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12 October, 2015

MORNINTON PENINSULA SHIRE
Private Bag 1000
ROSEBUD VIC 3939

Attention: Tony Pingiaro

COPY: CIVILTEST PTY LTD
10 Latham Street
MORNINGTON VIC 3931
Attention: Patrick Oai

Ref: 116983

Dear Sirs,

RE: Peer Review: 14 – 16 View Point Road, MCCRAE

Following your instructions we confirm having carried out a review of the geotechnical findings and risk assessment for redevelopment of the above site, including demolition of an existing single storey, timber and fibro sheet clad dwelling suspended on steel 'H' beam posts and construction of a new double level, articulated masonry veneer and clad dwelling with a lower floor garage, and report as follows:

The review is carried out on the basis of the following:

- An inspection of the subject site;
- Our knowledge of the regional conditions of the area, and conditions local to the subject site;
- A report prepared by GeoAust, reference: 1624-9-R, dated 14 September, 2011;
- A peer review conducted by Lane Piper, reference: 209242Report02.1, dated 7 November, 2011;
- A report prepared by Civiltest, reference: 1140220.2, dated 19 December, 2014;
- A peer review conducted by Intrax, reference: 61924.1, dated 7 November, 2011;
- Town Planning drawings Sheets 1 – 3, dated February 2013, prepared by J & P D'Helin;
- Structural Computations. Reference: CGR-6391, dated November, 2014, prepared by Chadwick Grimmond Consulting Engineers Pty Ltd.

Although a review of all the above reports has been conducted, the following peer review prepared by A.S. James Pty Ltd is relevant to the most recent investigation conducted by CivilTest (Ref: 1140220.2, dated 19 December, 2014). This latest report was amended following a peer review by Intrax therefore is considered the most complete investigation with regards to the relevant works proposed. We note that GeoAust's report (Ref: 1624-9-R, dated 14 September, 2011), and Lane Piper's peer review (Ref: 209242Report02.1, dated 7 November, 2011), were prepared on the basis of works previously proposed upslope, off View Point Road. The most recent development proposed is the construction of a residential dwelling at the base of the slope (off Penny Lane), following demolition of the existing dwelling (upslope).

The key aspects of this site and report are as follows:

- Civiltest's report is an amended report and was provided in response to queries raised in the peer review by Intrax Consulting Engineers (See above references).

- It is proposed to develop the site with a double storey articulated masonry veneer and clad dwelling with a lower floor garage.

- Geological maps indicate the site to be underlain by Devonian aged granodiorite and granite overlain by Quaternary Aeolian.

- The subject site is located between Penny Lane to the northwest and View Point Road to the southeast. The natural ground surface slopes are described as steep to very steep, with slopes varying between approximately 46^{o} near View Point Road, and 26^{o} near Penny Lane. Most trees noted on site, along with earth constructed steps, were inclined downslope as a result of creep and some scouring and erosion from surface run-off.

- An existing single storey timber, fibro sheet clad dwelling suspended on steel H columns is located upslope near to View Point Road. A timber cottage exists down slope near Penny Lane. These are to be demolished to give way to the construction of the proposed building. The dwelling upslope is thought to be founded on shallow concrete pile footings.

- Seven (7) boreholes were drilled by mechanical and hand auger along the slope and encountered residual sand and clays over variably weathered rock. Civiltest encountered what has been logged as weathered granitic rock / material in all bores (with the exception of Borehole 5), between the depth of 0.75 – 7.0 metres. In general, the granite is shallower at the base of the slope.

- Power auger refusal in higher strength weathered rock material was achieved at 2.5m, 2.3m and 2.2m depth in boreholes 2, 3 and 4 respectively. Hand auger refusal in dense granitic sand and fine gravels was achieved at 0.75m depth in boreholes 6 and 7 respectively.

- No groundwater was encountered during the investigation.

- Slope stability modelling was carried out using Slide 5.0 software to determine the factor of safety with respect to the natural slope (existing hillside) at the site. A number of methods have been used to analyse slope failure surfaces and determine the factor of safety with respect to the slope at the site. The analysis assumes a circular type slip surface occurring through the slope. The shear strength parameters adopted are based on limited laboratory testing and Civiltest's previous experience in the area. All models consider the effect of earthquake acceleration in the slope in question.

- A groundwater table was not included in modelling due to the steep slope of the site and sandy profile. It is expected that drainage at the site will be good.

