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G26029/1-Br GP:KW
12th December 2006

Attentus Projects and Properties Pty Ltd
c/- David Lane & Associates
3 Isabella Street
CAMPBERDOWN NSW 2050

Attention: Bill Jenner

Dear Sir

Re: Pelican Beach Resort, 740 Pacific Highway, Sapphire Bay: Geotechnical Assessment Addendum.

As requested we have reviewed existing file data and sited concept designs in order to comment on slope stability at the above site.

Our Report G26029/1-A of 16/3/06 provided advice and recommendations on excavation support requirements, footing options, retaining wall parameters and related construction advice for possible site redevelopment.

This addendum report should be read in conjunction with our previous report.

The upper western and lower eastern portions of the site are divided by a 30 to 40m wide, approximately 25º slope which becomes less steep (20º to 10º) towards the south and was vegetated at the time of our investigation. Our fieldwork did not include borehole drilling within the slope.

Conceptual plans indicate that the 25º slope will remain undeveloped. Building and pavement construction is proposed within the 10º to 20º slope and the flatter, upper and lower areas.

Based on the concept development sketches provided, the proposed development is understood to comprise the following:

- A first cluster of residential dwellings with basement floor level RL 22.0m located at the north-west of the site. Existing ground surface level in this area ranges from RL 28m to RL 24m.
- A second cluster of dwellings located on the south-east facing slope with floor levels ranging from RL 7.5m to RL 20.0m.
- A third cluster of dwellings with floor level at RL 7.5m located at the base of the escarpment.
- A fourth cluster of dwellings with floor level at RL 7.5m at beach front.
- Road 1 traversing across east facing slope.

The following potential instability mechanisms may be relevant in the assessment of risks of landslide in this site.

- Two clusters of dwellings are to be located on 20º to 10º east facing slope. Risk of instability of the slope containing the dwellings may be considered.

- Construction of building pads and access roads may require up to 6m depth of cut. Instability of cut slopes both during and after construction may be relevant.

- Construction of building pads for the beach front dwellings will require up to about 2m depth of filling. Instability of proposed buildings and fill embankments may be relevant.

Our assessment of risks of landslide instability are described below:

- Rock was found at shallow depths in Borehole BH1 and BH4 and it is likely that soil cover in the area proposed for first two clusters would be shallow. Therefore, it is assessed that failure of hillside slope containing proposed dwellings to be unlikely and consequence of such failure to be major or medium. Hence the risk to property damage is *moderate or low-moderate.* Dwellings on the 20º to 10º east facing slope should have footings extended or piered to insitu rock and proportioned in accordance with the recommendations in our Report G26029/1-A.

- All cuttings deeper than 1m should be retained by engineered retaining walls. Temporary batters should also be constructed with geotechnical supervision as recommended in our Report G26029/1-A. Under these conditions the risk of failure of cutting is assessed to be rare and consequences to be medium or minor. Hence the risk is assessed to be *very low to low.*

- Proposed buildings within the lower eastern portion of the site should be piered and fill embankments retained or battered in accordance with the recommendations in our Report G26029/1-A. Also, any future filling which extends east of the potential erosion hazard line should be supported by engineered retaining walls piled/piered to stable strata beneath the depth of possible storm scour. Under these conditions the risk of failure of buildings and fill embankments is assessed to be rare and consequences to be medium or minor. Hence the risk is assessed to be *very low to low*.

In view of the above, the overall risk of slope instability on No 740 is assessed to be **moderate** based on Australian Geomechanics Society (AGS 2002) Guidelines. The risk levels are defined in the attached Appendix G and the development should be carried out in accordance with sound engineering principles, good hillside construction practices as outlined in the attached Appendix J, and in accordance with the recommendations outlined in Section 4.0 of our Report G26029/1-A.

Filling should be carried out by static rolling as dynamic rolling may initiate vibration related damage to existing buildings on adjacent properties. The effect of filling on the dunal system should be assessed by a Coastal Engineering Consultant.

Groundwater was encountered at 3.0m and 4.2m depth in BH2 and BH3 respectively at the time of drilling (March 2006). No groundwater was encountered in BH1 and BH4 at 6m depth limit of investigation. It is unlikely that

groundwater table will be intercepted at the proposed depth of excavation. However minor seepage within the rock structure may be encountered. Such seepage would be unlikely to impact on groundwater regime.

Notwithstanding, we recommend that further subsurface investigation be carried out within the slope to verify anticipated soil/rock conditions and to assist structural design of retaining walls and footings. Final structural design plans should be reviewed by a Geotechnical Consultant.

Please contact the undersigned if you require further assistance.

For and on behalf of
Network Geotechnics Pty Ltd

Gary Peake *BE (Civil), GCE*
Senior Geotechnical Engineer

Reviewed by

V W de Silva *BScEng, MEng, SMIE Aust, CPEng*
Senior Geotechnical Engineer

Encl *Appendix G Australian Geomechanics Society Guidelines for Landslide Risk Assessment*
Appendix J Some Guidelines for Hillside Construction

APPENDIX G

LANDSLIDE RISK ASSESSMENT – EXAMPLE OF QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

Qualitative Measures of Likelihood

Level	Descriptor	Description	Indicative Annual Probability
A	ALMOST CERTAIN	The event is expected to occur	$>\approx 10^{-1}$
B	LIKELY	The event will probably occur under adverse conditions	$\approx 10^{-2}$
C	POSSIBLE	The event could occur under adverse conditions	$\approx 10^{-3}$
D	UNLIKELY	The event might occur under very adverse circumstances	$\approx 10^{-4}$
E	RARE	The event is conceivable but only under exceptional circumstances.	$\approx 10^{-5}$
F	NOT CREDIBLE	The event is inconceivable or fanciful	$<10^{-6}$

Note: "≈" means that the indicative value may vary by say ±• order of magnitude, or more.

Qualitative Measures of Consequences to Property

Level	Descriptor	Description
1	CATASTROPHIC	Structure completely destroyed or large scale damage requiring major engineering works for stabilisation.
2	MAJOR	Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilisation works.
3	MEDIUM	Moderate damage to some of structure, or significant part of site requiring large stabilisation works.
4	MINOR	Limited damage to part of structure, or part of site requiring some reinstatement/stabilisation works.
5	INSIGNIFICANT	Little damage.

Note: The "Description" may be edited to suit a particular case.

Qualitative Risk Analysis Matrix – Level of Risk to Property

LIKELIHOOD	CONSEQUENCES to PROPERTY				
	1: CATASTROPHIC	2: MAJOR	3: MEDIUM	4: MINOR	5: INSIGNIFICANT
A – ALMOST CERTAIN	VH	VH	H	H	M
B – LIKELY	VH	H	H	M	L-M
C – POSSIBLE	H	H	M	L-M	VL-L
D – UNLIKELY	M-H	M	L-M	VL-L	VL
E – RARE	M-L	L-M	VL-L	VL	VL
F – NOT CREDIBLE	VL	VL	VL	VL	VL

Risk Level Implications

Risk Level		Example Implications(1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H	HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels
M	MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.

(2) Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

APPENDIX J

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminant bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	