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24 August 2015

Gabrielle Wall
Ministry of Education
39 Princess Street
Christchurch

Courtesy Copies:

Brenden Winder CERA
Libby Elvidge CERA
Coralanne Child MinEdu

Dear Gabrielle,

Geotechnical Review – Redcliffs Boards of Trustees submission

In line with your instructions this letter summarise my comments on 'The Future of Redcliffs School' report provided for review by the Ministry of Education dated 30 June 2015.

I have reviewed this submission in my function as the Chief Geotechnical Engineering Advisor to the Crown, while working for the Canterbury Earthquake Recovery Authority (CERA).

I have been tasked by the Ministry for Education to review the submission from Redcliff's School dated 30 June 2015, as well as, other relevant technical reports.

I am providing the comments below in line with my professional expertise as a ground engineering specialist knowledgeable about the wider sites. I make my comments as an Institution of Professional Engineers in New Zealand (IPENZ) Chartered Professional Engineer. My field of expertise is ground engineering, including engineering geology, geotechnical engineering and risk management. I have more than 20 years professional expertise in the above fields, both as an academic and professional consultant working for the private and public sectors.

I am familiar with the site setting in my role as an engineering consultant for over 10 years in Christchurch. I am also intimately familiar with the wider site setting as an Urban Search and Rescue (USAR) Engineering Specialist and Chief Geotechnical Engineer for CERA providing technical input to policy makers. Over the past four years I led the technical assessment of land stability for CERA as it related to the demolition of red zoned properties along the cliff edges and bottom along Redcliffs.

I attended and contributed to a meeting of technical experts on 5 May 2015 where geotechnical and engineering geology issues of the cliff face, as well as risk exposure on Redcliffs School grounds were discussed. I reviewed the minutes and I am in general agreement with the meeting outcomes.

I am providing comments on individual sections and summarise my opinion at the end of this brief.

Section 2 p. 10

I believe that this section is a cherry picking exercise from expert reports rather than a summary of technical issues that were considered. This section focuses on low probability events rather than the most probable scenarios. Fundamentally it does not consider who is to make the decision to return after an event, i.e. which agency or consulting company would make the decision. I query if this would even be covered under a consultant's PI insurance. I note that the section on '*potential disruptions are extremely unlikely*' is incorrect and these should be expected over a time frame of say 50 to 100 years, which is the operational lifetime of a school. This was expressed at our technical expert meeting on 5 May 2015 where changes in the cliff face over say 50 years are to be expected, thus the potential for disruption does exist.

Section 2.1 p. 11

Definition of 'safety' is not provided, is there a number or common understanding on what safety is or means? AIFR 10^{-6} is mentioned as a possible criterion and compared to 10^{-4} as threshold for occupation for residential properties, however, no acknowledgement is made of vulnerability and potential number of fatalities that very much affect the overall risk acceptance levels.

I note that engineering models are necessarily uncertain and express the degree of what we know and do not know. For example asbestos was considered a suitable building and construction material on the basis of best engineering advice. This is no longer that case. Similarly prior to the Canterbury Earthquake sequence rock fall protection works only considered single rock impacts. Given our observations and experiences now it is industry practice to consider multiple impacts where the potential for rock flux (rock fall corridors) exists. Thus our best practice approach fundamentally changed with new experiences and additional knowledge. Engineering advice tends to change over time as new knowledge becomes available. Engineering advice can only be considered an evolving affair where our understanding of processes and materials changes over time. Conversely, I note that the values presented by the engineering experts appear to be appropriately conservative given our current understanding of matters at hand.

Section 2.2 p.11

'MWH report offers assurances of safety' - I strongly suggest that this is not the case as I would be surprised if MWH can contractually offer any such assurance or provide any sort of professional insurance policy to support such a claim.

Section 2.3 p.12

'events would have no impact on the safety measures and therefore have no potential for future disruption' - I fundamentally disagree with this since we cannot say what those events may be and therefore we cannot reasonably foresee what impact they may have. During the technical expert meeting we discussed this issue and agreed that the potential does exist.

I note that EQ triggers, well in excess of February and June may have a return period of 1:50,000 years and a statistical probability of about 1-2% per annum, but the more likely

triggers are February 2011 like earthquakes which are much more frequent and this does not make them '*extremely unlikely*'. GNS predicts for the Canterbury Region an occurrence probability of 6% per annum for a M6.0 to M6.9 earthquake, whilst M5.0 to M5.0 has an annual probability of 51%, Geonet (2015). By any reason or measure, these are not '*extreme unlikely events*'. Also the time frames to consider are 50 to 100 years. Thus, the aggregate probability of a strong EQ affecting the site should be seriously considered.

Section 2.4

I do agree that the design is based on conservative values, as it should be given the site's exposure. However, the issue is not about the rock hitting or overtopping the bund but what degree of disruption the '*event*' may cause and how this may impact on the operation of the school.

p.14

This section is using the very unlikely case of EQ with +2g accelerations. As mentioned above the 1-2g earthquakes are more probable and although no rock is expected to reach or hit the bund we are basing this assumption on past performance which may not match future performance. The likely scenario is that a large EQ has occurred and the school was unoccupied or students evacuated. The key question should be who would provide assurance to the school board or ministry that it is safe to return with a potential unknown damage to the steep slope or mass movement area? Furthermore, if we consider a new earthquake then there will be aftershocks.

p.14 (continued)

I believe that the volume of debris presented in the table is assuming that the debris is equally distributed along the cliff base which is unlikely to be the case. Hence, I suggest that the areas behind the bund does not have the quoted capacity. Any debris accumulating behind the rock fall protection bund will affect the debris runout in future events. Debris removal may be difficult to undertake due to a number of reasons including access restrictions, land ownership etc.

