24 February 2017 Ref No: J00581

Pokeno Village Holdings Limited
C/- Harrison Grierson Consultants Limited

Attention: Mr J Colbert

Dear Jarrod

RE: Preliminary Geotechnical Appraisal Report for Graham Block, Hitchen Road, Pokeno

1 INTRODUCTION

Lander Geotechnical Consultants Limited have been engaged by Pokeno Village Holdings Limited to undertake a desktop study and preliminary field investigation of geotechnical conditions within a study area depicted by the attached drawings. The study area is known as Graham Block ("the site") which is currently zoned rural. The attached Proposed Zone Plan (as supplied) shows the intended re-zoning to permit future intensification for residential end use.

2 SCOPE AND OBJECTIVES

Our brief principally relates to the preparation of a Preliminary Geotechnical Appraisal Report (PGAR), to support a plan change application per the Proposed Zone Plan drawing.

More specifically, our scope of work for the PGAR comprises:

- A site walkover and summary of the main topographical features present, soil types and underlying geology, areas of obvious historic land modification (e.g. fill), and potential constraints to future urban development
- The results of the Lander Geotechnical preliminary geotechnical field investigation
- Preparation of a PGAR presenting the findings of this preliminary work

In preparing this report, Lander Geotechnical have reviewed the following report:

- Coffey Geotechnics (NZ) Limited, Geotechnical Overview Pokeno Township and Surrounding Area, reference 13533, dated 2 August 2007

Where appropriate, sections of that report have been reiterated herein relating to the overall geological setting of the Pokeno Township and surrounds. In addition, Lander Geotechnical have undertaken detailed studies on the Hitchen Road residential subdivision to the north and east of the site which is currently under construction, and have drawn upon this experience.

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3 SITE SPECIFIC APPRAISAL FOR GRAHAM BLOCK

3.1 Site Description and Geomorphology

The site comprises steeply incised gully systems separated by broad to narrow tributary ridge spurs, leading to the main dividing broad ridge line containing Hitchen Road, in turn flanking most of the northern edge of the site and then bisecting centrally through the site in the North-South fashion. The site is used for grazing, although portions are also a vineyard. There are a few existing dwellings and ancillary buildings.

Geomorphic observations note both shallow and deep seated slope instability features associated with the moderate to steeply sloping ground flanking the various incised gullies (i.e. where slope gradients are generally steeper than 1(v) in 4(h)). They typically manifest as:

- shallow soil creep (i.e. sheep tracks / small terraces)
- isolated shallow slumping and erosional features
- subtle large scale incipient movement zones
- existing deeper seated slope failures

These are shown on the attached Figure 1 and the associated photographs illustrate the typical nature of these features.

3.2 Geology

Figure 2 attached provides an overview of geology within the site. These are described as follows:

3.2.1 Ash, Lapilli and Lithic Tuff

A large proportion of the site is depicted as containing ash, lapilli and lithic tuff deposits of the South Auckland Volcanic Field. Unconsolidated ash, lapilli and lithic tuff are described as soft, sensitive materials, prone to slumping on steep slopes (which is evident in Section 3.1 above).

3.2.2 Alluvium / Colluvium

Figure 2 shows these deposits east of the site, and they comprise sedimentary infill (pumice sands, silts and gravels) of the Taupo Pumice Alluvium. There may also be organic materials. Although not shown on the published geological map, sedimentary infill (e.g. gully mullock) will also be present in the base of the various incised gullies throughout the site, together with colluvium associated with existing landslide features on the flanks of the existing slopes.

3.2.3 Basalt Rock

Basalt rock weathers to fertile clayey/silty soils, while unweathered rock is generally strong and hard. No basalt rock outcrops were observed within the site.

3.3 Preliminary Borehole Findings

A preliminary investigation was undertaken on 15 February 2017. It involved the drilling of 3 hand auger boreholes to depths of up to 3 metres in the positions are shown on attached Figure 1.

