Proposed Plan Change 7 to the Selwyn District Plan

Liquefaction Hazard in rezoned Living Z areas, Rolleston and Lincoln

Introduction

1. My name is Ian Ferrier McCahon. I hold a degree of Bachelor of Engineering (Hons) from the University of Canterbury and am a Chartered Professional Engineer. I have more than 35 years of experience in civil engineering with 20 years specialising in geotechnical and hazard identification and mitigation work. I have investigated many sites in Christchurch and elsewhere for liquefaction potential and mapped the liquefaction zones for the Christchurch Engineering Lifelines Study and for the Canterbury Region. Since the 2010 Canterbury earthquake I have been advising Selwyn District Council on the liquefaction hazard in the district and how best to approach the issue in both planning and building consent processes.

Scope

2. This evidence is confined to a preliminary assessment of the liquefaction potential of the subject areas, how that may impact on the land, buildings and infrastructure should it be developed, and how the hazard may be mitigated.

3. Liquefaction occurs with strong shaking in loose, saturated soils. Liquefaction can occur in a range of soils from silts to gravely sand. However, it is most likely to occur in saturated, relatively uniform fine sands in a loose state, at depths less than 10 to 15m below ground level, and where the water table is within about 5m of the surface. Typically only geologically recent (Holocene age) sediments are susceptible because consolidation and cementation of older sediments produce a more stable soil structure. The most susceptible soils are clean uniform sands, although a wider range of soil gradings from silt to gravel have been known to liquefy.

4. Liquefaction can cause slope failure, ejection of sand and water to the ground surface, settlement and ground oscillation. This can result in foundation failures of structures, ground settlement, damage to underground services and lateral movement (ground extension) along river banks.

Liquefaction Assessment

5. A preliminary assessment has been carried out based on the following methodology:
    - Identify underlying geology from published geological maps
    - Review a sample of borelogs from the Ecan well data base in and close around each area
    - Limited observations from travel through the area and a fly- over of some of the re-zone areas following the 4 September 2010 Canterbury earthquake and the 22 February 2011 Christchurch earthquake
    - Review other work on liquefaction hazard in the district: the liquefaction section from the 2006 Earthquake Hazard Assessment for the Selwyn District (Ecan report U 06/7), the Liquefaction Report of 2010 Canterbury Earthquake for Selwyn District (Geotech Consulting Feb 2011)

6. There was no surface evidence of any liquefaction in any of the subject rezone areas around Rolleston or Lincoln in either the Canterbury or Christchurch earthquakes, as ascertained by drive through observation, helicopter fly over or reports.

Rolleston

7. Rolleston is underlain with shallow gravel. The water table is understood to be at 10 – 15m depth, well below any sand between the ground surface and the gravels, which are generally within 2m of the surface. Any lenses of liquefiable sand that may exist within the gravel are at depth and effects at the ground surface would be minimal.

8. It is concluded that there is low to very low risk of liquefaction for all the rezone areas around Rolleston, and that liquefaction does not need to be considered in the appropriateness or otherwise of the rezoning.

Lincoln

9. There are large areas around the east and south of Lincoln to be rezoned as LZ or LZ deferred. Lincoln is within a transition zone between the gravel dominated river fan alluvium of the Canterbury plains and the sand and silt dominated alluvium of the coastal fringe. The soil profiles vary considerably within a short distance with fingers of shallow gravel extending out into thicker finer soils. The preliminary assessment of the soil profiles in these areas suggests the following.

   (a) West of Birchs Rd – ODP Area 4
   The available borelogs show shallow gravel in the north, but with a surface clay and silt layer extending to over 5m depth by Birchs Rd. The soils are likely to be either too coarse or fine to liquefy readily, but there is some possible potential.

   (b) Between Birchs Rd and Ellesmere Rd, north of Edward St – ODP Area 3
   Gravel is found at depths of between about 3 and 8m, overlain with predominantly silt and clay soils, but several borelogs record sand or silty sand above the gravel. The water table appears to vary from over 3m at Birchs Rd to little more than 1m at Ellesmere Rd. There is a potential for some liquefaction, particularly at and above the top of the gravel, but if liquefaction was to occur, then surface manifestations are likely to be limited.