- Results of model 6.2 indicate the natural existing slope to have a minimum factor of safety (FoS) of 1.025 with earthquake loadings. It indicates all slip circles with a FoS < 1.5 are within the top 5.0 metres of the profile in the upper sands and loose colluvium. Civiltest state that the depth of failure circle (which is shown to be 5.0 metres from the existing surface level) is highly unlikely as the underlying sands are indurated. They reference Collins, B.D. and Sitar. N. (2009) who report the use of higher cohesion values (≤ 25kPa) for indurated sands. Civiltest have adopted 1kPa because of the unknown depth of soil disturbance and weathering.

- Results of model 6.3 which demonstrates the effect of the proposed installation of the upper row of piers as a retaining wall indicate a minimum factor of safety (FoS) of 1.082 with earthquake loadings. This slip circle with the lowest factor of safety is located on the steepest section of the site and within the upper sands and loose colluvium at depth depicted to be ~2.0 metres deep at most. Civiltest state the piers and wall will be structurally engineered and have sufficient strength to resist the lateral earth pressures as well as static and dynamic design actions (refer to our comments).

- Results of model 6.4 which demonstrates the effect of the proposed building loads with retaining walls also indicates a minimum factor of safety (FoS) of 1.082 with earthquake loadings. This slip circle with the lowest factor of safety is again located within the upper sands and loose colluvium at depth depicted to be ~2.0 metres deep at most. Again Civiltest state that the shear strength of the indurated sand used in the stability analysis for this site is conservative and that by increasing the cohesion to 10kPa, a FoS of 1.5 would be achieved.

- The “drained” friction angle for materials 1 – 5 (in particular 4 and 5), used in the modelling by Civiltest are considered too high. The “drained” cohesion for material 5 is also considered too high. This, however, is thought to not have a significant impact on the outcome of modelling, but should be checked.

- Civiltest has identified that the failure surfaces (slip circles) with a minimum factor of safety of 1.082 indicated in models 6.3 and 6.4 at the steeper section of the slope (escarpment) indicate that the stability of the site is not altered significantly as a result of construction. Also, the risk of any fall-out of material is minimised if the site works are undertaken commencing at the centre of the site and working downslope.

- Model 6.2 indicates that under existing conditions, the possible failure surfaces with a FoS less than 1.5, could extend to a depth of 5.0 metres below existing ground surface and is dependent on the degree of weathering and disturbance of the surface soils.

- Models 6.3 and 6.4 indicate that if the upslope retaining wall is engineered, the stability of the slope in general would be maintained.

- Downslope of the site weathered rock is expected below approximately 2.0 metre depth. At the propsoed building location, weathered rock is expected between 5.0 – 10.0 metres depth.

- All load bearing footings should be founded a minimum 2.0 metres into weathered rock.

- The upslope bored piers should penetrate weathered rock sufficiently and designed to support the load expected on the proposed building wall.

- The bored pier retaining wall should extend above ground level to stop the impact on the building of any material moving down the slope.

- Civiltest has identified two (2) potential slope instabilities relevant to the subject site. Shallow rotational/translational slide (Hazard A); and potential debris slide (Hazard B).

- A frequency analysis has indicated Hazard A is ‘Likely’ and Hazard B is ‘Possible’ with the consequence to property <u>Minor</u> for Hazard A, and <u>Medium</u> for Hazard B.

- The risk assessment for the property indicates both hazards to have <u>Moderate</u> risk with respect to the proposed development. Implementation of treatment options are therefore required to reduce the risk to <u>Low</u>.

- The risk to life is considered acceptable for Hazards A and B under existing conditions but is determined to be a moderate risk for the proposed development and surface profile.
- Foundations for the propsoed development should all be embedded in the weathered rock.
- Based on the risk assessment carried out, Civiltest state that the hazards will require management and treatment to reduce the risk level to preferably acceptable levels.
- To mitigate the risk of the failure hazards identified, the following measures would need to be incorporated into the proposed development.
  - Foundations for the propsoed development should be founded a minimum 1.0 metre into distinctly weathered rock and an allowable bearing pressure of 1200 kPa can be assumed.
  - Retention systems must be constructed prior to making site cuts. The retaining wall on bored piers (high side of slope), should extend above existing ground level to catch any dislodged or washout material.
  - The steep area below View Point Road should be covered by geotextile, or vegetation regrowth to minimise surface scouring and erosion that is expected during prolonged wet weather. To further improve the stability of the steep escarpment, the factor of safety can be increased by placing a wire mesh and pinning it down with soil nails or star pickets.
  - No fill should be placed on the site except for a small amount of levelling fill.
  - Control surface water and sub-surface groundwater and direct to the stormwater system.
  - Revegetation is encouraged on the existing slope face and on uncovered soil surfaces to prevent/reduce saturation of soils following prolonged rain event.
- Site cuts greater than 1.0 metre in height require an engineered retaining wall. Cuts less than 1.0 metre should be battered no steeper than 1V:2.0H.
- Where cut batters steeper than 35^{o} are required in the clayey sand, steep than 60^{o} in the weathered rock, these should be retained using engineered retaining walls. These retaining walls should be founded on deep piles, embedded a minimum 1.0 metre in distinctly weathered rock.
- Retaining walls must have an agricultural type drain surrounded by granular material which extends to the top of the wall, constructed behind them.