- Topsoil was encountered at all borehole locations and ranged between 100mm and 400mm in thickness.
- The natural subsoils investigated by our boreholes predominantly consisted of inorganic orange/brown, and reddish brown clayey silts, silty clays. These are weathered volcanic ashes and tuffs. No Basalt rock was encountered over the depths investigated.
- No filling was detected at our borehole locations although in farm environments the presence of old offal pits or rubbish pits can never be discounted[1].
- Vane shear strengths measured returned readings displaying stiff to very stiff deposits. Sensitivities to disturbance were typically low to moderate.
- Groundwater was not encountered during the time of our investigation.

3.4 Geotechnical Considerations

3.4.1 Foundations for Buildings

Where inorganic natural ground is present, bearing capacity is expected to be in accordance with the limitations imposed by NZS3604 (i.e. 300 kPa geotechnical ultimate). This assumes portions of the land will be modified during subdivision development to ease slope gradients to less than 1(v) in 4(h), thereby minimising the propensity for soil creep, etc. It also assumes development upon (or near) land displaying geomorphic signs of slope instability will be geotechnically investigated and remediated where required to deal with on-going slope stability risks.

- The soils are likely to fall within AS2870 Class H1 expansive site class, and this is subject to laboratory testing of soil samples collected during later more intensive investigations for the Resource Consent phase(s). Foundation design for end users will need to mitigate adverse effects from expansive soils.

3.4.2 Ground Stability

Significant portions of the site are steeply incised by gully features and display signs of shallow seated soil creep, slumping and large scale instability (refer Figure 1 attached for illustration of typical features and preliminary geomorphic mapping). Outside of such areas the land is generally undulating to rolling and shows no obvious geomorphic signs of ground instability.

- Consideration to development setbacks from incised gully flanks and areas displaying signs of slope instability will need to be assessed during detailed geotechnical site investigations of the land for Resource Consent.
- Where adequate setbacks cannot be achieved to mitigate slope instability risks, engineering intervention such as bulk earthworks (e.g. shear keys or buttress fills, and/ or remediation of slip areas), counterfort drains, palisade pile walls (i.e. in-ground retaining) can be designed and employed to mitigate slope instability. As already mentioned, engineering measures will be dependent on the findings of a detailed geotechnical site investigation that is commensurate with the subdivision scheme and earthworks proposals.

[1] Offal pit reportedly encountered in north-western quadrant of 201 Hitchen Road. Refer Coffey Limited, Preliminary Site Investigation (section 2.3.1), Ref No 773-AKLEN202326, dated 03/03/17

3.4.3 Earthworks and Infrastructure

The natural deposits encountered across the site are typically of high strength and have good engineering characteristics for foundations and earthwork handling, as has been experience on previous phases of residential development along Hitchen Road to date.

- The identified materials can be sensitive to disturbance during earthworks and repetitive trafficking from heavy machinery, and this is particularly relevant where works are in gully bases or near such areas (i.e. where the water table is expected to be relatively high, and sedimentary infill soils may prevail). Careful site management, subsoil drainage and drainage blankets / underfill drains have been effective in dealing with these issues at the neighbouring Hitchen Road subdivision under construction. If there are deeper cuts, it is likely to require conditioning prior to placement as filling, since insitu moisture contents will likely be higher than those required for optimum compaction.
- Deep trenches are prone to collapse especially where ground water conditions change rapidly and the materials are less cohesive, but this risk can be minimised by appropriate shoring or battering as required by legislation and safe construction practices.
- Road subgrades are prone to degradation once exposed to the elements, but is normally dealt with by engineering design (e.g. subgrade improvement via undercutting and replacement, or lime stabilising, construction sequencing to reduce subgrade exposure time, etc.).
- High allophane content is associated with the surficial ash derived soils and appropriate earthworks methodologies specific to subsequent subdivisional plans should be recommended to mitigate any problems associated with the placement and compaction of these soils.
- Underfill drainage is usually adopted to control natural groundwater seepages in the various drainage features that may be modified during development. They generally pose no constraints to end use if they are buried deep within engineered fills, or if this is not possible they can be aligned to site boundaries to avoid future building platforms.
- If slip areas are to be remediated during the subdivision, then they may contain weak ground at residual strength and special measures are normally required to minimise localised short term instability during construction (e.g. benching out to reduce destabilising loads and/ or special geotechnical drainage to relieve insitu porewater pressures).

