria, BC
V8W 9V1

Attn: Ms. Karen Christie, Project Assessment Director

Dear Ms. Christie:

We are writing to you regarding Lehigh's proposed Texada South limestone quarry project above Davie Bay on Texada Island, British Columbia. This quarry is located within Karst Unit 24488 (provincial Karst Potential Area identifier).

Projects such as this involve the extensive extraction of limestone bedrock which can be karstified (the process of forming karst landscape) and it is this aspect of the proposed project that is the focus of our comments. Karst is a distinctive type of terrain or landscape that develops when water dissolves readily soluble (typically carbonate) bedrock such as limestone, marble, dolomite or gypsum. Over time, the dissolving action of the water creates characteristic surface features ranging from small-scale fluted or pitted rock surfaces, to enclosed depressions known as "sinkholes", shafts, canyons, and dry valleys. Some of these features – fluted or pitted rock surfaces, for example – are a direct result of the dissolving action of water acting on the bedrock's surface. Other surface karst features such as grikes and sinkholes can be expressions of processes occurring beneath the surface of the karst. They occur because karst landscapes have an underground component made up of solutionally enlarged cracks, joints, conduits and caves. In well-developed karst, this network of void spaces forms numerous openings and connections between surface and subsurface resulting in a landscape that is highly permeable. This permeability, "openness" or "connectivity" makes it easy for matter such as water, sediments, organic debris or pollutants to move between the surface and subsurface components of the karst.

Karst and its management is our area of expertise. As qualified karst resource professionals whose business is evaluating karstified terrain, we provide karst-related professional services in ground searching, mapping, inventorying and evaluation,

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planning and development, monitoring, training, and auditing. The projects and issues have centred on the management of karst resources primarily in forested settings. Our clients have included government agencies, Crown corporations, First Nations, forest tenure holders, and proponents of energy projects. We have worked in many karst settings throughout BC and we are quite familiar with a number of karst sites on Texada Island, including sites in and about the proposed 46-ha upper quarry operation. Given the relative significance of some of the karst resources in close proximity to this proposed project, we believe we have an obligation as professionals to draw your attention to the need for a proper karst assessment in this case.

Perhaps more than other types of landscapes, karst must be approached as a functioning landscape system in order to manage it effectively. A "karst system" integrates the distinctive physical structure of karst with all of the synergies, processes and interactions occurring between/among the bedrock geology, water, soil, gases, and living things (IUCN 1997). The basic materials that are moved within the karst system include water, air, soil/rock and organic matter/biota. These materials, and the processes by which they are moved, are integral to the character, nature, and functioning of a karst system.[1]

Karst is much more than the sum of its geological or geomorphological components. The range of recognized values associated with karst often surprises people unfamiliar with this resource. An obvious economic value is the stone itself. The use of limestone as building material or aggregate is of course well known, but it is also used in an astounding array of other manufacturing processes and products. Even epikarst, defined as the upper layers of karst, is occasionally sold and used as garden rocks. Water is probably one of the most important values associated with karst. An estimated 25% of the world's population relies on karst aquifers for water. In the Pacific Northwest, the quality of karst waters is a very important aspect of downstream aquatic productivity. Karst is also associated with high quality timber in the temperate rainforest karsts of Tasmania, New Zealand, SE Alaska and Canada's west coast (Baichtal and Swanston 1996), and with agriculture in other parts of the world.

Karst also contributes to the earth's geological and biological diversity (IUCN 1997). The complexity of karst landscapes can provide highly variable microclimatic conditions and/or moisture regimes (e.g., see Gillieson 1996; Gillieson 2004; Whiteman *et al*. 2004; Bárány-Kevei 1999a; Bárány-Kevei 1999b), as well as isolation for some species or biological communities (e.g. Gillieson 2004; Kruckberg 2004). To some extent, these factors may account for the high incidence of endemic species associated with karst globally. While cave ecosystems provide some of the

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[1] A more detailed overview of karst systems and their associated values is provided by Griffiths and Ramsey (2009). Though focused primarily on the coastal karst of Haida Gwaii, the general information about karst in this region also holds true for the karst of Texada Island. An online version can be viewed at: http://members.shaw.ca/pgriff/Karst.pdf

best-known examples of biodiversity in karst, increasing attention is now being paid to lesser known karst habitats including epikarst, and surface karst landforms such as sinkholes and springs (e.g., Pipan 2005; Van der Kamp 1995). The Ramsar List recognizes karst systems as subterranean wetlands (e.g., see Beltram 2004).