   (c) South of Edward St to Liffey Stream – ODP Area 2
   There is little subsurface information in this area, but it is likely to be similar to (b) north of Edward St. There is a potential for lateral spread along Liffey Stream if liquefaction was to occur.

   (d) Liffey Stream to Springs Rd - ODP Area 1 & 5
   There is little subsurface information in this area, but it is likely to be similar to (b) north of Edward St, except that that the gravel may well be deeper at 6m or more. There is a potential for lateral spread along Liffey Stream if liquefaction was to occur.

(e) West of Springs Rd
There is little subsurface information in the area, but it appears that there is shallow gravel on the north side and deeper surface silts and fine grained soils to the south, and is thus similar to ODP area 4, west of Birchs Rd.

10. There have been no reports of ground damage in or close to Lincoln from either the 2010 Canterbury or 2011 Christchurch earthquakes. The closest observed liquefaction to the rezoning area was about one kilometre south of Ellesmere Road.

11. One Cone Penetration Test has been carried out in a site in the centre of Lincoln following the earthquake. Analysis of this test indicates that up to1.2m of soil within the 5.2m of soils above the gravel could liquefy in an earthquake, resulting in 50 – 80mm of ground settlement. While there was no evidence on the site that liquefaction occurred with the 2010 earthquake, this does indicate that there can be some risk in future earthquakes.

12. The south east boundary of the LZ deferred zone (ODP Areas 2 & 3) is on Ellesmere Road, which is the west boundary of the Potentially Liquefiable Ground Zone as defined in the SDC 2010 Canterbury earthquake Liquefaction Report. This boundary is acknowledged as being somewhat arbitrary, given the lack of subsurface information and the variable soil profiles in the area. No great significance should be read into this boundary juxtaposition, as the liquefaction report was focused on providing direction for building consent purposes within the rural zone and Tai Tapu township and did not include any assessment of existing or future urban areas.

13. It can be concluded that there is a potential for a liquefaction hazard to exist in parts of the Lincoln rezoning area, but that it is not likely to be severe given the lack of any liquefaction in the 2010 earthquake and the soil types present.

Development on potentially liquefiable ground

14. The fact that land may be liquefiable does not necessarily preclude the area from development, although the degree of acceptable risk and liquefaction induced damage is clearly the subject of debate following the Christchurch earthquake. Where the ground is highly susceptible and the damage level is high, it is prudent not to intensively develop such areas. However the Christchurch earthquake has also demonstrated that damage from minor liquefaction need be no more significant than shaking damage and is an acceptable risk for an event which has a relatively low probability of occurrence.

15. The issue was addressed in the Environment Court appeal over Pegasus New Town where liquefaction was identified as a hazard prior to the resource consent process. This resulted in the rules as set out in the Waimakariri District Plan pertaining to the new development. To our knowledge, this is the only District plan within New Zealand which specifically includes rules with respect to liquefaction, and these rules only pertain to the Pegasus Town development and no other part of the District. The particular criteria adopted are certainly questionable following the Christchurch earthquake, but the precedent of accepting some level of liquefaction risk is relevant.

16. Geotechnical reports are required for subdivision consent, and liquefaction should be explicitly addressed in the site investigations. If liquefaction is identified as a hazard, then the effects need to be predicted and mitigation measures designed and constructed if and where necessary. Mitigation may be as simple as requiring more robust house foundations, as outlined in the SDC 2010 Canterbury earthquake Liquefaction report.

Recommendation

17. I conclude that the liquefaction hazard is inconsequential in Rolleston, but that there is potentially a hazard at Lincoln. Liquefaction in itself is not sufficient to preclude the proposed plan change. The liquefaction hazard must be investigated as part of the subdivision geotechnical reporting, and if identified as a significant risk must be appropriately mitigated or designed for. It is not expected that liquefaction will be so severe a hazard that extensive ground improvement or other expensive remedial work would be needed.

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14 March 2011