4 CONCLUSIONS

Geotechnical characteristics of the site are no different to the rest of the structure plan area, details of which are discussed in detail in Coffey's (2007) geotechnical overview report. In summary, the site comprises topography and ground conditions that is steep in places and shows evidence of slope instability. However, Hitchen Road has seen significant land modifications to the north and east of this site to date, and provided there is consideration to prevailing or perceived geotechnical issues during detailed site investigations for Resource Consent, then the study area as defined herein is considered suitable for re-zoning to future urban use generally in accordance with the Proposed Zone Plan.

5 RECOMMENDATIONS

The assessments presented in this report are based on a desktop review and preliminary visual inspections, plus a limited number of shallow borehole tests on the prevailing landform.

It is recommended that:

- To support future development (i.e. Resource Consent / Subdivision design), further physical geotechnical site investigations that are commensurate with subdivision and earthworks scheme(s) should be undertaken to substantiate ground conditions and address any geotechnical constraints. Such investigations are expected to comprise (but are not limited to) detailed geomorphic mapping, hand auger boreholes, trial pits, rotary cored machine boreholes and soil sampling.
- Appropriate laboratory soil testing is undertaken to characterise engineering and earthworks handling properties, compressibility, permeability and susceptibility to erosion or dispersion. In addition, effective stress tri-axial testing may be warranted to support design assumptions for slope stability analyses and/ or any engineering remediation design that may result.