The Province of BC considers karst to be a sensitive environment that should be managed using an ecological approach. Karst in the project area and its zone of influence is a relatively rare occurrence in the Coastal Douglas Fir ecological zone. The area has previously been impacted by logging (possibly by repeat harvests) with significant adverse effects, as well as road building, and (possibly) fire. These events, coupled with the effects associated with developing the proposed upper quarry add up to a significant cumulative impact on this resource.

The karst within the proposed upper quarry site is known to exhibit numerous examples of small-scale surface relief features (i.e., grikes, rillenkarren). While the site does not have the numbers of larger surface karst features such as sinkholes typically found on karst in other parts of the BC coast, it is important to note that absence of these features does not necessarily mean the karst is not well developed at depth. The thickness of the Quatsino Formation limestone in this karst unit can attain 100 m or more. Surface features can be truncated or obliterated by glaciation, while underground components of karst systems remain intact. This may be the case in the same karst unit where there are known examples of well-developed karst shafts and caves despite the lack of typical surface karst features one might expect in Quatsino Formation limestone on the BC coast.

Hence we speculate the main karst-related issue with this project is not so much about protecting surface karst features on the proposed upper quarry site itself, but rather a case of sorting out the subsurface hydrology and protecting any significant karst elements that might be impacted within a zone of influence.

Very delicate and sensitive karst cave systems are known to occur within the contiguous karst unit down gradient of the proposed upper quarry operation. Karst caves can draw a following of specialized researchers, including speleologists, ecologists, climatologists, earth scientists, palaeontologists, archaeologists, and even pharmacologists. The scientific study of cave biology is a specialized field known as “biospeleology”. Many karst caves house a variety of secondary mineral deposits. Speleothems, comprised of calcium carbonate, can take many forms, the most well known being stalactites and stalagmites.

In our professional opinion, even the documented caves in the vicinity of the project are the most extensive and well-decorated of all known karst caves along the BC Mainland coast between Washington and Alaska. While these caves have not been fully assessed in accordance with provincial protocols, we have already noted important resource contents including stalactites of possible record length for BC, petromorphs (rocky relief features) and biota. Some of the caves are abundantly decorated with fragile calcite formations including stalactites, stalagmites, columns, draperies, mondmilch and gours. Aside from obvious intrinsic natural values, these caves have considerable heritage value. And while their sensitivity and inherent hazards render them unsuitable for development as tourist caves, they could present economic opportunities for Texada Island residents through remote appreciation venues such as replica caves or an interpretive centre.

The nearest known cave system is less than 500 m away from the proposed upper quarry, and more passageways or conduits may be developed within the contiguous karst unit in the direction of the site, and thus be closer to the site. The perennial cave streams we have observed help to sustain the base flows in the fish-bearing reaches of the streams that rise below. While these underground water flows would appear intuitively to be coupled to allogenic surface streams, including Mossy Creek which closely borders the proposed upper quarry, a recharge delineation study is required to establish the relative importance of allogenic versus the autogenic recharge for the known cave systems and whether the zone of autogenic recharge extends into the proposed upper quarry site.

It is difficult to predict where undocumented cave systems, subsurface connections and flow paths occur based solely on the topographical setting within the karst unit. Other notable karst caves documented to date in the contiguous karst unit, albeit probably not in conflict with the proposed quarry operation, are not known to be associated with present day surface streams or convergent topography.

Given the exceptional values of these cave resources and the usual degree of surface-subsurface connectivity in karst, it would be prudent to ascertain that there are no hydrological connections between the proposed upper quarry site and the known caves, using a karst assessment which includes a well-designed dye tracing component. The "water tables" in karst areas can be highly irregular in elevation and water-carrying conduits can develop at various elevations. Therefore a water table in a conventional sense is often absent in karst units with topographical relief. It is important that karst hydrological studies be carried out as early as possible to allow the capture of seasonal differences in water stages, and make adjustments to the project before a quarry plan is finalized in order to avoid or possible mitigate any adverse effects where practicable.