Section 2.5 p.14

I agree that technical assessment of the cliff for small scale '*events*' could occur in a short period of time, say hours to days, BUT the critical question is: are the people inspecting the cliff able and capable to make a decision for the school to return to site and operate? At this stage and to my best knowledge there is no formalised monitoring of the cliff face and debris talus slope. I also note that the cliff face is in private ownership.

I do not agree with the second part of the section as cliff collapse debris will not spread uniformly across the base. The authors make the assumption that all debris will fall from the face and evenly distribute which may or may not be case. However, I agree that modelling uses conservative best values but as I understand the Ministry concerns are not about the issue whether the bund is hit or overtopped but what impact the changes to the cliff face may have on the school.

I do not agree with the author's position on 3rd last para on p. 15 that reinspection is an unlikely scenario that '*lies outside the bounds of the very conservative scientific modelling*', I rather suggest that due to heightened sensitivity around the cliff face and mass movement area pretty much any significant change in the cliff face will require some form of inspection, engineering advice and re-evaluation of the current engineering models and their inherent assumptions. Therefore I do not believe that the '*school could operate safely while such a reappraisal was conducted*' as there may be engineering issues, as well as, political, public and media pressures that are difficult to quantify.

Section 2.6

Once again the authors infer that the only event that could trigger a reassessment is when a rock hits the bund, which I do not believe is the only credible scenario, there are others more likely scenarios that I believe should trigger a reassessment of the cliff face and those are actually quite likely when seen over the operational life time of 50 to 100years. Thus, I believe that the trigger levels are not just '*unprecedented events*'.

I agree that with a full rearrangement of the school layout, the risk of disruption could be greatly reduced, but this will need a careful economic evaluation and will take time to implement. I have not reviewed any options in details, but if all school buildings are located towards Main Road and landscape areas are left towards the cliff base this may reduce the impact, but not necessarily address the Ministry's concern about future disruption to the school operations.

P. 17 Maintenance Planning

There is a suggestion to access the area behind the bund using the school land. While this may be a practical option, traffic and construction management would affect the school. Alternative access may be via southern Crown owned land, but this may require an agreement between various agencies. I am unable to comment on this issue, but note from my experience in the Port Hills that such access agreements can be very difficult to formalise.

I also note that the cliff face and land behind the school are not, as claimed by the submission, Crown owned, but in majority held in private ownership (The property owner has not settled with the Crown (as of August 2015)) and therefore any access would have to be negotiated with private individuals.

P. 17 (continued)

Although in concept the school is correct to state that the visual impact may be minor, I challenge this, as a 4m (plus) high bund is an impressive structure, one example is being constructed nearby along Taupata Street in Redcliffs where CCC is conducting mass movement remediation works. I also suggest that the owners of the private property between the school and cliff face may be impacted by a 4m high bund fronting their property. Incidentally this also would cut off their only current physical access to their property as the former principal access on Main Road is compromised by cliff collapse debris and has a s45 of the CER Act imposed on it due to life safety concerns. Their current physical access is via school grounds and this would effectively be cut off by the bund.

Based on my experience on past projects I believe that the above access and visual impact issues are actually far more critical than given credit for in the school submission. Resource consent applications and access negotiations may significantly delay any potential bund construction. This should be considered and professional advice sought from planners and visual impact consultants such as landscape architects as it is technically outside my area of expertise.

Section 2.7 p. 17

I note that houses remaining on the cliff face and the mass movement area are now being managed by private insurers, rather than the Crown via CERA and no demolition time frames are available at the time of writing. Overall there are six houses in total with three remaining on the cliff face. Based on my experience to date, I do not share the school's optimism that a timely resolution can be found.

Section 2.8 p.18

I do not share the opinions presented in the summary and have provided my opinion in the sections above. I also believe that the technical expert present in the meeting on 5 May 2015 may choose to disagree.

To close out, I have reviewed the submission in my function as a ground engineering specialist on behalf of the Crown and can only make comments on matters relating to my expertise. Hence, I have reviewed Section 1 to 2.8 only as they relate to ground engineering issues. I have read and noted the remainder of the document.

Summary

The Central Government, via CERA, made decisions on managing risk on the Port Hills by giving vulnerable residents an opportunity to move away from the hazard – fundamental basis of the red zone policy on the Port Hills to offer to purchase the properties.

The Crown has to date considered that provision of Crown-funded area wide mitigation measures on the Port Hills is not a viable long term hazard management strategy. The school if indeed being protected by a bund and remaining on site would effectively contradict earlier Crown policy decisions, despite having a higher number of vulnerable individuals than any other property that was zoned red.

The school submission appears to cherry pick best case and worst case scenarios to support their case of remaining on site. While I agree that the bund design and overall mitigation strategy are conservative, there are a number of uncertainties that may eventuate over the considered design lifetime which is at least another 50 to 100 years.

I believe that over the considered period there will be a number of events that may trigger an inspection of the cliff or evacuation of the school. What is not clear and cannot be provided with any certainty, is the process that allows the school to be re-occupied. The process also fundamentally relies on an individual professional engineer or private consulting company taking liability for that decision. There are public and private liabilities and professional

indemnity insurance cover issues to consider. Thus, there are likely to be a number of instances where deterioration of the cliff face or activation of the mass movement areas above may trigger disruption to the school operations, which is in line with the Ministry's concerns. There may be technical mitigation and administrative measures put in place to reduce the impact from any disruption but I suggest that this may be an economic and policy decision outside my technical expertise.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'Jan Kupec', with a horizontal line extending to the right. Below the signature, the text 'elect. sign' is written in a smaller, lighter blue font.

Dr Jan Kupec

Chief Geotechnical Engineer CERA

PhD MSc candIng MIPENZ CPEng IntPE | NZGS IGS ISSMGE NZSEE