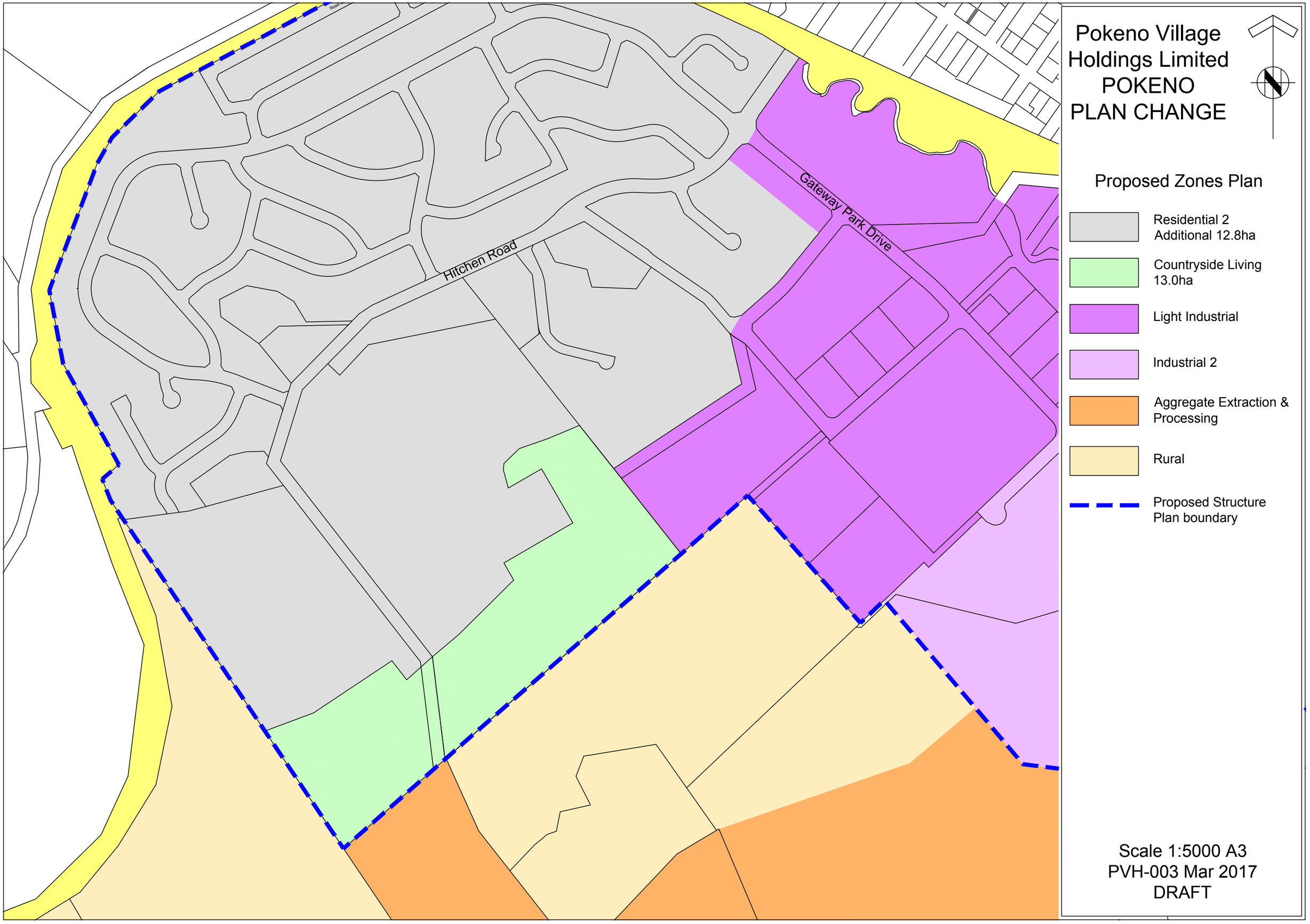
6 LIMITATIONS

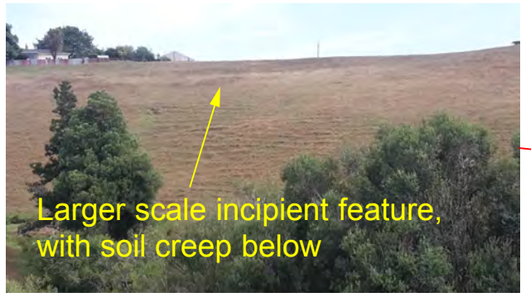
This report has been prepared solely for the use of our client, Pokeno Village Holdings