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14 August 1995

Chief Executive
Tauranga District Council
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TAURANGA

Attention: Mr B Petrenas

Dear Sir

re: SLOPE INSTABILITY CONCERNS - TE HONO STREET - MAUNGATAPU

1. INTRODUCTION

Further to the site visits and discussions last Saturday (12 August 1995) with you and Craig Batchelor, I have completed my preliminary assessment of the available data and I am pleased to forward my initial recommendations concerning the above matter. In preparing this brief summary report I have relied extensively on the data contained in the reports by Tonkin & Taylor Ltd (Hegan, 1995) and Babbage Consultants Ltd (Luxford, 1995), and I have also referred to NZ Geological Survey Report EG348 (Houghton & Hegan, 1980) as well as to other correspondence provided by yourselves. Although I have not yet been able to access all the information necessary for a full geotechnical evaluation, and specific conclusions may thus be slightly modified in my final report, I am sufficiently concerned with the present situation in Te Hono Street to advise that an immediate course of action be implemented by Council. Specifically, I consider that continued use of soakage holes for stormwater disposal on Maungatapu Peninsula cannot be justified, and that Council must adopt at once a programme for the phased elimination of this practice commencing with piping to the street for certain properties adjacent to Te Hono Street.

2. PRESENT INSTABILITY - NOS 83-89 TE HONO STREET

2.1 Probable Extent of Cliff Retreat: It is clear from our site inspections of 12 August 1995 that continued cliff failures can be expected along this part of the Maungatapu Peninsula, and that this is of direct concern both to the existing property owners and to Council. Whilst we were present in the area a small (< $3m^3$) slide occurred from the lower part of the cliff face at No 85 Te Hono Street, and regression upslope is anticipated given the observed development of fresh tension cracks on the upper

part of the face. In summary, it is my opinion that 1) some 2-3m of cliff-top retreat will occur at the boundary between Nos 83 and 85 where subsidence cracking is already evident; 2) a further 1-2m of retreat is likely in front of the conservatory at No 85; 3) the vegetated slope in front of No 87 will probably fail back to the new cliff top positions at the boundaries with Nos 85 and 89; 4) the cliff top in front of No 89 can be expected to retreat by a further 1-2m; and 5) minor failures may occur at or close to the boundary between Nos 89 and 91. I stress that these conclusions have been reached from visual observations of the existing state of the cliff at Nos 83, 85 and 89 Te Hono Street, and not from any quantitative analysis of slope stability.

2.2 Stability Implications: Whilst such additional slope failures will not threaten the immediate security of the houses involved, continued fretting of the cliff face and top has to be of concern for the longer-term stability of the house sites and will at the very least continue to affect the psychological well-being of the occupants. In the case of No 85 Te Hono Street, I expect that the present phase of slope regression will reach to within 2m of the pergola and 4m of the conservatory, and this must be close to the acceptable minimum condition for the continued safe occupation of the house on its present site. In the longer term (1-5 years) it will almost certainly be necessary for site-specific slope stabilisation measures to be undertaken to protect these four properties, and various options have been outlined by Hegan (1995) including horizontal drainage and soil nailing. However, as discussed later, I do not consider that such engineering works are a matter for Council at this stage, and the individual owners should be encouraged to seek further advice from their insurers and/or geotechnical professionals.

3. CLIFF FAILURE MECHANISMS AND CAUSES

3.1 Suggested Failure Model: The Tonkin & Taylor Ltd report (Hegan, 1995) identifies cliff failure as being initiated by a "blow-out" mechanism in the TG3 "loose" silty sand unit above a whitish silty clay (TG4) located at a depth of about 14m below the cliff top. My field observations confirmed that significant groundwater seepage is occurring above the TG4 unit, and that removal of basal support at this depth results in upslope retrogression and retreat of the cliff top. Whether failure is actually occurring in the "loose" silty sands, or at the top of the underlying highly sensitive whitish silty clay unit (as suggested by Houghton & Hegan, 1980), is not of immediate concern and would certainly require additional site investigation and soil testing. The general failure mechanism and its association with a strong seepage zone at the top of the TG4 (whitish silty clay) unit has also been confirmed in reports by Shrimpton & Lipinski Ltd (Hughes, 1995) and Babbage Consultants Ltd (Luxford, 1995).

