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Geotech Report

Geotechnical Completion Report
Halswell Commons Development – Stage 2A, 2B and 2C
2019-07-17

Danne Mora holdings Limited
c/o Davie Lovell-Smith Ltd
Attn: Jamie Verstappen
Via Email: Jamie.Verstappen@dls.co.nz

Dear Jamie

Halswell Commons – Geotechnical Completion Report for Stages 2A, 2B and 2C
(Lots 301 to 308 and 338 to 362)
Aurecon Ref. 239575-04

1 Introduction
Danne Mora Holdings Limited is in the process of developing the Halswell Commons Residential Subdivision located in Southwest Christchurch, with the development for Stages 2A, 2B and 2C nearing completion. A plan showing the lot layout is attached.

The site is considered to be susceptible to seismically induced ground damage from liquefaction, as detailed in the Aurecon Report “Halswell Commons Residential Subdivision, Liquefaction Assessment Review – Stages 2 to 3” Revision 1, dated 14 May 2019 (Aurecon, 2019). Based on this report, the residential lots in Stages 2A, 2B and 2C of the development are expected to perform to an equivalent Technical Category 2 (TC2) site.

2 Geotechnical Investigations
Aurecon has undertaken a multi-staged geotechnical site investigation across the wider 70-hectare Halswell Commons site between 2014 and 2018, along with a review of previous geotechnical assessments carried out in 2013. The geotechnical investigation undertaken to date meet the intent the Ministry of Business Innovation and Employment (MBIE) Guidance “Repairing and Rebuilding Houses affected by the Canterbury Earthquakes” (MBIE, 2012 and 2014) for new residential subdivisions.


3 Liquefaction Hazard Assessment
We have assessed the expected ground performance for the site during seismic events based on the MBIE Technical Category Classification for residential properties. A description of the expected site performance and respective deformation limits for each Technical Category are outlined below:

- **Technical Category 1 (TC1)** – Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.
- **Technical Category 2 (TC2)** – Minor to moderate land damage from liquefaction is possible in future large earthquakes.
- **Technical Category 3 (TC3)** – Moderate to significant land damage from liquefaction is possible in future large earthquakes.

<table>
<thead>
<tr>
<th>Technical Category</th>
<th>Index Liquefaction Deformation Limits</th>
<th>Likely Implication for House Foundations (subject to individual assessment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical</td>
<td>Lateral Spread</td>
</tr>
<tr>
<td>TC1</td>
<td>15mm</td>
<td>25mm</td>
</tr>
<tr>
<td>TC2</td>
<td>50mm</td>
<td>100mm</td>
</tr>
<tr>
<td>TC3</td>
<td>&gt;50mm</td>
<td>&gt;100mm</td>
</tr>
</tbody>
</table>

We have undertaken a liquefaction hazard assessment for Stages 2 and 3 at the Halswell Commons Development, which is detailed in the 2019 Aurecon Report. The site-specific design parameters and methods used in our liquefaction assessment are summarised in Table 2. Please refer to the 2019 Aurecon Report for more details.

<table>
<thead>
<tr>
<th>Test</th>
<th>Liquefaction Assessment Method</th>
<th>Fines Content</th>
<th>Liquefaction Cut Off</th>
<th>Crust Thickens</th>
<th>Liquefaction Settlement Method</th>
<th>Liquefaction Ground Damage Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT</td>
<td>Boulanger and Idriss (2014)</td>
<td>Based upon Ic with $C_{FC}=0.2$</td>
<td>Based on a 2.4 Ic cut off</td>
<td>Cumulative thickness of upper soils where $FoS_{liq}&gt;1.0$</td>
<td>Zhang et. al. (2002)</td>
<td>Ishihara (1985) and LSN (van Ballegoo et al., 2014)</td>
</tr>
</tbody>
</table>

Based on the liquefaction assessment, the residential lots in Stages 2A, 2B, and 2C are expected to perform equivalent to a TC2 site, meaning “minor to moderate land damage from liquefaction is possible in future large earthquakes”. It is understood that there has been no cutting below the original ground level and all earth-fill that has been placed has meet the compaction specifications.
4  Foundation Recommendations

As the lots within Stages 2A, 2B and 2C are likely to perform to an equivalent TC2, we recommend that residential buildings are founded on MBIE TC2 Type enhanced foundations, as outlined in Section 5 of the MBIE Guidance (2012 and 2014).

In accordance with the MBIE Guidance, lot specific geotechnical investigations are required to confirm the available bearing capacity and ground conditions for each lot to support Building Consent.

5  References


6 Explanatory Statement

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using appropriate investigation methods with limited site coverage. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgment and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

This report is not to be reproduced either wholly or in part without our prior written permission.

Prepared by,

Jack Martin
Geotechnical Engineer

Reviewed,

James Muirson
Senior Engineering Geologist

Approved,

Dr Jan Kupec
Technical Director – Ground Engineering

Enc: Location Plan for Stages 2A, 2B, and 2C