Limestone quarries of a much smaller size (e.g., less than 100 cubic meters) in the wrong locations have caused irreparable damage to sensitive karst and cave resources in BC. The direct quarrying impacts to karst resources can range from loss of biodiversity, disruption of drainage patterns, habitat loss, aesthetic impacts to the landscape, and noise or vibration. Quarrying on karst can also produce indirect and at times unanticipated "off-site" effects, often linked to the down gradient or downstream karst resource features within the same karst unit. These can include alterations to hydrology if a quarry site forms part of the recharge area for the karst system.

The proposed project is designated by the Environmental assessment Office (EAO) as "not reviewable" because its projected annual production capacity falls 10,000 tonnes short of the 250,000-tonne threshold. Thus, consideration of karst falls within the normal provincial permitting and approval processes. However, the evidence to date suggests that these alternative processes, even if well intentioned, can be deficient where karst is an environmental aspect of a quarry project (even at the exploration stage). Accordingly, we recommend that the Minister of Environment use his powers to designate the Texada South quarry project "reviewable" on the grounds that it is in the public interest to do so. Alternatively, we urge the EAO to encourage the proponent to "opt-in" to a review that is comprehensive enough to include a karst assessment.

As for the caves in particular, the documented ones in potential conflict with the proposed quarry project are all situated on Crown land (to the limit of current mapping). The legal authority and responsibility for managing Crown land caves in BC rests clearly with the provincial government (Prov. of BC 1981). To date, the province has largely neglected its responsibility to take an active role in managing its cave resources even as the quality of some of these resources declines. It is a situation that is not likely to improve in this period of fiscal restraint. Cave Management in BC in recent years may be most charitably characterized as "benign neglect", with the responsibility for cave mapping, inventorying, assessing, planning and monitoring, being downloaded in a very piecemeal, haphazard fashion onto private citizens and recreational caving organizations. The serious cave management deficiencies on publicly managed lands in BC makes it all the more important to trigger an environmental assessment in this particular case.

Given that karst in coastal BC is recognized by government as an especially sensitive resource, and that the quarry project could result in significant direct and indirect impacts to karst elements, we suggest that a karst assessment should be carried out as a minimal due diligence action. Conducting such an assessment is consistent with the Precautionary Approach to managing environmental risk (Ref. Precautionary Document, Environmental Assessment Office – i.e., *A Framework for the Application of Precaution in the Application of Science-Based Decision Making About Risk* - 2003; Government of Canada publication).

A proper karst assessment done to existing provincial standards and conducted by qualified and competent karst resource professionals[2] would serve to document on-site karst resource features that may be damaged or destroyed should it not be possible to avoid potential impacts or develop strategies to mitigate impacts when they cannot be avoided. Such an assessment would also help to establish the possible zone of influence, and karst-specific baseline conditions that would allow the detection and ongoing monitoring of any changes to the karst that may result from the

[2] Minimum qualifications and karst assessment standards as defined by government (i.e., RISC 2003).

project and help to identify direct and indirect impacts, which might be prevented or mitigated. Finally, a thorough karst assessment would assist in developing karst-specific monitoring and contingency plans.

Similar karst assessments have been carried out in BC for other types of projects where the impacts to karst are less obvious or less direct, ranging from forest development to energy projects. BC already has a number or best practices guidelines for various land use activities in and around caves and other karst resource features (i.e., *Karst Management Handbook for British Columbia* (MOF 2003), *Best Management Practices for Palaeontological and Archaeological Cave Resources* (Griffiths & Ramsey 2005)), as well as standards and procedures in place for conducting karst field assessments and vulnerability mapping (i.e., *Karst Inventory Standards and Vulnerability Assessment Procedures for British Columbia* (RISC 2003)).

We fully understand the need to balance social, economic, and environmental aspects when it comes to protecting and managing karst resources. However, given the proximity and significance of cave systems at possible risk, the connectivity potential between the proposed upper quarry site and the documented high-value caves, and the poorly understood nature of Texada Island's non-commodity karst resource values in general, we cannot overemphasize the need for a credible and rigorous environmental assessment in the case of this project.

A comprehensive karst assessment conducted by qualified and competent karst resource professionals will help to support sustainable development on Texada Island.