- The upslope walls of the proposed dwelling should be designed as part of the soil retaining wall if there is no separate retaining wall structure.

- Earth coefficients provided by Civiltest are considered adequate.

- Bored piers for the proposed dwelling should be founded not less than 1.0 metre into the distinctly weathered rock and can be assumed to have an allowable end bearing pressure of 1200kPa at this depth. At an embedment depth of 1.5 metres into distinctly weathered rock, 1500kPa can be assumed.

- Access for construction machinery to the site would be from Penny Lane. It is likely an access track will have to be constructed leading to the proposed building location. Access for construction of the propsoed bored piers upslope will require some cut and fill.

Discussion

Based on a site inspection carried out by A.S. James Pty Ltd, and following review of the above referenced reports / peers reviews, we provide the following comments:

- We understand construction of the proposed dwelling is to be carried out following demolition of the existing dwelling upslope. This is stated on the permit application and we emphasise this should be adhered to as bulk earthworks may have an adverse affect on the existing dwelling's footings. As far as A.S. James are aware, a detailed investigation of the existing footings has not been carried out therefore founding conditions have been assumed.

- Modelling conducted by Civiltest indicates the stability of the site will not be altered significantly as a result of construction. It is insufficient to state this, as stability needs to be improved to acceptable levels.

- Factors of Safety are considered marginal pre and post construction (~1.025 – 1.082). A.S. James recommends forcing a slip circle with a Factor of Safety of 1.5 to ensure proposed footings extend below this level. This should be achieved in the weathered rock. A.S. James Pty Ltd note, however, drained friction angles adopted for materials 4 and 5 appear too high and should be revised when carrying this out.

- Civiltest states all load bearing bored pier footings should extend a minimum 2.0m into weathered rock. The depth of these footings will be determined ultimately by the depth of soil to be resisted should a failure occur. Civiltest's models have indicted a 'depicted' depth of 2.0 metres for the depth of loose colluvium and upper sands which footing design is required to resist. A.S. James Pty Ltd would suggest this depth is defined more accurately so footing design can be carried out adequately and the forces to be resisted laterally can be determined.

- Civiltest states the upslope bored piers should penetrate the weathered rock sufficiently and designed to support the load expected on the propsoed building wall. Again, A.S. James Pty Ltd suggest a definitive height of the soil to be resisted is provided for footing design.

- Civiltest states the bored pier retaining wall (upslope row) should extend above ground level to stop the impact on the building of any material moving down the slope. A.S. James Pty Ltd agrees and suggests a debris flow barrier constructed on top of the retaining wall should be designed to resist a potential failure. Because the Factors of Safety are marginal (~1.0) post construction, the debris flow barrier should be designed to resist a possible event i.e. should the "depicted' 2.0 metre depth of colluvium and upper sands fail, will the debris flow barrier resist this? This can be designed by companies such as Geobrugg Australia or by specialist designers and should be a requirement of the development.

- The risk assessment outcome appears satisfactory however we are unsure how annual probabilities of 2.0×10^{-3} and 2.0×10^{-4} were determined.

- Where Civiltest describe risk mitigation and building foundations, they state a minimum depth of embedment of 1.0 metre is required. Previously a minimum depth of embedment of 2.0 metres was recommended. We also note they state these should be founded in distinctly weathered rock. No mention of distinctly weathered rock had been made in the report and the borelogs describe only extremely weathered rock. This may cause some confusion during footing design and has led to confusion by us.

- A.S. James agree all footings should extend into the weathered rock however, Civiltest do not appear to make mention of how to achieve the required lateral capacity required to resist the surface flows of overburden colluvium and upper sands. Given the slope of the site and the outcome of modelling, the footing arrangement should be designed to provide sufficient lateral capacity to resist the identified hazards. This could incorporate shear walls and bored piers constructed for the strutted condition, raking piles or other appropriate methods.

- Civiltest touch on access to the site for construction machinery. Mobilisation of significant construction plant will require a stability check depending upon proximity to the escarpment and loads. Stability assessments and engineering advice should be provided and risk mitigation implemented to reduce the risk to within tolerable limits. A piling platform design may be required.

Should any point remain in doubt please do not hesitate to contact us.

Yours faithfully,

Irrelevant / Sensitive **Irrelevant / Sensitive**

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