3.2 Triggering Factors: It is generally accepted that abnormally high porewater pressures are responsible for the present series of landslips on Maungatapu Peninsula, and that these were also the cause of similar slope failures which occurred there in March

1979. Although natural infiltration of rainfall through lawn and garden areas is the major source of groundwater recharge, it is clear that a significant contribution is derived from the current practice of discharging roof stormwater into soakage holes in the ground in areas to the south and west of Te Hono Street. Advice from Mr B Child (91 Te Hono Street) indicated that soakage holes at Maungatapu were drilled to approximate depths of 10m, although the Shrimpton & Lipinski Ltd report (Hughes, 1995) suggests that these are traditionally drilled only to the Rotoehu Ash which is at a depth of some 4-5m at this site (Hegan, 1995). Whilst this discrepancy should be resolved, the three open standpipe piezometers recently installed by Tonkin & Taylor Ltd have recorded daily changes at times in excess of 0.5m and a response typically delayed by about 24 hours following rainfall: this implies significant hydraulic connection to the depth of the major seepage flows above the whitish silty clay (TG4) unit, and almost certainly the presence of locally perched groundwater.

4. SOAKAGE DISPOSAL OF STORMWATER

4.1 Effect on Subsurface Flows: The effect of point injection of stormwater via soakage holes up-gradient from the cliff face at Maungatapu is to raise the hydraulic head during or following prolonged wet periods because of the generally lower permeability of the clayey and silty volcanic soils. This in turn increases the discharge seepage velocity in the more permeable sandy units, potentially resulting in erosion and development of significant uplift pressures: a similar head-discharge model has been used to explain the delayed increase in flow rates for natural springs from bedrock following rainfall events at times of the year when groundwater storage in fractures is high. In addition, the lensoidal nature of some of the units present in the sequence at Maungatapu would result in leaky connections between the main aquifers and, whilst the subsurface hydrological model is undoubtedly complex, it is clear that direct infiltration of rainfall and stormwater soakage disposal are both contributing to the present cliff instability. The effects of soakage disposal of stormwater on the groundwater regime in the Tauranga area, and its potential impacts in landslip-prone areas such as Maungatapu, were correctly identified by Houghton & Hegan (1980) and they commented (p13) that "it is well worth considering installation of a stormwater drain system".

4.2 Cliff Stability Implications: The fact that a similar episode of cliff collapse occurred in 1979 could be interpreted to show that the triggering groundwater conditions develop on a 15-20 year "cycle" accompanying prolonged and relatively rare wet periods, but this is a simplistic view and one that ignores the important contribution that soakage disposal will continue to have in recharging groundwater. Quantification of the relative inputs from infiltration and soakage could be carried out, as suggested by Luxford (1995), but I doubt that such an analysis would justify the continued widespread discharge of stormwater by soakage into the ground on Maungatapu Peninsula. It is not simply the quantity of water that is being intercepted and discharged into the ground by soakage disposal, which may well

be of a similar magnitude to that entering the ground from rainfall prior to development, but the fact that this water is being fed rapidly and directly into the groundwater system at or close to the depth of a principal sandy aquifer. I agree with the observation by Hughes (1995) that, whilst some face seepage will have come from the soakage hole discharges at No 87 Te Hono Street, most of the contributing subsurface flow is likely to have been sourced from natural infiltration and from soakage holes further up-gradient (ie to the south and west of Te Hono Street).

