31 August 2018

Ngāi Tahu Property Limited
PO Box 13-0060
Christchurch
New Zealand

Attention: Dean Christie

Geotechnical and Foundation Report: Lot 35, Manakura Neighbourhood, Karamū Subdivision, Riccarton, Christchurch

1 Introduction

This report provides the geotechnical appraisal and foundation recommendations for Lot 35 (DP 518068), Manakura Neighbourhood, Karamū Subdivision, Riccarton, Christchurch.

We anticipate the building will comprise a residential dwelling that is designed and constructed within the scope of NZS 3604:2011. Buildings outside the scope of NZS 3604:2011 require specific engineering design.

This report is intended to be used as technical supporting documentation for foundation design and Building Consent application purposes.

2 Ground Model

Our knowledge of the ground model is based on information from a number of sources, including:

Subdivision investigation\(^1\) including shallow and deep testing. The subdivision report concluded “Based on our liquefaction assessment, we consider the site to behave similarly to MBIE Technical Category 1 (TC1)”. The surface geology is Springston Formation alluvium, comprising mixtures of silt, sand and gravel. Groundwater is at approximately 10m depth.

Subdivision earthworks engineering undertaken with Eliot Sinclair as designer and Engineer to Contract, and works constructed by Blakely Construction Limited. All controlled fill placed across the subdivision area was supervised by an Engineer from Eliot Sinclair & Partners, and has been certified to NZS4431 as reported in the Inspecting Engineer’s Report\(^2\). The existing topsoil layer and any unsuitable material was removed down to clean insitu alluvium, followed by placement of controlled fill and finished with topsoil.

Site specific testing - see details below.

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3 Site Specific Testing

Following the completion of the earthworks, we undertook site specific geotechnical testing across all residential lots within the subdivision. Testing within Lot 35 comprised 1 shallow spade hole and 3 hydraulic penetrometers.

Table 1 presents the inferred ground profile in Lot 35. The site investigation factual records and test location plans are attached.

Table 1: Inferred ground profile in Lot 35.

<table>
<thead>
<tr>
<th>Depth (Below Ground Level)</th>
<th>Soil Description</th>
<th>Information Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0m to 0.4-0.5m</td>
<td>Silty TOPSOIL FILL.</td>
<td>Spade hole and survey data following the earthworks.</td>
</tr>
<tr>
<td>0.4-0.5m to 0.6-2.2m</td>
<td>Controlled Fill: sandy SILT and/or silty SAND with minor to some gravel content.</td>
<td>Observations made during the earthworks.</td>
</tr>
<tr>
<td>0.6-2.2m to 1.0-1.8m</td>
<td>In situ silts and sands.</td>
<td>Refusal depths from neighbouring lot penetrometers.</td>
</tr>
<tr>
<td>1.0-2.2m to &gt;10m</td>
<td>Insitu sandy gravels.</td>
<td>Site wide subdivision testing.</td>
</tr>
</tbody>
</table>

4 Foundation Recommendations

The TC1 foundation design provisions of the MBIE residential guidelines apply to the site – refer to MBIE Section 5, Figure 5.1.

Typically, below the topsoil layer the penetrometer test results generally indicate a geotechnical ultimate bearing capacity >300kPa. Penetrometer P01 falls slightly below the NZS3604 definition of “Good Ground” between 0.5 – 0.7m depth. Compaction or proof rolling within a foundation excavation will increase the bearing resistance. Therefore, we consider standard foundations for dwellings within the scope of NZS 3604:2011 are suitable for Lot 35. Refer to MBIE Section 5.2 Overview of new foundations options.

For a more resilient design the TC2 raft foundations Options 2 – 4 are suitable for the site.

Foundations for dwellings outside the scope of NZS 3604:2011 require specific engineering design.

General foundation design and construction advice is as follows:

1 Foundations should be excavated through the topsoil layer and bear onto competent subgrade material.

2 All turf and topsoil shall be removed to at least 100mm bgl, along with any deeper areas of soft or organic rich topsoil, from beneath the lightly loaded floor slab area. The depth of the topsoil strip shall be confirmed at the time of inspection (as described in Section 5 below) to confirm a satisfactory surface is achieved. The subgrade will then need to be proof-rolled or compacted to achieve a firm uniform surface. The area can then be backfilled by placing and compacting AP40 sandy gravels in maximum 200mm thick loose layers to achieve a minimum dry density of 2150kg/m³ up to the underside of the floor slab.
3 Internal floor slab thickenings and any other pads that are supporting concentrations of weight from roof trusses or columns shall be supported on, or be replaced with, mass concrete filled pads of the same area that are excavated through the topsoil and bear onto competent subgrade material.