Limited, its professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

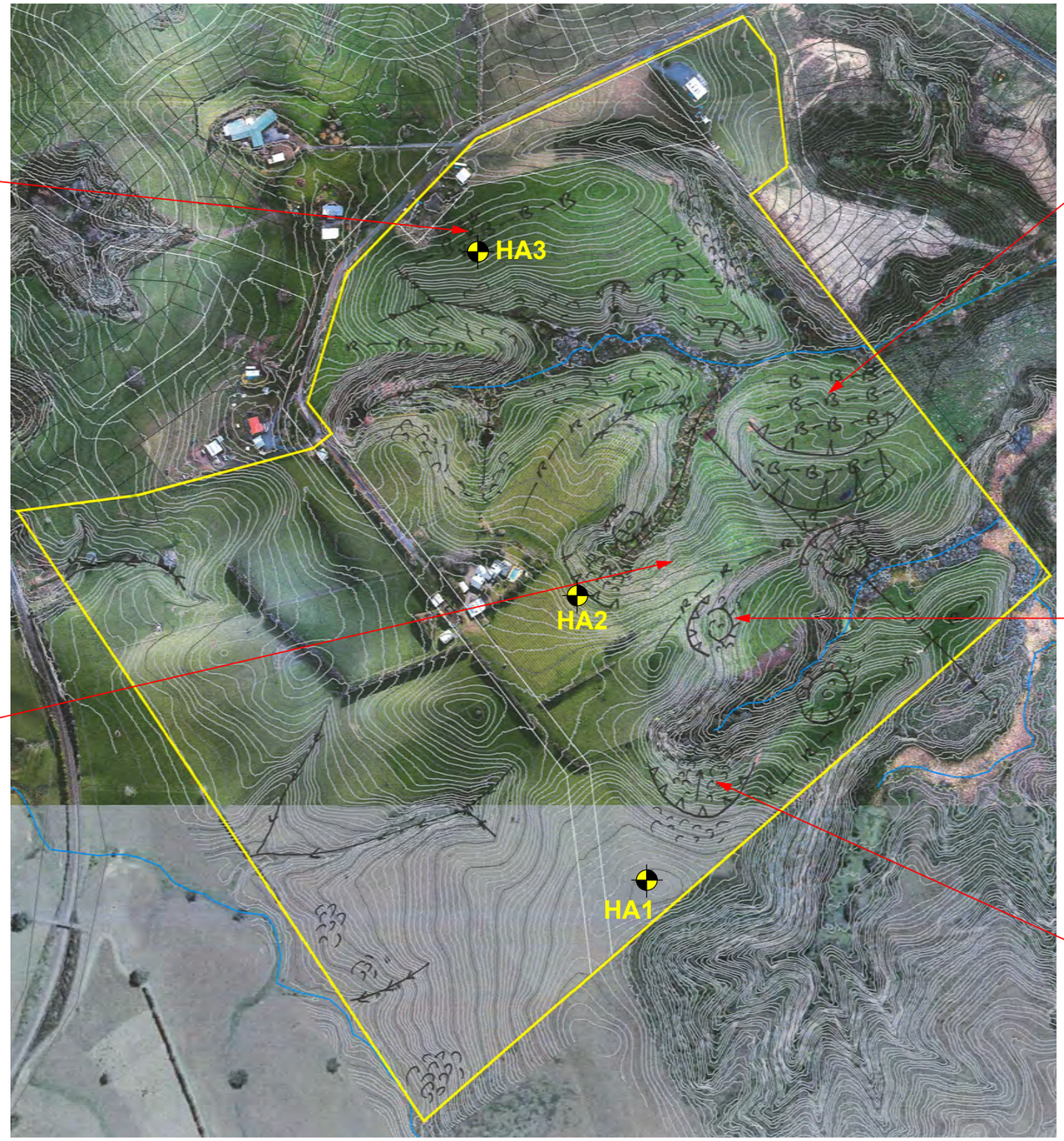
For and on behalf of Lander Geotechnical Consultants Limited