5. COUNCIL'S POSITION

5.1 May 1981 Letter to Some Property Owners: Following the March 1979 cliff instability episode on Maungatapu Peninsula, the City of Tauranga in May 1981 sent a standard letter to those property owners affected by landslip damage. This letter quite clearly drew attention to the fact that the use of soakage holes for stormwater disposal was "an additional risk factor to (slope) stability", and required the owners "to dispose of stormwater from your roofs, yards and drives by means of a piped drain" either to the street kerb or to the estuary or to an approved outlet. The letter also identified other "good housekeeping" practices that would minimise future landslip risks, such as drainage of springs and careful maintenance of vegetation. One outcome of this letter was that most houses between Nos 75 and 105 Te Hono Street were required to cease using soakage disposal holes for stormwater, and No 87 was clearly advised at the time although only in the last week has the piped connection been made to the street. With the benefit of hindsight it is unfortunate that the potential contribution to instability of soakage hole disposal from houses further away from the cliff faces was not recognised in 1981, as geotechnically the logical extension of that new policy was to require all houses on the Peninsula to transfer to a reticulated stormwater disposal system.

5.2 Legal and Technical Implications: In view of the clear identification by Council (or at least its predecessor) in 1981 of a causal relationship between soakage disposal of stormwater and landslip damage on steep land or cliff faces at Maungatapu, I must seriously question Conclusion 9.6 in the report by Babbage Consultants Ltd that "it is unlikely that Council could be held liable for allowing ground soakage to continue" (Luxford, 1995, p5). The clear weight of geotechnical evidence is that the practice of stormwater disposal by soakage is no longer appropriate for the geological conditions that exist on the Maungatapu Peninsula, and that it is at least a contributing factor to the present (as well as to past) episodes of cliff instability. Council stated nearly 15 years ago that the practice was no longer appropriate, and the events since late May this year have reconfirmed the need to eliminate soakage disposal of stormwater at Maungatapu as a matter of urgency. Whilst a quantitative analysis may establish that the soakage contribution to subsurface flow is only a small fraction (say, 10-20%) of the direct infiltration component, and therefore that stormwater disposal by soakage was not the prime cause of cliff failure in

the present situation, I consider that Council would nevertheless have considerable difficulty in defending at law a continuation of the current practices should they be challenged. Legal advice should be sought on this matter, but my view is certainly that while Council cannot be held to be directly liable for the cliff failures presently occurring at Nos 83-89 Te Hono Street, it would be imprudent (and possibly negligent) not to take immediate steps to eliminate the soakage component of groundwater recharge and subsurface flow. It must be noted, of course, that this will not prevent future cliff failures during extreme rainfall events or periods, but that it will reduce by an as yet unquantified (but probably small) amount the extent of direct recharge to a principal aquifer unit with which slope instability is clearly associated at Maungatapu.

6. STAGED ELIMINATION OF SOAKAGE DISPOSAL

6.1 Policy Recommendation: It is my recommendation that Council implement immediately a policy for the staged elimination of stormwater disposal via soakage holes on Maungatapu Peninsula, and that this be expedited for the Te Hono Street area where present cliff instability is of particular concern. The staged programme should progressively eliminate stormwater soakages in the following areas:-

1) First Priority: Nos 54-86 on the south-western side of Te Hono Street, as well as Nos 27-43 on the southern side of Maihi Crescent, as these dwellings are directly up-gradient from the properties presently experiencing landslip damage.

2) Second Priority: Nos 96-110 Te Hono Street, Nos 10-40 on the northern side of Maihi Crescent, Nos 11-21 on the southern side of Maihi Crescent, and Nos 20-34 Te Wati Street.

3) Third Priority: All dwellings on the estuary side of Te Hono Street that are not presently discharging to the street or to another approved outfall.

4) Fourth Priority: All other dwellings located on Te Hono Street, Maihi Crescent, and Te Wati Street.

5) Fifth Priority: Other parts of the Maungatapu Peninsula in an order of priority to be decided following further geotechnical evaluation.

It is recommended, subject to requirements for notification of property owners, that work commence immediately on Priority 1 dwellings, and that street connections for Priority 2 dwellings be completed within 3 months. Elimination of stormwater soakage from Priority 3 dwellings should be completed within 6 months, and from Priority 4 dwellings within 12 months. The further timetable for the reticulation and disposal of stormwater can be determined within the first 12 month period, and its staged implementation would then follow. My opinion is that the costs of a full stormwater system should be borne by Council as part of its ongoing policy to upgrade services in terms of the

relevant legislation, and not be levied as a charge on the property owners concerned. Practical difficulties may arise where gravity drainage is not possible because parts of some properties are below the invert level of the existing stormwater pipes, and concurrent engineering design will be necessary as will be inspection and approval of all outfalls installed to street or other frontages.