Sincerely,

Paul Griffiths

for Paul Griffiths and Carol Ramsey

cc: Ms. Rachel Shaw, Project Assessment Officer, EAO
Mr. Don Turner, Planner, Powell River Regional District
Mr. Blake Fougere, Stewardship Officer, Sunshine Coast Forest District, MFR
Mr. Frank Ullman, Recreation Officer, South Coast Recreation District, MTCA
Mr. Nicholas Simons, MLA Powell River-Sunshine Coast
Mr. Scott Fraser, MLA Alberni-Qualicum

Selected photos of karst resource features are attached

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Fig. 1 Solutionally enlarged karst openings on proposed upper quarry site

Fig. 2 Eipkarst exposure with rillenkarren on proposed upper quarry site

Fig. 3 Karst pipe on proposed upper quarry site

Fig. 4 Soil loss on proposed upper quarry site

Fig. 5 Petromorph (rocky relief feature) on karst cave ceiling

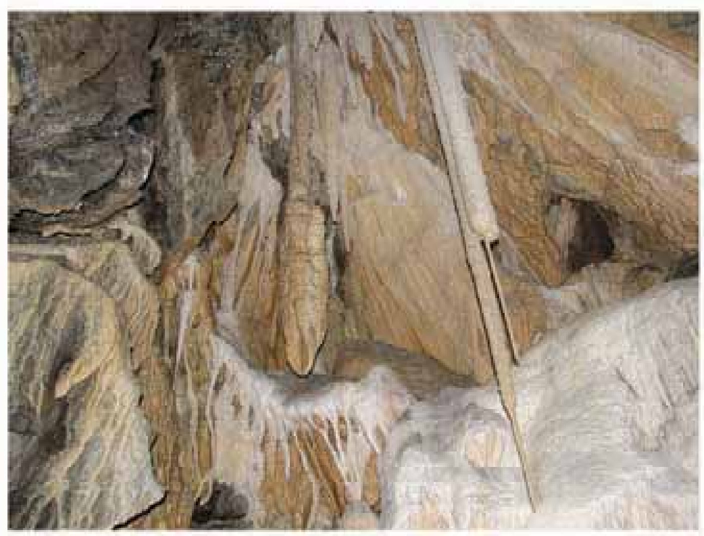

Fig. 6 Stalactites of possible record length in karst cave

Fig. 7 Calcite column in karst cave

Fig. 8 Calcite curtain in karst cave

Fig. 9 Petromorph and mondmich encrusted stalagmites in karst cave

Fig. 10 Water percolate at tip of stalactite in karst cave

Fig. 11 Calcite gours in karst cave

Fig. 12 Stalagmites and flowstone in karst cave

Fig. 13 Underground water flow in karst cave

Fig. 14 Ponded water in karst cave

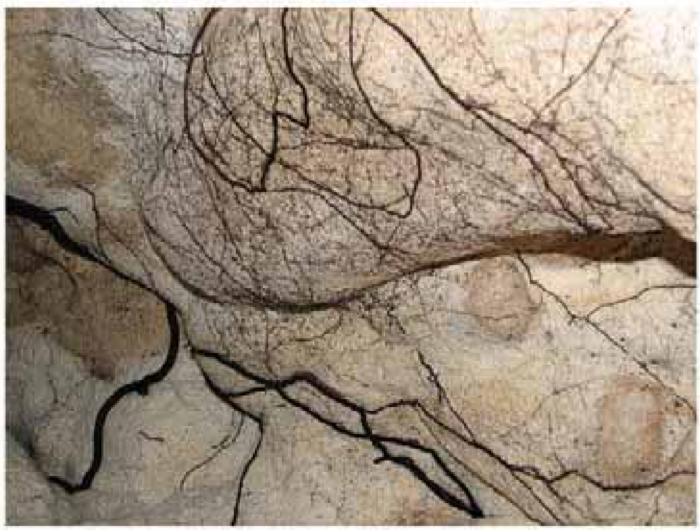

Fig. 15 Roots deep in karst cave

Fig. 16 Millipede in karst cave

Fig. 17 Mondmilch and harvestman (centre of photo) in karst cave

Fig. 18 Mating cave crickets