4 Reinforcing in floor slabs shall be a minimum of 2.27kg/m² welded reinforcing mesh sheets and the reinforcing is to be Ductility Class E in accordance with NZS 4671.

5 Inspection Requirements

A suitably competent and experienced inspector should validate that the ground conditions exposed in the foundation excavations are consistent with the findings of this report and the foundation design assumptions. Loose material should be removed from excavations. Foundations should bear onto competent subgrade material.

The inspection can be undertaken by Council personnel or a consultant’s engineering personnel.

Please contact us with 48 hours’ notice if you require Eliot Sinclair & Partners to undertake the inspection work. Following a satisfactory inspection, we will provide a ‘Producer Statement - Construction Review’ to validate the exposed ground conditions.

6 Disclaimer

Comments made in this report are based on reporting by others, our earthworks reporting, our soil investigations, and the Ministry of Business Innovation & Employment Guidelines.

Whilst every care was taken during our investigation and interpretation of subsurface conditions, there may well be subsoil strata and features that were not detected. Additionally, on-going seismicity in the general area may lead to deterioration or additional ground movement that could not have been anticipated at time of writing of this report.

The exposure of such conditions, or occurrence of additional strong seismicity, or any future update of MBIE’s guidelines or the NZBC, may require a review of our recommendations. Eliot Sinclair & Partners should be contacted to confirm the validity of this report should this occur.

This report has been prepared for the benefit of Ngāi Tahu Property Ltd (or purchasers of the site from Ngāi Tahu Property Ltd), and the Christchurch City Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party.

Yours sincerely
ELIOT SINCLAIR & PARTNERS LTD

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Encl.

- Site Investigation Records – 1 page.
SITE INVESTIGATION RECORD

Client: Ngāi Tahu Property Ltd
Site: Stage 1, Manakura Neighbourhood, Karamū Subdivision, Riccarton Park

SCALA PENETROMETER TEST RESULTS

<table>
<thead>
<tr>
<th>Water</th>
<th>TC1 Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>0.6</td>
<td></td>
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<tr>
<td>0.8</td>
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<td>2.6</td>
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<tr>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

SOIL PROFILE

Test Location - Lot 35, A

Silty TOPSOIL, with trace gravel; dark brown. Moist; trace rootlets.

FILL: sandy fine to coarse GRAVEL; greyish brown. Gravel, subround to round.

EOH: 0.55m - Target depth.

0.80m: Indicative depth of controlled fill at P01.

0.90m: Indicative depth of controlled fill at P03.

2.00m: Indicative depth of controlled fill at P02 and A.

COMMENTS

Scala penetrometers undertaken by Canterbury Geotest Ltd using a Hydraulic penetrometer rig.

For test locations, refer to Eliot Sinclair & Partners drawing: "Geotechnical Test Locations and Controlled/Engineered Fill Thickness Contour Plan"; Project No. 419748; Set No. G7; Sht No. 1 or 2; Rev. A.
Notes:
1) The Aurecon test locations shown have been sourced from Aurecon New Zealand Limited - Champions Mile Geotechnical Investigation Report, dated 23 September 2016. The coordinates of test locations have not been confirmed or verified by Eliot Sinclair.
2) Lots 6, 7, and 8 have been amalgamated into one lot - Lot 6 under consent variation RMA/2017/2099/A

Legend
- Controlled Fill Thickness
- Spade Hole Location
- Penetrometer Test Location
- Aurecon Borehole Location
- Aurecon CPT Location
- Aurecon Test Pit Location
- NZGD CPT Location

The area shown in grey has not been updated at the time of reporting and for preparation.

Area shown in green has not been updated at the time of reporting and field preparation.

Area shown in purple has not been updated at the time of reporting and field preparation.

Area shown in pink has not been updated at the time of reporting and field preparation.

The area shown in the inset 1:200 scale map is an indicative layout, based on the green block above.

The area shown in the inset 1:500 scale map is an indicative layout, based on the green block above.

The area shown in the inset 1:2000 scale map is an indicative layout, based on the green block above.

The area shown in the inset 1:5000 scale map is an indicative layout, based on the green block above.