6.2 Concurrent Investigation Programme: It is clear that ongoing engineering design of any stormwater reticulation system will be necessary, and I understand that Shrimpton & Lipinski Ltd have already been approached to prepare cost estimates for such work. In addition I would endorse Recommendation 10.7 made by Babbage Consultants Ltd that "it would be prudent for Council to initiate a geotechnical study of groundwater fluctuations and soil strengths...." (Luxford, 1995, p5), and I note that this should be done not only in the context of cliff setback distances but also to provide a hydrogeological model for the Te Hono Street area to assist with planning and evaluation of the stormwater reticulation system. I recommend that some 10-12 CPT holes be drilled and logged at appropriate sites, and that piezometers be installed in these for routine monitoring of groundwater levels in conjunction with rainfall records: such data will in my view be essential to facilitate design of the reticulation system and to allow a quantitative assessment of the effects of eliminating soakage disposal of stormwater. Concurrently with the groundwater monitoring programme I would also recommend that a study be made of the geotechnical characteristics of the various soil units on the Maungatapu Peninsula that are associated with the present landslip problems, although this work should include a number of parameters such as particle size, density, Atterberg Limits, permeability, and erodibility in addition to peak and residual strengths. A study of this type could be done as a University thesis study at minimal cost to Council, or by consultants specifically briefed for the project.

7. MONITORING AND EVALUATION OF CLIFF STABILITY

7.1 Short-Term Monitoring Studies: I consider it essential that Council maintain its own records of the active cliff retreat that is presently affecting Nos 83-89 Te Hono Street, and that this be extended to other properties if appropriate. At this stage I would envisage twice-weekly visual inspections with recording of any cliff-top regression or other relevant data, and arrangements with individual property owners for more frequent site visits if necessary. I understand that the Tauranga office of Beca Carter Hollings & Ferner Ltd has been approached to carry out this work, and I endorse the need for this approach to be continued for an indefinite period until either the landslips cease or remedial measures are undertaken on specific properties. It would also be useful for the three piezometers in the front of Nos 85 and 87 Te Hono Street to be read at the time of each visit until the recommended hydrogeological study is implemented, and a suitable arrangement could be made with the Earthquake Commission to share the costs of data collection. Should the cliff top at No 85 Te Hono Street regress to within 2m of the pergola (ie less than 4m

from the conservatory) I would recommend that temporary evacuation of the dwelling be considered until such time as a full geotechnical re-evaluation of slope stability is carried out and/or suitable remedial measures are implemented.

7.2 Cliff Stabilisation Measures: As noted earlier in this report it is my view that specific remedial measures for each of the affected properties is the responsibility of the individual owners, their insurers and professional advisers. I do not consider that Council can be held directly liable for the present episode of cliff instability because it has been triggered by a prolonged wet period involving abnormal rainfall conditions, and it is my opinion that any duty of care extends only to the well-being of the occupiers of the properties concerned. Involvement in remedial works by Council could be seen as an admission of at least partial liability, and it would also create a precedent for future such situations in the Tauranga District. I certainly do not consider that the immediate installation of a reticulated stormwater system at Maungatapu is an admission of any liability on the part of Council, but rather a prudent response to the geotechnical advice now available following the 1995 cliff failure episode which is also consistent with an improvement in the service to ratepayers. I do note with some concern, however, that the extent of cliff retreat at Nos 83 and 89 Te Hono Street has yet to reach the 8m limit set by the Earthquake Commission for their involvement, and I consider that this approach is quite unreasonable in the circumstances because both properties have clearly been affected by landsliding and further retreat of the 25m high cliff is probable. Site investigation, design and construction of remedial works should be carried out on both properties immediately rather than waiting for further damage to occur, and I would urge Council to make representations to the Earthquake Commission on behalf of both owners. I consider it to be outside my brief to comment on the specific stabilisation measures proposed in the Tonkin & Taylor Ltd report (Hegan, 1995), but I would note that inclined drainage holes may be more appropriate than horizontal drains into the silty sand (TG3) unit and that construction of some of the options may be extremely difficult given site access and topographic constraints.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Assessment of Current Instability: Present cliff instability at Nos 83-89 Te Hono Street can be attributed to a prolonged wet period involving abnormally high groundwater levels, with the principal recharge from direct rainfall infiltration and a small but significant contribution from soakage disposal of stormwater. Failure is being intitiated at a prominent seepage horizon some 12-14m below the ground surface, and further cliff-top retreat is anticipated although none of the dwellings is in immediate danger.