S.G. Lander
Principal Geotechnical Engineer
MIPENZ, CPEng., Int.PE(NZ)

Attachments: Proposed Zone Plan (draft)
Figure 1 – Geomorphology Overview
Figure 2 – Geology Overview
Hand Auger Borehole Records


Pokeno Village Holdings Limited
POKENO
PLAN CHANGE
Proposed Zones Plan
Residential 2 Additional 12.8ha
Countryside Living 13.0ha
Light Industrial
Industrial 2
Aggregate Extraction & Processing
Rural
Proposed Structure Plan boundary
Scale 1:5000 A3
PVH-003 Mar 2017
DRAFT
Hitchen Road
Gateway Park Drive





B–B–B Mid-slope bench (generated by slope movement)

Major scarp : head of slide or flow (teeth pointing downslope)

Hummocky, irregular, undulating ground

Slope mound indicating a debris slide (developed from a former block slide)

Swampy ground, surface ponding

Hand Auger Borehole

BASE DRAWING SOURCE: DFH JOINT VENTURE LIMITED (C/- RUSSELL PARKINSON)

revision	description	drawn	approved	date
	PRELIMINARY			

drawn	SL
approved	sl
date	24/02/17
scale	N.T.S.
original size	A3

LANDER geotechnical

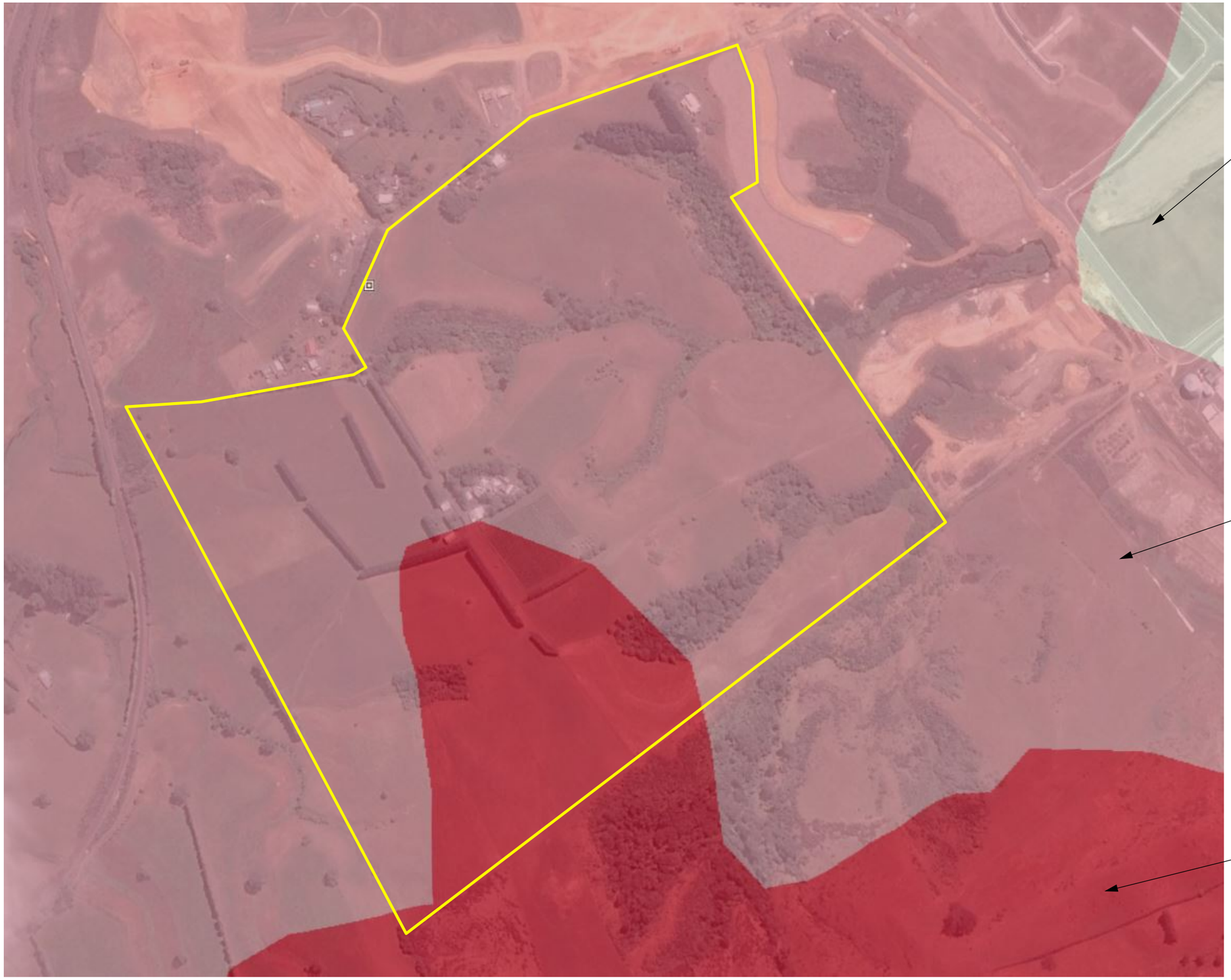
client: DFH JOINT VENTURE LIMITED

project: GRAHAM BLOCK, HITCHEN ROAD, POKENO

title: GEOMORPHOLOGY OVERVIEW

project no: J00581 figure no: 01

Template revision: 1:1000 (10/12/14)



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NZL_GNS_250K_geological_units_scale500k

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- **group_equi:** Tauranga Group
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- **abs_max:** 0.014
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- **abs_max:** 1.59
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- **qmap_name:** Auckland

BASE DRAWING SOURCE: GOOGLE EARTH WITH QMAPS GEOLOGY OVERLAY

revision	description	drawn	approved	date

drawn	SL
approved	sl
date	24/02/17
scale	N.T.S.
original size	A3

LANDER geotechnical

client: **DFH JOINT VENTURE LIMITED**

project: **GRAHAM BLOCK, HITCHEN ROAD, POKENO**

title: **GEOLOGY OVERVIEW**

project no: **J00581** figure no: **02**

Template revision: 1:1000 (10/12/14)

Client :	DFH JOINT VENTURE LIMITED	**Auger Borehole No.**	HA01
Project Location :	GRAHAM BLOCK, HITCHEN ROAD, POKENO	Sheet	1 of 3
Job Number:	J00581	Vane Head: 1900 / Logged By: GB / Processor : GB	Date: 15.02.17

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
slightly clayey SILT, orange/ brown. Very stiff, dry, no plasticity, moderately sensitive						
becoming clayey SILT, no to low plasticity		0.5		133/ 36	3.7	
silty CLAY, orange and light grey mottled brown. Very stiff, moist, medium plasticity, insensitive						
at 0.9m, becoming orange streaked light grey, medium to high plasticity, with some limonite staining		1.0		123/ 86	1.4	
at 1.1m, becoming high plasticity, with some dark orange limonite silt inclusions						
becoming dark orange mottled light grey, with major dark orange limonite silt inclusions						
becoming moderately sensitive		1.5		110/ 49	2.2	
becoming light grey mottled orange/ brown, with some dark orange limonite silt inclusions						
becoming insensitive		2.0		108/ 59	1.8	
becoming light grey streaked brown/ red						
becoming moderately sensitive		2.5		116/ 56	2.1	
becoming brown/ red						
clayey SILT, pink streaked brown/ red. Very stiff, moist, medium to low plasticity, insensitive						
EOB at 3.0m. Target Depth.		3.0		128/ 98	1.3	
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic
Fill	Gravel	Siltstone	No Core
Clay	Organic	Limestone	
Silt	Pumice	Volcanic	

Client :	DFH JOINT VENTURE LIMITED	**Auger Borehole No.**	HA02
Project Location :	GRAHAM BLOCK, HITCHEN ROAD, POKENO		Sheet 2 of 3
Job Number:	J00581	Vane Head: 1900 / Logged By: GB / Processor : GB	Date: 15.02.17

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
SILT, dark brown/ orange. Medium dense, dry, no plasticity		0.5		208+		
slightly clayey SILT, orange/ brown. Very stiff, moist, no plasticity, moderately sensitive, with minor black fine gravel sized clasts						
becoming clayey SILT, low plasticity, without black clasts		1.0		148/ 49	3.0	
becoming grey mottled orange/ brown, with some dark orange limonite silt inclusions		1.5		193/101	1.9	
at 1.5m, becoming insensitive						
becoming mottled pink, orange/ brown and light grey, medium plasticity						
becoming stiff, moderately sensitive		2.0		99/ 46	2.2	
silty CLAY, grey specked red/ brown. Very stiff, moist, medium plasticity, insensitive		2.5		101/ 85	1.2	
EOB at 3.0m. Target Depth.		3.0		116/102	1.1	
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil		Sand		Sandstone		Plutonic	
Fill		Gravel		Siltstone		No Core	
Clay		Organic		Limestone			
Silt		Pumice		Volcanic			

Client :	DFH JOINT VENTURE LIMITED	**Auger Borehole No.**	HA03
Project Location :	GRAHAM BLOCK, HITCHEN ROAD, POKENO		Sheet 3 of 3
Job Number:	J00581	Vane Head: 1900 / Logged By: GB / Processor : GB	Date: 15.02.17

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, orange mottled brown. Very stiff, dry, medium plasticity, sensitive		0.5		126/ 28	4.5	
becoming orange/ brown mottled grey, moist, high plasticity, with some red/ orange limonite silt inclusions						
becoming insensitive		1.0		101/ 74	1.4	
becoming red/ orange mottled light grey, medium plasticity						
		1.5		105/ 68	1.5	
becoming streaked light grey and red/ brown, stiff						
becoming red/ brown		2.0		80/ 60	1.2	
becoming very stiff		2.5		111/ 92	1.2	
clayey SILT, brown. Very stiff, moist, low to medium plasticity, moderately sensitive, with minor fine gravel sized silt clasts		3.0		148/ 42	3.5	
EOB at 3.0m. Target Depth.		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic
Fill	Gravel	Siltstone	No Core
Clay	Organic	Limestone	
Silt	Pumice	Volcanic	