8.2 Soakage Disposal of Stormwater: Point injection of stormwater via soakage holes has a significant effect on the groundwater regime at Maungatapu, and it contributes to the recharge of the silty sand aquifer unit with which cliff failure initiation is

associated. The clear weight of geotechnical evidence is that this practice is inappropriate for the geological conditions that exist on the Peninsula, and it is therefore recommended that the phased elimination of soakage disposal of stormwater be commenced immediately.

8.3 Concurrent Geotechnical Investigations: In conjunction with the staged introduction of a stormwater reticulation system for Maungatapu Peninsula, a hydrogeological study is recommended involving some 10-12 monitoring boreholes in order to facilitate the engineering design requirements and to quantify the effects on the groundwater regime. A concurrent evaluation of a range of geotechnical properties of the various soil units involved in the landslide failures is also recommended to assist Council with its planning functions.

8.4 Council's Legal Position: Although I do not consider that Council can be held liable for the present cliff instability on Maungatapu Peninsula, a letter sent to some residents in 1981 did acknowledge the potential impact of soakage disposal on slope stability and certain owners in Te Hono Street were required to discharge stormwater directly to the street. In my opinion it would now be imprudent for Council not to act immediately to progressively eliminate soakage disposal of stormwater on the Peninsula, and I recommend also that legal advice be taken on this matter.

8.5 Ongoing Monitoring and Cliff Stabilisation: I consider that Council has a duty of care to closely monitor the present cliff instability situation at Nos 83-89 Te Hono Street, and I would recommend that this continue indefinitely until either the slope failures cease or appropriate remedial measures are implemented. I recommend that Council does not become involved in the design or installation of cliff stabilisation measures, and that this matter be dealt with by individual owners through their insurers and/or geotechnical advisers.

8.6 Approach to Earthquake Commission: I am concerned that the owners of Nos 83 and 89 Te Hono Street are unable to presently obtain assistance from EQC because the distance from the cliff failures to their dwellings is greater than 8m, and I recommend that Council makes strong representations on their behalf. Any stabilisation measures for these properties should be designed and constructed immediately, rather than after further cliff retreat, and I consider that the Commission's criterion for assistance is inappropriate in this situation.

9. REFERENCES

HEGAN, B D (1995) Landslip Damage at 85 & 89 Te Hono Street, Maungatapu, Tauranga Report by Tonkin & Taylor Ltd to McLarens (Bay of Plenty) Ltd dated 29 June 1995: 15pp

HOUGHTON, B F; HEGAN, B D (1980) A Preliminary Assessment of Geological Factors influencing Slope Stability and Landslipping in and around Tauranga City New Zealand

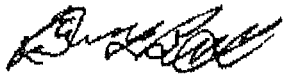
Geological Survey Engineering Geology Report EG348 dated October 1980: 19pp

HUGHES, M W (1995) Landslips at 85, 87, 89 Te Hono Street Report by Shrimpton & Lipinski Ltd to Tauranga District Council dated 31 May 1995: 2pp

LUXFORD, N S (1995) 85-89 Te Hono Street, Maungatapu, Tauranga Report by Babbage Consultants Ltd to Heaney Jones dated 26 July 1995: 5pp

I trust that the above report is sufficient for your immediate needs, and I look forward to your response in due course. I hope that my specific recommendations are clear and acceptable to Council, but do not hesitate to contact me if clarification or further detail is required.

Yours sincerely



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